NAVIGATING THROUGH TECHNOLOGY

TECHNOLOGY AND THE DUTCH EAST INDIA COMPANY
VOC IN THE EIGHTEENTH CENTURY

JOHAN DE JONG

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Technology and the Dutch East India Company VOC in the eighteenth century

Johan de Jong

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PROEFSCHRIFT

ter verkrijging van
de graad van doctor aan de Universiteit Twente,
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Johannes Dirk de Jong
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te Sneek

Dit proefschrift is goedgekeurd door de promotor :
Prof. dr. L.L. Roberts

“De Ervarenheid heeft my geleerd, dat de wetenschappen niet ons, maar wy de wetenschappen moeten zoeken”

Gerard de Lairese “Groot Schilderboek” (1707/1712), p. 1

VOOR LIDY

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PREFACE

"NAVIGATING..."

"Navigating" is the first word in the title of this dissertation. It points to the fact that the ships of the Dutch East India Company VOC (and the company as such) were dependent on different technologies for their journeys between the Dutch Republic and Asia and for the journeys within Asia. It also refers to the often complicated way in which the VOC engaged with technologies, concerning their introduction, use, development, improvement and rejection. As we will see in this book, finding a way through technology may have been just as complicated as finding a way across the oceans as safely and healthy as possible.

On a personal level, the word "navigating" brings a number of different images and experiences to my mind. Of regatta sailing in a small dinghy on inland lakes or sometimes at sea. Of climbing up and down pathless mountains in Scotland, sometimes in mist or drizzle and almost always on my own, with just a map and a compass to find the summit and a safe way down again. Of standing on the bridge of a small ship in the pack ice off Spitsbergen and hearing the captain say to his first mate about the course the ship should follow: "Don't interfere, just let her find her own way". Of treading my way through the philosophy and history of science, technology and society at the University of Twente, at home, in archives or wherever. Although these experiences are thousands of miles and several decades apart, they have one important aspect in common: what it means to navigate through space and time. This dissertation covers the whole of the eighteenth century and it took me more than five years to complete. My involvement with regatta sailing lasted for about fifteen years. Climbing all major mountains and hills in Scotland and walking along their ridges has taken me two decades to complete, and there are still many more hills and mountains to explore. It took the ship near Spitsbergen two hours to reach open water. And finally, my route through the philosophy and history of science, technology and society has taken me more than thirteen years and it may never really come to an end. Different as these experiences may be, they provide a personal connection with the subject of this dissertation, inspiring and assisting me during the long process of research and writing. This sounds rather obvious for my route through the philosophy and history of science, technology and society, but – in sometimes unexpected ways – it is also valid for my regatta sailing, my climbing in Scotland, and the voyage on the ship around Spitsbergen.

When I took part in sailing regattas I experienced what it means to have to cope with wind (or the lack of it), waves and currents and how it feels when you are at the mercy of these elements. It makes it possible for me to

sympathize with the sailors of more than two centuries ago who experienced the forces of nature in a much more intense (and sometimes life threatening) way. Finding the optimal route during a regatta could be complicated (even with the help of a sketchy chart and a compass), but it was nothing compared to finding a route across the oceans in the eighteenth century, even with the help of charts, compasses, heavenly bodies and years of experience in reading wind, currents and waves. And whereas a regatta would be called off when the circumstances became too risky, such an escape was not available to the sailors that we will come across in this dissertation. Route finding on a much more intense level occurred when I climbed mountains in Scotland. First of all, connecting map and compass with the physical terrain I walked through could be challenging even without mist or drizzle descending upon me. Moreover, once on my own in the mountains there was often no easy escape when the weather took a turn for the worse. That increased the importance of reading the weather beforehand and of relating chart and compass to the physical environment either on the way to the summit or down again, while avoiding dangerous cliffs and precipices. In that sense, climbing mountains might even have come closer to sailing across oceans than regatta sailing in coastal waters could. And – be it now or in the eighteenth century – one has to rely completely on the ship on which one sails, and on the navigational tools available. The Spitsbergen experience showed me the intense relation that a skipper has with the ship he commands; by referring to “her” it becomes clear that he experiences his ship not just as an artefact but as a living creature that seems to know what she is doing and which is not always in need of human interference.

These personal experiences were with me when I navigated my way through the research for and the writing of this dissertation. The seeds for its subject were sown when (sometime in 2007) Lissa Roberts suggested to me that “developments in eighteenth century Dutch ship design and shipbuilding” might be a suitable topic for my master’s thesis. That thesis (defended in 2010) about “standardization and innovation in design and production of the VOC *retourschip* during the eighteenth century” then led to a suggestion by Lissa to continue and widen my research as a PhD project. As I liked the topic of eighteenth century technological developments in connection with the VOC, enjoyed doing archival research and the process of writing, and had been able to take early retirement by then, there was nothing to stop me from doing so. That is to say, as long as my partner Lidy and I could take a break every now and again for going on short or on very long holidays, some of which (those to Australia and New Zealand) even provided links with the VOC. Examples of these are the Houtman Abrolhos islands off the coast of Western Australia where the *Batavia* was wrecked, the museum in Geraldton that contains a gateway for Batavia that was carried as ballast by the *Batavia*, the museum in

Freemantle that has part of the original hull of the *Batavia*, the island of Tasmania, which was “discovered” by Abel Tasman and Golden Bay (on the north-west coast of South Island of New Zealand) where Abel Tasman later anchored his ships. These experiences brought vividly to life the huge distance the great number of ships of the VOC travelled on a very regular basis.

Interspersed with our holidays, it has taken me six years as an external PhD candidate to complete my dissertation. That could have been a lonely job had it not been for the company, the camaraderie and the critical support of the people at STePS. First of all Lissa whose incisive questions, critical comments and sometimes even praise have contributed a great deal to the fact that I kept on course when I might have wandered off. Then there is Adri, whose wise advice helped me to get out of the doldrums on a few occasions. It was great that I could share a room with Tjerk, Ivo, Andreas and Joppe for a time, which was also very convenient when one had mislaid one’s coffee card. Thanks to Fokko Jan who introduced me (way back in 2003) to the master *Wijsbegeerte van Wetenschap, Techniek en Samenleving* and who has been asking critical questions ever since. I shouldn’t forget Ellen, Peter, Haico, Nelly, Rob, Stefan, Arie and Gonzalo who all by commenting on my presentations at the STePS Research Days made me realize that I should and could make my point more clearly. Evelien, Hilde and Marjetta have been marvellous in helping me with all sorts of practicalities, keeping an eye on my back-up disk during holidays and especially in navigating me through the intricacies of the unavoidable bureaucracy involved in being an external PhD candidate. I enjoyed the company of Carla, Alejandro and Junwen, fellow PhD candidates from abroad, who I not only met at floor 4 of Ravelijn but also at the fabulous STePS summer parties in Gronau.

When it came to finding primary or secondary sources for my research several institutions and people have been of great help. The librarians of the University of Twente coped very friendly and efficiently with my requests for books that sometimes hadn’t been lent out for years, and they managed to find even more obscure books and articles from elsewhere, be it in the Netherlands or abroad. The staff at the National Archives in The Hague and the Zeeuws Archief at Middelburg couldn’t have been more helpful in unearthing material and allowing me to view otherwise inaccessible files. Staff at the *Bijzondere Collecties* of the library of the University of Amsterdam and of the *Special Collections* of the library of the University of Leiden provided access to some rare printed or written material dating back to the eighteenth century. Very special thanks are due to prof. em. dr. J.M. Bruijn who entrusted me with possibly the only existing copy of the master’s thesis by B. Loeve. The way in which we eventually met at the railway station of Leiden could easily have been part of an espionage thriller.

More than three centuries ago the painter Gerard de Lairese wrote

“Wie tot eedele Konsten en verheevene weetenschappen zich wil begeeven, moet zich eenen moeyelyken arbeid getroosten: en nimmer verdrietig zijn, om dat het einde 't welk hy hem voorsteld, niet aanstonds aan hem openbaar werd, en zijne verwachting voldoet: Het gelukt zelf den allergrootste Meesteren niet, dat zy, met altoos eeven groote schreeden hun gewenste doel naderen”
(Gerard de Lairese “Groot Schilderboek” (1707/1712), p. 1)

I couldn't possibly have finished my – sometimes - difficult task (“*moeyelyken arbeid*”) and achieved my desired goal (“*gewenste doel*”) without the unfailing support, constant encouragement and enduring love of Lidy to whom I dedicate this book.

INTRODUCTION

INTRODUCTION

The *Vereenigde Oostindische Compagnie VOC* (Dutch East India Company VOC) could not have existed for almost two centuries, had it not been for the technologies that were developed, introduced, used, improved and rejected for its wide spectrum of shipping activities. However, instead of such technologies being readily available, the VOC, its directors, its skippers and its crews had to navigate their way through emerging and disappearing technologies, sometimes in the face of a hostile and dangerous environment. Such a “hostile and dangerous environment” not only refers to oceans, shallows, hurricanes, uncharted islands and many more aspects of the natural world but it also points to matters of sickness and health, to hostility displayed by skippers and crews towards technologies forced upon them, to the dangers of disgruntled crews, and to the tensions that existed between the different groups that governed the VOC in the Republic and in Asia. Technologies connected, divided and mediated between ship design and shipbuilding, between health, sickness and death, between directors and users, between ships, oceans and hidden dangers, and between typhoons and profitable trade. The development, introduction, use, improvement and rejection of these technologies had to be (re)negotiated over and over again. The outcome of these negotiations depended in no small measure on the humans and non-humans involved in the hybrid networks of which the ships as such were also a part, on the scale of a whole fleet and on the level of individual ships.

2

In this dissertation I consider a number of technologies that were (for a longer or shorter period of time) part of the network of the VOC during the eighteenth century. These technologies were connected with ship design and shipbuilding (as we will see in the first chapter and again in the third chapter), with technologies for health such as machines for distilling drinking water out of seawater, ventilators for providing fresh air on board and procedures to combat diseases (these are the subject of the second chapter) and with navigational technologies like charts, sailing instructions and position-finding at sea which we will come across in the fourth chapter. They all had an impact (positive or negative) on the fortunes of the company and of its employees. My intention is to get an insight in the reasons behind the “success” or “failure” of these technologies. The use of quotation marks in the preceding sentence is meant to point to the fact that the success or the failure of a technology is never a foregone conclusion which is inherent to the technology itself; it is always dependent on the outcome of negotiations that can be reopened. Although the decisions to engage (or not) with these technologies were taken by the directors and/or employees of the VOC, some of these technologies were also suggested, supported or promoted by societies that became

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established in the Dutch Republic and in the East Indies during the second half of the eighteenth century.

Much has been written about political, economic, organizational and (proto)-colonial issues concerning the VOC, whereby the company has been characterized in different ways such as being the first multinational, as the first company to issue shares, as the largest trading and shipping company of the seventeenth and eighteenth century, as an early example of a public/private enterprise and as a state within the state of the Dutch Republic of the 17th and 18th century.¹ The investigation into the rather complicated engagement of the VOC with technology forms the core of this dissertation. Although I will touch on political issues, economic considerations and organizational problems, the main focus will be on the relation between *technology* and the *VOC* during the (long) *eighteenth century*, a relation that was from time to time decisively influenced by publications that originated in a number of societies that became established in the Republic during the second half of that century.

The VOC

Towards the end of the sixteenth century, Dutch merchants started exploring shipping routes to Asia in an attempt to bypass the Iberian monopoly on spice-trading, as Pieter van Dam wrote in the opening sentence of the *Beschryvinge van de Oostindische Compagnie* (1701),

Indien Philippus de Tweede, koninck van Spangien, by oogluuckinge hadde kunnen aansien en blyven gedogen de vaart en handel van de ingesetenen deser landen op Spangien en Portugael, het is zeer waarschynelyk, dat men noyt sonde hebben getragt deselve verder uyt te breyden, gelijk men dat in die tyden, uyt die insighten, heeft beginnen te doen, selfs tot in Oost-Indiën toe. (transl.: If Philip II, king of Spain, could have feigned ignorance and had condoned the navigating to and trade of these lands with Spain and Portugal, then one would very likely never have tried to expand these in the way as happened from then on, based on the insights of the time, even as far as the East Indies)²

This sentence, written a century after the VOC had been established, almost sounds like an apology; the “what if...” implied by this sentence suggests that - had it not been for the policies of king Philip II of Spain (1527-1598) during

¹ On the subject of “multinational” Lucassen (2004), 12; “shares” Bruijn e.a. (1979-1987) Part 1, pp. 8 -11, Gaastra (2001/2007), pp. 21-29; “largest company” Nijman (1994), p. 211, Lucassen (2004), p. 12; “public/private” Bruijn e.a. (1979-1987) Part 1, pp. 7 & 14; “state within state” Bruijn e.a. (1979-1987) Part 1, pp. 6-7; Gaastra (2001/2007), pp. 21-23, Lucassen (2004), p. 13

² Dam, van (1701/1927), DI 1.1, p. 1

Fig. 0.1 Model of the *retourschip* *Mercurius* (by an anonymous maker, 1747)
 This model was displayed as a showmodel at the East India House in Middelburg (Zeeland). It is a typical Zeeland *retourschip* of the 18th century. Considering the year it was made, it is presumably of the standard post-1742 design. Although name and year are mentioned, in the VOC archives no *Mercurius* is known as belonging to the Zeeland chamber at that time. (Rijksmuseum Amsterdam NG-MC-652)

the “Eighty Years War” (the war for independence that led to the Republic of the Seven United Provinces) - the VOC might never have existed. Pieter van Dam would not have written the voluminous tomes in which he described the first century of the company; the people living in the East Indies would have continued to be confronted by the Portuguese instead of by the Dutch³ and hundreds of books that have been devoted to different aspects of the VOC

³ And to a lesser extent the Spanish who conquered the Philippines during the sixteenth century, naming it after their crown prince at time, the later king Philip II against whom the Dutch war of independence took place.

would not have been written and neither would this dissertation. In that respect I can count myself lucky, although (as will become clear from the next chapters) thousands of people employed by the VOC suffered terribly on the voyages they made on the ships of the company or while serving in the East Indies; not to mention the suffering endured by local people in the East Indies who were – often brutally - subjected to VOC’s relentless quest for profit during the two centuries that it tried to control larger or smaller parts of those countries that are now known as Bangladesh, Indonesia, Iran, India, Malaysia, Taiwan, Sri Lanka and South Africa. Probably the only sites where the VOC was not in a position to command local people were the quite de-centrally situated factories at Dejima in Japan and at Canton in China. As we will notice in chapter 3 and 4, the factory in Canton played a part in discussions about an “improved” ship design and in trying to solve problems regarding the charts of the VOC.

Whereas finding a route to the East Indies via the north of Europe failed, a successful expedition following the Portuguese route took place between 1595 and 1597.⁴ The States-General (the federal governing body of the fledgling *Republiek der Zeven Verenigde Nederlanden*) supported this expedition, and the link between government and private enterprise became a recurring theme in the history of Dutch-Asiatic trading. After this *Eerste Scheepvaart* (First Shipping) competing merchants from different provinces of the Republic fitted out more or less successful expeditions of their own, with the result that they were not only trying to break a foreign monopoly, but were also competing against one another. Through intervention by the governments of some provinces (the States of Holland and the States of Zeeland) as well as by the federal government (the States-General), the *raadspensionaris* (pensionary of the States General) Johan van Oldebarneveltdt and the *stadhouder* (stadholder) Maurits, an agreement was reached on March 20, 1602, which marks the beginning of the VOC.⁵ This agreement merged six local companies into one large company, but the original companies (or chambers) remained as semi-independent entities; the conglomerate formed the VOC. A central board, consisting of seventeen gentlemen (called the

⁴ For a more extensive overview of the early history of the VOC see Bruijn e.a. (1979-1987) Part 1, chapter 1 and Gaastra (2001/2007), hoofdstuk 1

⁵ Oldebarneveltdt’s position at the time may be compared with that of a present-day prime minister. He might not have been quite impartial, because his brother, his banker and many of his friends from Rotterdam had interests in the East Indian trade (Grimm (1994), p. 10). The title *stadhouder* referred to the fact that the holder of that office had originally been the representative of the (Habsburg) king of Spain who ruled the Seven Provinces before the war of independence. The stadholder was usually the commander of the army and the navy, it was a more or less hereditary post, which was sometimes not taken up for years but then revived in times of war.

Fig. 0.2 Map of the East Indies, showing most of the official trade zone (*octrooigebied*) of the VOC according to the VOC Charter, which was between Cape of Good Hope (South Africa) and Street Magallan (South America). This map was printed c. 1700, at the time when Pieter van Dam wrote his *Beschryvinge*.

(https://commons.wikimedia.org/wiki/File:VOC_Octrooigebied_1.jpg)

Heeren XVII) governed the VOC as a whole. The States-General granted the VOC an *octrooi* (monopoly) for all shipping east of the Cape of Good Hope and through the Straits of Magellan. This *octrooi* had to be renewed on a regular basis, for which a handsome fee was to be paid. One can therefore argue that the VOC was an early example of a private-public enterprise. Concerning the raising of capital, the VOC relied on private investors, usually merchants from the cities in which the chambers had their domicile. Its public character was shown by the fact that the VOC was given power by the States-General to act as a state in Asia, which meant that it was allowed to enter into treaties with local rulers and states, to build fortifications, to employ an army, to wage war, and to rule its territories. On the other hand, high-ranking officials had to swear allegiance to the States-General and upon return of the fleet, reports had to be presented to a committee of the States-General. Apart from having close relations with the States-General, the VOC also had a special relationship with the stadholder.

This relationship emerged already in 1602 when stadholder Maurits intervened in the negotiations, which laid the foundation of the VOC. In 1674, the VOC decided that the stadholder should receive three percent of all dividends. In the eighteenth century, the stadholder could act as chairman of meetings of the *Heeren XVII* and of board meetings of the chambers, and he was given the right to appoint directors.⁶ The VOC existed until the end of the eighteenth century, reaching the height of its trading, shipping and shipbuilding operations in the middle of that century. Its demise was a long drawn out affair between 1795 and 1800. By that time the original confederal Republic had been replaced by the more centralized *Bataafsche Republiek* (Batavian Republic) after the French had invaded the Republic by the end of 1794 and had assisted with overthrowing the “*ancien regime*”. As we saw, the organization of the VOC reflected its beginnings, in that it was based on the six chambers (Amsterdam, Delft, Enkhuizen, Hoorn, Rotterdam and Zeeland) of which Amsterdam was by far the most important. Activities such as the building and equipping of ships and the sale of goods were determined roughly according to the amount of money that had originally been invested in the company: Amsterdam was responsible for one-half, Zeeland for a quarter and the remaining chambers for one-sixteenth each. Each chamber had its own number of directors, Amsterdam twenty, Zeeland twelve and the smaller chambers seven each. These directors decided two or three times a year who would represent them in the meeting of the *Heeren XVII*, which means that being a member of the *Heeren XVII* was – in principle – not a permanent post. One could argue that the organisational structure of the VOC mirrored the structure of the Republic, which was a conglomerate of seven semi-independent provinces. The number of seats in the central board also reflected the relative importance of the chambers: Amsterdam appointed eight representatives to the board, Zeeland four and the remaining chambers each one. To prevent Amsterdam from being able to obtain total control a seventeenth representative was appointed in turn by either Zeeland or one of the smaller chambers. The *Heeren XVII* convened for a few weeks three times each year, during six consecutive years in Amsterdam and for the next two years in Middelburg (the capital town of Zeeland). The most important meeting of the *Heeren XVII* took place in September, after the return of the fleet from Asia. In this meeting, the number of ships to be dispatched for the next season (from September of the next year until June of the year thereafter) had to be decided upon, the (provisional) amount of gold and silver to be shipped out had to be decided, as well as (provisionally) which goods and how much of these had to be brought back from Asia. Finally, the auction of the imported goods had to be organized. The next official meeting of the *Heeren*

⁶ Bruijn e.a. (1979-1987) Part 1, p. 14

XVII took place in February/March, when the past auctions were discussed and the spring auction was organized. The definitive amount of goods to be brought back and the corresponding amount of gold and silver was decided upon. A decision was taken on the dividend that should be paid out as well as on the dates at which the *Haags Besogne* should meet (a committee of the *Heeren XVII* that convened at The Hague, the seat of the federal government). Any results of this committee were discussed at the summer meeting of the *Heeren XVII* and a provisional decision was taken about the number of ships that should sail in late autumn. From the middle of the eighteenth century onwards, this meeting was scrapped and responsibilities for any decisions that should be taken moved to the *Haags Besogne*.

The six chambers had to put the decisions by the *Heeren XVII* into effect, each chamber according to its share. The directors of the larger chambers met several times a week, and within these chambers, committees (or departments) were set up. In Amsterdam, they consisted of an *equipage*-department (equipment department), responsible for the building, repairing and fitting out of ships and for supplying the ships with crews; a warehouse-department, which administered the merchandize; a reception-department, which was responsible for all financial affairs between the chamber and Asia, and finally the audit-department, which oversaw the accounts and controlled the cash office. Zeeland had a similar arrangement, although the two financial committees were combined. Not much is known about the smaller chambers because the resolution books of these chambers have not survived. The six chambers of the VOC each employed a large workforce, not only at their shipyards, but also as bookkeepers, clerks and other administrative workers, the greatest number of course being in the employment of the chamber Amsterdam. As far as shipbuilding was concerned, the individual chambers had to make sure that the numbers of ships, allocated to their chamber, were available for the outward fleets; this meant either repairing existing ships or building new ships on their own shipyards. As we will see later, the chambers were increasingly restricted in the design and dimensions of the ships they had to build. The tension between the (semi-)independence of each chamber and the organizational, commercial and technological operations it had to carry out on the one hand and on the other hand the increasingly centralized way in which the VOC was run will become clear in this dissertation. These tensions also had an impact on the technologies (and vice versa) that form the core subject of this dissertation.

When reflecting on technology in general, three characteristics can be distinguished: “artefacts and technical systems, knowledge about these and the practices of handling these artefacts and systems”. These characteristics seem to describe quite accurately what was the case within the VOC as a whole and also on the more detailed level of individual ships. This suggests

that using the term “technology” is not inappropriate or anachronistic when applied in an eighteenth century context. When he considered the question “What is technology?” the philosopher of technology Thomas Misa suggested four possible answers. The first of these is the interpretation of technology as a type of knowledge, the second answer consists in giving empirical examples, the third answer means formulating a definition (such as “a systematic, purposeful manipulation of the material world”) and the final answer concentrates on the relationship between the material world and the human world. This last characteristic is especially apposite in the case of the eighteenth century technologies of the VOC; it will form an important part of the analysis in the main body of this dissertation.

When trying to find a definition for technology, appropriate in the case of the VOC and its *retourschepen*, I paraphrase one that was originally suggested by the sociologist of technology John Law:

“For the VOC, technology was a continually evolving knowledgeably informed method for the construction of a relatively stable system (known as retourschip) of related bits and pieces (and of these bits and pieces as such) with emergent properties in a hostile or indifferent environment”.

I have explicitly added the “bits and pieces” because (although related to or constituent elements of the *retourschip*) they were often also technologically endowed elements on their own. Examples of these bits and pieces are the seawater distillation machine and the mechanical ventilator that we will come across.

Before discussing the technologies in more detail, I first look into historiographical and methodological issues. I consider my sources and the historiographical approach that I used to uncover the technologies of the VOC. In that section I also mention how my research has made some hitherto unknown sources accessible. In the section thereafter, I explain how my interpretation of what the sources revealed is informed by approaches offered by Science & Technology Studies (STS). I describe these approaches in some detail, succinctly pointing out how these approaches find their place in the different chapters. Until now, relatively little has been published about the connection between the VOC and its technology and even less so by historians of technology using perspectives, principles and methods developed in the field of Science and Technology Studies.⁷ My research has generated some

⁷ A number of books that are (at least partly) concerned with technological subjects in relation to the VOC are: (on ship design, ship building and technical drawings) Bruijn e.a. (1979-1987), Gawronski (1996), Hoving & Lemmens (2001), Hoving & Parthesius (1991), Jong, de (2010), Loeve (2001); (on health issues) Bruijn (2009), Leuftink (1991/2008),

new insights, confirmed existing points of view or questioned some of those. Therefore, I consider it important to add this dissertation to the many books that have already been devoted to the VOC. After a section on sources and my historiographical approach and a section on the methodology that I have used, I show how my research can be situated within the wider body of work that has been devoted to the VOC and how it may enrich it.

Finally, I give an overview of the four chapters of this dissertation. There I consider in some detail the four technologies that are discussed in this dissertation as having sailed through the VOC during the eighteenth century (or alternatively that the VOC had to navigate its way through). The succession of these technologies illustrates what I consider to have been the evolving relation between the VOC and its technology. When discussing these relations, the role that STS approaches played (and which approach in particular) will become more explicit, as will the position my research assumes in the wider body of research on the VOC.

Sources and historiography

To get to grips with (contested) technologies of the VOC, I interrogated contemporary primary sources to uncover these technologies and to reconstruct what had been going on regarding their introduction, acceptance, rejection, abolishment or continued use. For the greatest part this involved studying primary archival material from the (late) seventeenth and the eighteenth century at the *Nationaal Archief* (the National Archives) in The Hague and (to a lesser extent) at the *Zeeuwsch Archief* (the Zeeland Archives) in Middelburg. Material from the VOC archives at *Arsip Nasional Republik Indonesia* (the National Archives of the Republic of Indonesia) in Jakarta is available as scans; the “Resolutions of the Council of Policy of Cape of Good Hope” are in edited form available from the Cape Town Archives Repository in South Africa.⁸ I consulted a number of eighteenth century manuscripts, books

Schoute (1929) & (1937); (on navigational techniques and instruments) Davids (1986), Jonkers (2003), Mörzer Bruyns (2003); (on charts) , Meer, de (2007), Mil, van & Scharloo (eds.) (1988), Paesie (2010B) and Zandvliet (1998), Some articles related (either partially or completely) to technology and the VOC are: (on ship design, ship building and technical drawings) Kist (1985), Kist (1992); (on health issues) Haarhoff (2009), Roessingh (1967) and 1970; (on navigational techniques and instruments) Davids (1990). Jonkers (1996A.) and (1996B), Mörzer Bruyns (1985), (1988) and (1992)); (on charts) Paesie (2010A) and Schilder (1976) & (1988). In his dissertation “Zeewezen en Wetenschap”(1986), Davids explicitly referred to the philosophers of science Kuhn and Feyerabend and to the sociologists of science Barnes and Bloor when he discussed the character of science.

⁸ The VOC sources at the Indonesian archives at Jakarta can be approached through <https://sejarah-nusantara.anri.go.id/>; those at the South African archives in Cape Town through <http://databases.tanap.net/cgh/>

and atlases at the Special Collections of the University of Leiden library and at the *Bijzondere Collecties* (Special Collections) of the University of Amsterdam library. Almost all publications by seventeenth and eighteenth century societies are meanwhile available in digitized format, as well as a number of books. In addition I frequently used the database constructed on the Dutch-Asiatic shipping of the VOC and the one giving access to those on board of the ships of the VOC.⁹ In all cases it asked for reading with no preconceptions (or at least as few as possible) to allow oneself to be surprised before coming to possible conclusions. It became clear that issues of technology were constantly connected with political, commercial, organizational and health issues, revealing that

‘History generally, and the history of technology in particular, is always richer in content, more varied, more many-sided, more lively, and subtle than even’ the best historian and the best methodologist can imagine.¹⁰

This adapted quote from the philosopher of science Paul Feyerabend (I inserted “technology” for “revolution”) turned out to be very appropriate regarding the history (or long term development) of the eighteenth century technology of the VOC. Feyerabend went on to advocate an anarchistic approach (“anything goes”) to the philosophy of science and the nature of knowledge in particular, writing that “the history of science will be as complex, chaotic, full of mistakes, and entertaining as the ideas it contains (...)”¹¹. His characterization of the history of science perfectly mirrors that of the history of technology that forms the subject of this dissertation. Therefore I approached my sources in an “unmethodical” way which means that I did not squeeze the texts that I came across into a pre-conceptualized mould. Instead I first tried to read what was actually written (even when it was sometimes crossed out or replaced by something else) and then I tried to build a narrative from those contemporary texts without the disadvantage of hindsight. That led to a number of narratives (rich or “thick” descriptions) about technologies introduced, used and discarded within the VOC. It was not until after those narratives had been written, that I started to do any interpreting or reading in between the lines. In that way I tried to “(...) approach the past in its own terms”¹², with the *caveat* “as far as possible for somebody living in the twenty-first century”.

⁹ These databases are “Dutch-Asiatic Shipping in the 17th and 18th centuries” <http://resources.huygens.knaw.nl/das> and “VOC Opvarenden” Database on the ships’ personnel of the VOC <http://vocopvarenden.nationaalarchief.nl/default.aspx>

¹⁰ Feyerabend (1993/2002), p. 9. Where he has “history of revolution” I have “history of technology”. In fact, Feyerabend adapted this quote from V.I. Lenin.

¹¹ Ibid., p. 11

¹² Ibid., p. ix

The study of archival material in the National Archives, the Zeeland Archives and the (digitally available) Indonesian and South African Archives revealed a number of sources that have not been mentioned in earlier research. In chapter 2, these concern the fate of the *equipagemeester* Van Thiel in Batavia in the early 1700s (in section 2.3.1 under *First appearance and disappearance of the waterwerk*) and the existence of a larger number of Batavia-produced distillation machines than had previously been assumed (in section 2.3.1 under *Second appearance and disappearance of the waterwerk*). In chapter 3, more details became available about the panel of judges in the Zeeland society's competition on ship design and the reaction of the shipwright Udemans (in section 3.1 under *Connecting design and society*). In chapter 4, a number of documents came to light originating from VOC's Canton factory about the wrecking of the *Admiraal de Suffren*, the most important of which is the sworn statement by a number of common crewmembers (in section 4.3 under *The (un)charted island of Lincoln*).

Methodology

When it comes to interpreting the narratives, I use methods taken from the toolbox of *Science & Technology Studies*. These offer a wide repertoire of sometimes overlapping, sometimes conflicting methods that can be used to gain an insight into the (long term) development of technology and technological artefacts. The first of these methods (chronologically speaking) is the *Sociology of Scientific Knowledge* (SSK). Particularly appropriate within a technological context are the second and the third of the "four tenets" that made up its *Strong Programme*. In 1976, these were formulated as

- (2) It would be impartial with respect to truth and falsity, rationality or irrationality, success or failure. Both sides of these dichotomies will require explanation.
- (3) It would be symmetrical in its style of explanation. The same types of cause would explain, say, true and false beliefs.¹³

The second tenet can be applied to technological issues as it is stated, whereas a translation of the third tenet into technological terms leads to "(3) *The same types of cause would explain, say, the success or failure of an invention, a machine or a procedure*". This means that when considering the "success" or "failure" of a technology, one should apply the same approach irrespective of what the eventual outcome of that technology was or - to put it in other words - "successful" technologies should not be privileged over "failed" technologies.

¹³ Bloor (1976), pp. 4-5

Instrumental in further developments of STS were the results of a workshop that was organized on new developments in the Social and Historical Studies of Technology at the University of Twente in 1984. The book resulting from that workshop was one of the first books that explicitly formulated the link between the sociology of technology and the history of technology.¹⁴ Partly building on ideas from SSK, a number of approaches were described that concentrated on the sociology and history of technology. The three approaches that figured prominently were the *Social Construction of Technology* (SCOT), *Large-scale Technological Systems* (LTS) and *Actor-Network Theory* (ANT).¹⁵ They all aim at “a greater understanding of the social processes involved in technological development while respecting the seamless web character of technology and society”,¹⁶ although each approach has its own specific emphasis. Considering the different technologies that I investigate in this dissertation and the sometimes complicated patterns that emerge, it seems not sensible to squeeze the narratives that unfold into one single mould. Instead (mirroring what I wrote earlier about ongoing negotiations) one might say that negotiations between narrative and approach lead to the method that I follow in each case.

The *Social Construction of Technology* offers the insight that “users (and non-users) matter.”¹⁷ The emphasis is on the role different groups of users play in the construction or the development of a technology or a technological artefact (the most famous example being the “safety bicycle”).¹⁸ Technological artefacts can (and often will) be interpreted in different ways (“interpretative flexibility”) by different groups of users, the so-called relevant social groups. To stabilize an artefact, a form of “closure” has to be found for which two mechanisms seem to be available. The first one is the “rhetorical closure” which implies that “the relevant social groups see the problem as being solved.”¹⁹ The other mechanism is the “redefinition of the problem” which means that a contested artefact is shown to have another meaning than it originally was designed for.²⁰ Both aspects become visible in the third chapter when a re-design of the *retourschip* was contested by different groups. As we will notice, in the end closure relied partly on rhetorics and partly on an

¹⁴ Bijker, Hughes & Pinch (eds.) *The Social Construction of Technological Systems* (1987). An “anniversary edition” of this book appeared in 2012. All references made to this book are based on the 2012 edition.

¹⁵ For instance, feminist studies of technology were conspicuous by their absence, as was recognized in Bijker e.a (2012), pp. xv-xvi

¹⁶ Bijker e.a. (1987/2012), p. 4

¹⁷ Bijker e.a (1987/2012), Bijker (1995/2002), Oudshoorn & Pinch (eds.) (2003)

¹⁸ Bijker e.a. (1987/2012), pp. 21-39

¹⁹ Ibid., p. 37 (*italics in original*)

²⁰ Ibid., pp. 38-39

extra meaning that could experientially be attached to the design. Users (and non-users) can also play a part in the outright acceptance or rejection of a technological artefact or a technology. The philosopher of techno-science Bruno Latour wrote “We study *science in action* and not ready made science or technology; to do so, we either arrive before the facts and machines are blackboxed or we follow the controversies that reopen them”.²¹ The first of such a controversy appears in the second chapter, when I describe how the technology of seawater distillation turned into a controversial issue. It was introduced with the support of a small group of directors of the VOC and opposed by a group of skippers who had to work with the system. Both groups used rhetorics and redefinitions to defend their positions but (as it turned out) no compromise could be found. As will be shown, ultimately the arguments of the non-users seem to have mattered most. The role of users becomes also prevalent in the fourth chapter when the technology of charts and sailing instructions is discussed. There we notice some problems that individual users (be it skippers, examiners or societies) encountered when dealing with the increasingly centralized VOC. It was not until a richly laden *retourschip* was wrecked on an uncharted island that the company started re-considering its policies, which showed the agency of nonhuman actors; an approach which is explained below when we look into the Actor-Network Theory.

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The approach “*Large-scale Technological Systems*” looks at the entanglement of humans and materiality in a technological system of considerable size. These “technological systems contain messy, complex, problem-solving components. They are both socially constructed and society shaping.”²² In the first chapter I consider the ship designing and shipbuilding activities of the VOC as such a large system. The company had six semi-independent shipyards, the independence of which had already decreased over time because of increased standardization. In the 1740s the yards were to an even larger degree amalgamated into one *de facto* large-scale enterprise with six different production units. That happened because of the need to solve the complex problems of a ship design that had become less seaworthy because of adaptations that had been carried out, combined with political pressure from government circles in the Dutch Republic. The combination of urging by human institutions and problems with technological artefacts led to a powerful large-scale technological system that existed for over half a century until the demise of the VOC.

When trying to understand the mechanisms through which this system could function for that length of time the *Actor-Network Theory* offers

²¹ Latour (1987), p. 258 Rules of Method #1 (*italics* in original)

²² Hughes in Bijker e.a. (1987/2012), pp. 45-76. The quote is the opening sentence of the essay.

important insights.²³ This approach emphasizes the hybridity of networks. One should note that the word “network” used here does not refer to the technical meaning of network, like an electricity -, railway - or telephone network. Nor does it refer to social networks as such. Hybrid networks as conceived in this theory contain both human actors and non-human actors (sometimes the word actant is used to encompass both types of actors). These actors (human, machines, natural forces) shape the trajectory of paths that are taken within the network leading to and from centres of accumulation and calculation.²⁴ *ANT* - with its ideas about hybrids, (hybrid) networks, immutable mobiles and centres of accumulation and calculation²⁵ - shows that agency should not only be granted to humans but also to technology and technological artefacts.²⁶ Hybrids and hybrid networks also make their appearance when I consider in more detail the large-scale technological system in which the ships of the VOC were built. The system as such can be seen as hybrid but the ships produced by that system are hybrid entities as well. The hybrid character of ships turns out to be even more complex when (in the second chapter) I discuss how the ships had a bearing on the health of its crews. In the fourth chapter hybrid networks can be recognized in the inseparable fusion of expertise and technology on which the ships and their crew relied for a safe navigation. In that chapter we also recognize the fact that even a wrecked ship could have an active role when it concerned the introduction of foreign expertise into the existing body of charts and sailing instructions of the VOC. The cases described in these chapters show that the concept of hybrid networks (consisting of humans and non-humans, mediating between nature and technology) assist us in revealing the complicated state of affairs regarding technology within the company.

To these STS approaches I have added the notion of *technologies of trust*, which played a role in several of the negotiations that users and non-users engaged in.²⁷ This term, coined by the historian of science Theodore Porter, describes different “systems” on which trust could be based.²⁸ In the context of this dissertation two technologies are visible. The first of these to appear in this dissertation is the “gentlemanly trust” which relied on the

²³ The term “actor network” was introduced by the sociologist Callon *in* Bijker e.a. (1987/2012), pp. 86-91

²⁴ Latour (1996), *passim*; more specifically for centres of accumulation and calculation see Latour (1987), ch. 6

²⁵ The term “hybrids” in combination with networks was introduced by Latour (1993), pp. 10-11.

²⁶ See for instance also Latour (1986/1990), Latour (1987) and Latour (1993)

²⁷ On numbers Porter (1995); on technologies of trust Shapin (1984) and Shapin (1994/1995)

²⁸ Theodore Porter introduced the term “technologies of trust” in Porter (1995), p. 15

societal status of spokespersons to assert their trustworthiness. Later one sees the “literary technology of virtual witnessing” being used, especially by the societies that became established in enlightened Europe.²⁹ This “literary technology” played an important part in the negotiations on a change to the standard design of the *retourschip* as will be discussed in the third chapter. In the fourth chapter, I have also to some extent relied on points raised by *critical cartography* about maps and charts as social issues and expressions of power and knowledge when I interpreted the role of charts within the VOC.³⁰

A short example may illustrate what a “following of controversies” could entail. Around the turn of the seventeenth/eighteenth century letters and memoranda were going to-and-fro between officials of the VOC in the Dutch Republic and their counterparts in Batavia about the continuation of the technology of seawater distillation on the ships of the VOC. On a large number of the company’s ships, distillation machines had been installed with produced drinking water out of seawater during the voyage to and from the East Indies. The technology turned out to be a rather contested one. Johannes Hudde, one of the directors of the company, wrote in the margin of a letter that had voiced opposition

(...) zodat men het niet alleen op lange maar ook korten reize, en niet alleen voor de uitgaande maar ook voor de retournerende schepen met ‘er tijd zal aanzien voor een mededeeling van Godes gunst. (transl.: (...) so that one will, not only on long but also on short voyages and not only on outward bound ships but also on returning ships, recognize this (i.e. seawater distillation technology) in due course as a token of God’s grace)³¹

This shows that a discussion on the advantages or disadvantages of technologies could evoke emotional, theological arguments pro and contra; more importantly it shows that the VOC was actively engaged with this new technology at least a century and a half ahead of other companies or navies. And then, a decade and a half after it had been introduced, the VOC discarded this technology. Answering the question whether for the VOC the technology of distilling seawater was a “success” or a “failure” (and “why” or “how”) is therefore not straightforward. There may have been a conflict between success defined according to the technical details of the seawater distillation, success as seen through the eyes of skippers who had to convince their crews and themselves that the system was convenient to use and above all safe, and between success when defined as the commercial advantage of being able to

²⁹ Shapin (1984)

³⁰ Kitchin and Dodge (2007)

³¹ Comments by Hudde in the margin of a (copy of a) letter to the Governor General of the East Indies that had been written on 21 February 1698 (NA 1.10.48/24 *Letter to Van Oudshoorn*)

ship more cargo because less water had to be stowed. As we will see in the second chapter, “users mattered” – the construction of the fact that seawater distillation on board of wooden sailing ships should be (dis)continued was a collective process in which a group of skippers positioned themselves against the directors of the VOC by sending their arguments and opinions back to the Republic from Batavia. The circuitous route taken illustrates (if needed) that the social construction of technology is not straightforward and that it is probably never a linear process. Quoting Latour again: “To sum up, the construction of facts and machines is a *collective* process.”³²

Situating this dissertation

Considering how to position my research and interpretations within the wider body of work devoted to the VOC and how to limit the boundaries so that a comparison is still manageable, the obvious solution is to limit myself to the topics of ship design and shipbuilding, health, trade and navigation. After all, these topics (with the exception of trade) form the backbone of the four chapters of this dissertation. Trade has been added because in the course of my research on the re-design of the *retourschip* (in the third chapter) the primary sources explicitly made the link between design and trade.

The first chapter on ship design and shipbuilding is an important “port of departure” (to borrow a nautical term) because it reveals the hybrid character of ship design, shipbuilding and the ships themselves. Important, ground-breaking and immensely useful as the three volumes by J.R. Bruijn, F.S. Gaastra and I. Schöffer *Dutch Asiatic Shipping in the 17th and 18th Centuries* (as well as several smaller essays by its authors) have been for me, they lacked the reflection on ships, design and building that was made possible through the *Large-Scale Technological Systems* approach and the *Actor-Network Theory*.³³ In that respect, this dissertation opens new ways of reflecting on the character of the ships of the VOC.

The topic of health (which is the subject of the second chapter) revealed another layer of hybridity of the ships, that of their socio-material character within the wider network of the VOC with all the tensions that it (increasingly) contained. The micro-society that existed on board of the ships was not only spatially defined by the dimensions of the ship, but the ship itself played an active role in constituting, sustaining and threatening that society. The cramped physical conditions on board, the lack of fresh food and water, and the often hostile environment through which the ships had to sail contributed to sometimes severe health problems. These problems have been

³² Latour (1987), p. 29, italics in original

³³ Bruijn, Gaastra & Schöffer (1979-1987) Part I; Part II and III have been incorporated in the Dutch Asiatic Shipping (DAS) website.

the subject of a number of books and dissertations. Here I specifically refer to the historian of medicine D. Schoute's *De geneeskunde in den dienst der Oost-Indische Compagnie in Nederlandsch-Indië*, the historian of medicine A.E. Leuftink's *Harde Heelmeesters: Zeelieden en hun dokters in de 18^{de} eeuw* and the nautical historian I. Bruijn's dissertation *Ship's Surgeons of the Dutch East India Company: Trade and the Progress of Medicine in the Eighteenth Century*.³⁴ Schoute is an important source on the health situation in Batavia in the eighteenth century. He also offers access to the advice given to the VOC by Boerhaave, with a complete transcription of the original letter. Leuftink's book is concerned with health care at sea in general, and has separate chapters on the VOC, whale hunting in the Arctic regions, the West India Company and the Dutch navies. In her study on ships' surgeons employed by the VOC, I. Bruijn also devotes part of a chapter to the medical policies of the company. Both Leuftink and Bruijn mention the policies introduced by the directors of the VOC to overcome the health crisis of the early 1770s. The research that I carried out on that subject yields results that are quite different from those presented by Leuftink and Bruijn. In contrast to their point of view, I show in the second chapter that (as a result of one of the measures taken) an effective reduction in the size of the crew was realized by the VOC. If anything, average crewnumbers kept falling until the outbreak of the fourth Anglo-Dutch war in 1780. This then corroborates the observations made by the social historian Van Rossum in *Werkers van de Wereld* when he referred to the shortfall in numbers of European sailors in Asia in the 1770s.³⁵

In that second chapter I also look into mechanical means to improve conditions on board. This concerns the use of machines for seawater distillation and the use of mechanical ventilators. The archivist Roessingh published two essays on that subject ("*De watervoorziening op de schepen van de VOC*" and "*The water supply aboard ships of the United East Indies Company*").³⁶ The historian of technology Haarhoff published "*The Distillation of Seawater on Ships in the 17th and 18th Centuries*" which gives a more general overview but in which he extensively dwells on the experiments of the VOC.³⁷ Because of the SCOT approach I took ("users matter") I come to conclusions that differ from those suggested by Roessingh and Haarhoff. Whereas Roessingh suggests that the High Government in Batavia was opposed to the system and Haarhoff suggests problems with the provision of firewood, my approach points instead to the role that users (i.e. skippers and crew) played in an attempt to get the system abolished. The introduction and subsequent abolition of mechanical ventilation on the ships of the VOC has

³⁴ Schoute (1929), Leuftink (1991/2008) and Bruijn (2009)

³⁵ Rossum, Van (2014), also Rossum, Van (2011)

³⁶ Roessingh, M.P.H. (1967) and Roessingh, (M.)P.H. (1970)

³⁷ Haarhoff,, Johannes (2009)

hardly been investigated before; in fact the only essay that covers the subject in depth is the one by Bicker “*Verhandeling ter beandwoording der vraag: De nuttigheid der ventilators (etc.)*” (Treatise for answering the question about the usefulness of ventilators (etc.)) of 1801.³⁸ This treatise has the advantage of being almost contemporary with the abolition of these machines and – interestingly – it points to the role that (non)users played in that abolition.

The third chapter is concerned with a re-design of the current *retourschip*, proposed in 1763 by the master shipwrights of the Zeeland shipyard of the VOC, and the reasons why this re-design was finally accepted in 1780. Earlier publications on that subject are the master’s thesis by the student of nautical history Loeve *De Driedekker, Drie Decennia Discussie* (The Three-decker, Three Decades of Discussion), a mention in *Dutch Asiatic Shipping in the 17th and 18th Centuries* (pp. 48-50) and references in Bruijn’s *Schippers van de VOC in de achttiende eeuw* (translated as *Commanders of Dutch East India Ships in the Eighteenth Century*).³⁹ The approach that I used, based on the “literary technology of virtual witnessing”, yields a different reason for the ultimate acceptance of the re-design than the previous publications have suggested. In this chapter I also quote contemporary evidence on the profitability of the tea-trade with China, which corroborates the conclusions that have been drawn by Yong Liu in his dissertation *The Dutch East India Company’s Tea Trade with China 1757-1781*.⁴⁰

In the fourth chapter I look into navigational issues, concentrating on charts and sailing instructions. It can be seen as an addition to the nautical historian Davids’s *Zeewezen en Wetenschap* where it concerns the (reluctant) way in which the VOC introduced foreign expertise, knowledge, charts and sailing instructions.⁴¹ Compared to Bruijn’s *Schippers (etc)*, my research gives more details on the decision (and the reasons for it) that was taken by the VOC in 1789 to allow limited use of foreign charts and sailing instructions. These details became available through the study of primary archival sources, combined with an approach that took into account the role of users and a shift in the technology of trust as compared to what had happened in 1780.

Navigating through Hybrids: immutable drawings and mobile ships

In the first chapter I investigate the appearance in 1742 of a new design for VOC’s *retourschip* (in three different sizes or *charters* as they were called) which was achieved by the introduction of identical measured design drawings at all shipyards of the company. The introduction of these

³⁸ Bicker, L. (1801)

³⁹ Loeve (2001), Bruijn (2008), pp.197-201 resp. (2011), pp. 255-259

⁴⁰ Liu, Yong (2007)

⁴¹ Davids (1986), pp. 217-226

standardized drawings signalled a move towards a greater standardization and centralization of the shipbuilding practices of the VOC. In this chapter I consider the VOC as a complex and hybrid pattern of interactively linked centres of accumulation, using therefore an approach suggested by the philosopher of technology Bruno Latour. The hybridity is visible in the design of its ships, in the shipbuilding practices (the technological face of the VOC) and in the shipping operations which formed the backbone of its commercial face. The ships of the VOC themselves can also be seen as hybrid – in fact I will argue that the ships themselves were in a double sense hybrid.⁴² The shipyards of the VOC (I concentrate on the Oostenburg yard in Amsterdam⁴³) had a hybrid character, as the design and the building of ships was carried out in and through a network of closely connected human and non-human actors. The skill and knowledge (the “know-how”) of shipwrights and workers, the disciplining by drawings, templates and moulds, and the materials accumulated from all over Europe intricately joined forces to produce large numbers of highly standardized *retourschepen* for the VOC in a (proto)industrial setting. The designs that were used to build these ships (from 1742 onwards until the demise of the company) are characterized as examples of an *immutable mobile*, a term coined by Latour.⁴⁴ Although the basic design remained largely unchanged, we will notice (especially in the third chapter) that the immutability of the design was open to some degree of flexibility.

Thereafter I consider the working lives of the ships that had been built on the yards of the VOC. It then emerges that the *retourschip* itself was also hybrid in character – or rather that it displayed a double hybrid character. For one, it was hybrid because it was the materialized result of the hybrid network of humans and non-humans that we considered earlier; it was also hybrid because of the activities it engaged in. Whereas the design drawings can be seen as immutable mobiles, the *retourschip* (product of this design) can be interpreted as a mutable mobile. It played different roles on its outward bound journey as compared to its homebound journey. This different role also had a bearing on how to interpret the situation of the common crewmembers

⁴² The concepts of hybrids and hybrid networks were introduced by Latour (1993)

⁴³ The Middelburg shipyard of the Zeeland chamber of the VOC assumes pride of place in the third chapter of this volume, as an illustration of the fact that – against the centralizing tendencies of the directors – local sites still could play an important role during the second half of the eighteenth century.

⁴⁴ Latour (1986), p. 6 “In sum, you have to invent objects which have the properties of being *mobile* but also *immutable*, *presentable*, *readable* and *combinable* with one another” (italics in original). Latour then names these objects “immutable mobiles” and again in Latour (1987) p. 227 he writes “... a long network that generates what I will call **immutable and combinable mobiles**” (bold in original). Again this is then abbreviated to “immutable mobiles”.

(i.e. sailors and soldiers). Finally I explain – through combining the ideas developed in this chapter - how each individual *retourschip* acted as a mirror image of the VOC as a whole.

Navigating through Health: tensions, machines and procedures

In the second chapter, I look into the health situation on board of the ships of the VOC, whereby yet another layer of hybridity is revealed that became visible on and through the ships of the VOC. That layer is the socio-material character of the *retourschepen*, within the larger tension-filled network of the VOC. It will be shown that the micro-society that existed on board of the ships was not only spatially defined by the dimensions of the ship, but that the ship itself played an active role within that society. On a number of occasions during the eighteenth century severe health problems emerged on the ships of the VOC, particularly on the outward bound journey. These health problems went beyond the “normal” scourge of scurvy, and were caused by contagious putrid fevers (*rotkoorts* in Dutch) as they were called at the time. To establish possible causes, cures and means of prevention I turn to contemporary writers, such as a ships’ surgeon, physicians and essayists that contributed to the inquiries by two of the societies that had become established in the Dutch Republic during the second half of the eighteenth century. Some of these essays were partly based on the actual experience at sea of the writers. Two different (though not necessarily mutually exclusive) ways of improving the health situation (or rather to alleviate the usual unhealthy situation) can be discerned. One was the use of machine technology which around the turn of the eighteenth century consisted of the introduction of distillation machines (the so-called *waterwerk*) to turn seawater into drinking water. In the late 1740s, mechanical ventilators were introduced to improve the air quality on board. Providing its ships with a sufficient amount of fresh water and fresh air had been a concern for the directors from the early days of the VOC. When in the 1690s, the *waterwerk* was introduced on most ships of the VOC, this innovation promised to offer a partial solution to the problem of water not being available in sufficient quantity and quality.⁴⁵ However, the use of these machines only lasted for fifteen years, although they made a rather surprising but short-lived return between 1768 and 1770. It will be argued that when in the early 1700s these machines were abolished, users (or actually anti-users) made their voices decisively heard; the second time only one user seemed to have mattered, but he was nevertheless quoted when the decision was taken to abolish the machine again. Problems with extracting foul air and providing

⁴⁵ For instance, about three-quarter of the ships of the Amsterdam chamber were supplied with these machines and had the specialized personnel on board to operate these machines

fresh air between decks were mechanically tackled from 1746 onwards when the *Heeren XVII* introduced hand-driven *ventilators* to expel noxious airs. Although the ventilators were replaced by an improved machine in the 1760s, they were discarded on the homebound voyage in 1772 and in 1791 they were completely abandoned; non-users were (again) instrumental in the first (partial) abolition of these machines.

When I consider the reasons for the introduction of *waterwerk* and *ventilator*, I discuss different opinions about their effectiveness, and look into the reasons and circumstances that led to their demise. A shift in emphasis becomes visible away from machines that played a role within an individual ship, controlled by the skipper and his officers, towards a disciplinary practice that was uniformly applied to all ships. In an effort to contain and prevent the final and most severe outbreak of the so-called *rotkoorts* in the early 1770s, the *Heeren XVII* engaged in extensive discussions. By then, the emphasis within the VOC was predominantly on procedures and disciplinary practice, leaving behind the earlier (partial) mechanical approach. Using contemporary evidence, I evaluate the outcome of some of these procedures and their consequences for skippers, officers and crew. The alternative, centralized procedural approach turned the ships into even more regulated and standardized entities. Finally I consider the contemporary experiences of a number of those who personally had to go through the outbreak of contagious diseases on board of a ship. That helps to put the analyses and the mechanical and procedural approach into a human perspective, leading to an interpretation of the way the VOC sought to tackle matters of health through different strategies. In the course of the eighteenth century, one sees within the VOC an increasingly reluctant use of machines. Instead the company emphasized prescribed and standardized courses of action that had to be taken by officers, surgeons and crew without the aid of machines. As we will also notice in the next chapters, this quest for centralization could cause tensions between the *Heeren XVII* and the chambers, and between the *Heeren XVII* and skippers. By the end of the eighteenth century, all machines for health had been discarded and a policy of prescription took their place. The skipper, officers and ordinary sailors that operated the ships were subjected to a bureaucratic system of disciplinary practice and were turned into an increasingly controlled workforce. Through this approach the VOC tried to strengthen its control regarding the way ships were operated – and as a consequence the degree of independence of the skippers decreased, ironically partly through their own actions as non-users.

In the third chapter we see a new design for the standard series of *retourschepen* of the VOC emerge, when the shipwrights of the Zeeland shipyard proposed to transform the *retourschip* into a so-called three-decker. A number of these ships were built at the Zeeland yard, and although heralded as a definite improvement, the VOC was very reluctant to accept these three-deckers. The fact that those in favour of the new design had to make their point repeatedly over more than a dozen years shows that it may not be assumed that the design and construction of a supposedly superior artefact is accepted without any resistance, even by those who seem to gain the most by it. The enlisting of a sufficient number of important allies (either human or non-human) was (and is) crucial.⁴⁶ Just as we saw in the previous chapter, users mattered, as became clear from the experiences of those who sailed on these ships. The artefact itself also mattered, because it offered experiential proof of the soundness of its design, regarding the aspects of health, of nautical safety and of profitability. However, this experiential evidence made no sufficient impact, until essays in the *Transactions* of the *Zeeuwsch Genootschap der Wetenschappen* (the Zeeland society) breathed new life into the discussions of the reluctant *Heeren XVII*. Coincidentally, the introduction of the new design occurred almost simultaneous with the founding of the Zeeland society. The Zeeland chamber of the VOC and the new society became connected, first on a personal level when a director of the Zeeland chamber also became one of the very many directors of the society. The connection deepened when the society published essays on the health problems within the VOC, as discussed in the previous chapter. These health problems also had a bearing on the new ship design; one of the arguments invoked against it suggested that it would be detrimental to the wellbeing of the crew whereas those advocating the new design argued that it would be beneficial. Another supposed advantage of the new design was its improved ability to withstand the forces of nature; this implied that the design was more seaworthy and that it enabled a more efficient running of the ship. This last aspect in turn partly depended on the possibility to discipline the crew more efficiently. This spatially more efficient way of disciplining the crew made it also possible to better assert authority over aspects of sickness and health. When the discussions around the new design had come to a standstill, the Zeeland society organized a competition on the question which ship design was the

⁴⁶ This is an example of one of the most important insights that has been revealed by the Social Construction of Technology (SCOT) approach: the superiority of new inventions is rarely obvious but has to be agreed upon through (sometimes tough and long drawn out) negotiations in which numbers, experiences and the number of allies count. See Latour (1987), Bijker, Hughes & Pinch (eds.) (1987/2012) and Bijker (1995)

most suitable for the needs of the VOC as far as seaworthiness, health of the crew and profitable trade were concerned. The prize-winning essays argued extensively in favour of the new design. The aspects of health and of seaworthiness were answered by invoking experiences of those who had sailed on these three-deckers as compared to experiences with ships of the classic design. The aspect of profitable trade was experientially answered based using VOC's tea transactions with China.

Then I show how the discussions of the *Heeren XVII* regarding the introduction of the new design were guided and governed by the *Transactions* of the Zeeland society. The outcome of the discussion showed that the combination of (experiential) evidence and (formal) knowledge mattered, and through the arguments developed in the *Transactions* of the Zeeland society these aspects became publicly accessible. The arguments were powerful because they were based on the experience of users on the one hand and on the other hand because they were channelled through a society that used the nationally and internationally accepted literary technology of virtual witnessing. Possibly the most important aspect of this combination was that – precisely because the essays had been published through the channels of a society – they could be presented as neutral and as coming from a trustworthy source, and so the essays were able to construct a bridge between the quest for centralization and standardization within the upper echelons of the VOC and the desire for local independence and decision making of at least some of its chambers. This use of publicly published arguments in their decision-making shows that the VOC of the late eighteenth century was not always plagued by the stagnant, dithering and inward-looking process of decision-making that is often attributed to the company at that time. It shows that the directors of the VOC were positively responding to public scrutiny, used it to advantage in their decision-making process and acted in a similar innovative way as when they took the decision to introduce measured design drawings in 1742. It also shows that there had been a shift in the “technology of trust”, moving from “gentlemanly trust” (as was noticed in the second chapter) to disinterested experiences and numbers, filtered through the socially and culturally sanctioned procedures of a society.

Navigating through Charts: construction, observations and reliability

In the final chapter I look into the subject of navigation focusing on charts and sailing instructions, and on how the VOC engaged with new charts, new expertise and new knowledge concerning geographical, nautical or astronomical issues. Much of this new information came either from abroad, was acquired by foreigners on territories under the control of the VOC or was produced by persons employed by the VOC but located in sites that were in a

de-central position compared to the directors of the company in Amsterdam. Specific attention is paid to skippers on the *retourschepen* of the company or staff at the VOC's factory in Canton.⁴⁷

Regarding the production of charts for and by the VOC, in the course of the eighteenth century a shift becomes visible from the constant copying of manuscript charts to the printing of charts, at least as far as the charts issued from the Republic were concerned. Batavia continued with producing manuscript charts for the Asian waters. A consideration of the policies inscribed into charts and sailing instructions leads to an interpretation of the character of these charts. Reliable charts and instructions could not be produced without the observation and mapping of phenomena that existed above the surface of the earth (i.e. the heavens) and that existed near and below its surface (i.e. the earth's magnetism). I investigate whether the knowledge that became so available (and that could be translated into navigational tools) made its way into the official body of cartographical and navigational knowledge of the VOC. It will be seen that information collected by skippers on the earth's magnetism was used to advantage. Sustained attempts to increase knowledge about the stars in the southern sky or to establish the longitude and latitude of the Cape of Good Hope, of significant sites on Java or elsewhere in Asia were not undertaken by the VOC itself. Even when such knowledge became available through other sources, then quite often it did not find its way onto the charts and sailing instructions issued by the company.

Charts mattered to its users and these users (be it skippers or official examiners of the company) tried to make their views regarding charts matter to the company as well. They not always succeeded in getting their voice heard, but skippers sometimes navigated their way around the official route-finding procedures by using private, "unofficial" knowledge. Especially in the second half of the eighteenth century, complaints about the usability and reliability of charts manifested themselves regularly. When in 1771 a vessel was wrecked on apparently uncharted rocky shallows near Madura in the East Indies, officials in Batavia and skippers accused each other for not timely alerting to or responding to issues of unreliability of current charts. The next year a *retourschip* destined for China went down with almost all hands on its approach to Canton; this led to the publication of an improved chart of these approaches by a member of the staff in Canton, this chart however probably never became part of the official cartographic knowledge of the VOC. Some years later skippers complained again; the *Bataviaasch Genootschap der*

⁴⁷ This means that in this chapter the introduction of (new or improved) navigational instruments (apart from charts) is left out, as there is no point in trying to improve on Karel Davids's extensive dissertation *Zeewezen en Wetenschap* (1986) on the development of navigational instrumental technology in the Netherlands between 1585 and 1815.

Kunsten en Wetenschappen in Batavia (the “Batavia Society of Arts and Sciences”) became involved when it published two articles on problems with the current Dutch (i.e. VOC’s) charts. Again no reaction came forward until in 1788 the largest *retourschip* of the VOC foundered on its way home from Canton on an uncharted island, which caused the loss of the vessel and of all its cargo, highlighting the high price of unreliable charts. A court martial in the Republic concluded that the officers concerned were not to blame and that the disaster was caused by not up-to-date charts. The proceedings of the court martial give an interesting insight into the *technologies of trust* that were employed then. When a sworn statement by common crewmembers threatened to reveal an inconvenient truth, the court martial returned to the old system of “gentlemanly trust” which meant that trustworthiness was again linked to the societal status of spokespersons.

Only after the disaster and the court martial did the VOC act on the complaints about its charts and after what seems to have been a rather intense debate it provided its ships in the China trade with foreign charts. In contrast to the original proposal all other ships had still to rely on the original charts as provided by the VOC. Although the decision that was taken can be seen as a watered-down version of the original proposal it nevertheless signalled a decrease of the power that the VOC could exert through its own charts. On the one hand a chart could empower its users against the hostile environment they were sailing through by giving them a (metaphorical) view over the horizon. On the other hand it granted power to the directors of the VOC in two ways. First, it offered them the opportunity to determine along which route a skipper should be sailing, as is still visible on a number of charts in the lines that demarcated the “*wagenweg*” that guided ships across the equator. Second, it enabled the directors (in hindsight) to ascertain whether the prescribed route had been followed by checking the actual route that had been marked on the chart. Being master of its own charts seemed therefore essential – unless it was shown beyond any doubt that charts (and the knowledge and experience on which these charts was based) that had been produced outside the VOC were more powerful than charts exclusively produced by and for the VOC. The decision as it was taken also showed the limits of the centralizing tendencies within the VOC. On the one hand the company continued with the obligation for its skippers to follow the routes as described in its own sailing instructions instead of allowing them more freedom to navigate as they saw fit, thereby emphasizing a centralistic approach. On the other hand skippers that had to sail to China were finally allowed to use foreign charts and sailing instructions for (at least) that part of the voyage, thereby escaping part of the company’s centralistic approach.

Finally

The *retourschepen* of the VOC played a central role within the company, and so they do in this dissertation. Partly through essays in the *Transactions* of eighteenth century societies (such as the *Zeeuwsch Genootschap*, the *Bataafsch Genootschap* and the *Bataviaasch Genootschap*), relations became visible for the enlightened public of that time (and for present-day readers) between the VOC, technology, knowledge, safety, health, nature and trade; these relations were to a large extent made possible through and materialized in the *retourschepen* of the company. This results in the fact that these powerful *retourschepen* continuously sail through all chapters of this dissertation.

1

NAVIGATING THROUGH HYBRIDS

NAVIGATING THROUGH HYBRIDS: IMMUTABLE DRAWINGS AND MOBILE SHIPS ⁴⁸

In the second half of the eighteenth century, the shipbuilding enterprise of the *Vereenigde Oostindische Compagnie* or *VOC* (the Dutch East India Company) was nationally and internationally unique in its use of technical measured drawings for designing its merchant ships and in the connection of this innovative way of design with standardized building methods and the use of interchangeable standard parts for the large-scale production of these ships.⁴⁹ In 1701, a century after the creation of the VOC, Pieter Van Dam – *advocaat* (counsel) and fulltime secretary of the board of the VOC – finished the *Beschryvinge van de Oostindische Compagnie*.⁵⁰ Apart from describing the history and the workings of the VOC, this book was also intended as a handbook for exclusive use by its board, the *Heeren XVII*, therefore it was kept under lock and seal at their offices. When writing about ships and shipbuilding, Van Dam pointed out that it took about twenty years after the inception of the company before the VOC started producing most of its ships on its own shipyards. Therefore by the 1620s, each of the six chambers had its own yard, although quite different in size and capacity. This meant that not every yard was capable of building all three types (or “charters” as they were called) of the large *retourschepen* that became increasingly the backbone of the intercontinental shipping system of the VOC. In total, at least 1461 ships (and probably some 120 more) were built on the yards of the VOC until its demise at the end of the eighteenth century. At the Oostenburg yard in Amsterdam, almost half of this number was built; the Middelburg yard in Zeeland produced about twenty percent and the smaller yards of the other chambers (Rotterdam, Delft, Hoorn and Enkhuizen) each built an equal share of the remainder.⁵¹ Amsterdam and Zeeland specialized in the building of ships of the first – that is, the largest – charter. On average, the Amsterdam yard built four ships every year, the Zeeland yard about three ships every two

⁴⁸ This chapter relies on research carried out for and insights developed in my master’s thesis (Jong, Johan de (2010); an earlier version of this chapter was published as “Drawings, Ships and Spices: Accumulation at the Dutch East India Company” in Roberts (2011), pp. 177-204.

⁴⁹ Jong, Johan de (2010), ch. 1.2 & 3.3

⁵⁰ See <http://resources.huygens.knaw.nl/vocbeschrijvingvandam>

⁵¹ The number of 1461 is given in Bruijn e.a (1979-1987), p. 54.

According to <http://voc-kenniscentrum.nl/kamers.html> and then looking under each separate *kamer* (accessed 20.11.2015) the Amsterdam yard probably built 728 ships, Middelburg 306, Delft 111, Enkhuizen 108, Hoorn 102 and Rotterdam 110, whereby the four smaller yards usually only built the smaller second and third charter, so in tonnage the difference between the smaller yards and the two large yards would have been even larger than the number of ships suggest.

years and the smaller yards approximately two ships every three years. This means that usually about eight new ships were produced every year. Apart from the building of new ships, repair and maintenance formed an important business. Upon return in *patria*, the *retourschepen* were inspected and a decision was taken as to whether the wear and tear caused by the trip to Asia and stay in tropical waters could be repaired or whether a ship had to be scrapped. In fact, quite a number of *retourschepen* managed to complete six or even more roundtrips, leading to an average lifespan of about fifteen years.⁵²

The decision that the VOC took in 1742 to start using measured drawings in the design and construction of almost all of its ships was at that time unparalleled in the world of commercial shipbuilding. This use of drawings in guiding and controlling the design and the building process (thereby effectively separating the design and the building phases) continued until the long drawn out demise of the company between 1795 and 1800. When (in 1795) the *Bataafse Republiek* (the Batavian Republic) replaced the *ancien régime* of the *Republiek der Zeven Verenigde Nederlanden* (the Republic of the Seven United Dutch Provinces⁵³), the VOC had been in severe financial difficulties for a number of years, partly because of the geopolitical situation at that time. The number of ships that were built in its yards had dropped considerably, from between eight and ten each year in the late 1780s to four or five in the early 1790s, with only two (or possibly four) ships on the stocks in 1794.⁵⁴ In a letter (22 May 1795) to the State Committee that had

⁵² *Retourschip* (plural: *retourschepen*) is the Dutch name given to an East Indiaman, signifying the return trips between the Republic and the East Indies (or China) these vessels were specifically designed and built for. On the numbers built, see Bruijn e.a. (1979-1987) Part 1, chapter 3. On the number of trips, see Bruijn e.a. (1979-1987) Part 1, p. 95. A lifespan of fifteen years is mentioned at the website of the *VOC-Kenniscentrum*, a project by the *Koninklijk Instituut voor Taal-, Land- en Volkenkunde* ([KITLV](http://www.voc-kenniscentrum.nl/vocschepen.html)), affiliated to the *Koninklijke Nederlandse Akademie van Wetenschappen* ([KNAW](http://www.knaw.nl)), <http://www.voc-kenniscentrum.nl/vocschepen.html>. Of the 1742 designs, the first charter had a length of 150 (Amsterdam) feet (i.e. 42,5 metres in modern measures) and a carrying capacity of 1150 tons (in modern measures); the second charter had a length of 136 feet (i.e. 38,5 metres) later increased to 140 feet (almost 40 metres) with a capacity of 850 – 880 tons and the third charter (which was hardly built at all) had a length of 120 feet (34 metres) and could take 600 tons.

⁵³ Hereafter abbreviated as the “Republic”

⁵⁴ According to Dillo (1992), pp. 276-277 (Bijlage 4) only two ships were built in 1794, a 150 ft three-decker *retourschip* at the Amsterdam yard and a 142 ft. *pinkschip* at the Zeeland yard. However, Eyck van Heslinga (1988) p. 34 mentions that in January 1794 the *Heeren XVII* allowed the Amsterdam chamber, the Delft chamber and the Hoorn chamber to build one ship each, while on 7 June 1794 the Zeeland chamber got permission to build a *pinkschip*. But Eyck van Heslinga (1988) p. 228-230 (Bijlage 2) is somewhat confusing: at the bottom of page 228 one ship of 150 ft. is mentioned as being on the stocks, which could be assumed to have been the *Admiraal de Ruyter* that was finished in 1796 and sold in

supervised the VOC since 1790, the executive board of the company, the *Heeren XVII* (the Seventeen Gentlemen) wrote that it had decided to put an end to the building of new ships on all six shipyards of the VOC, thereby effectively ending the role of the VOC as a large-scale technological enterprise.⁵⁵

In this chapter, I consider the VOC as a complex and hybrid pattern of interactively linked centres of accumulation. This hybridity is visible in the design of its ships, in its shipbuilding practices (the technological face of the VOC) and in its shipping operations (the backbone of the commercial face of the VOC). Moreover, I consider the ships of the VOC as hybrid as well – in fact it will be argued that the ships were in a double sense hybrid.⁵⁶ The connection will be shown between the accumulation related to the design and building of the *retourschepen*, the accumulation involved in the operation of these ships and the accumulation of the goods and persons that these ships carried to and from the East Indies. In the first section I will discuss and interpret the design of the ships, the shipbuilding processes and the extensive accumulation that took place on the shipyards of the VOC, with an emphasis on the largest yard of the company, Oostenburg in Amsterdam.⁵⁷ It should come as no surprise that the shipyards of the VOC can be seen as having a hybrid character, as the design and the building of ships was carried out in and through a network of closely connected human and non-human actants. The skill and knowledge (the “know-how”) of shipwrights and workers, the disciplining by drawings, templates and moulds, and the materials accumulated from all over Europe intricately joined forces to produce large numbers of highly standardized *retourschepen* for the VOC in a (proto)industrial setting. The designs that were used to build these ships

1804, or it may be read in the sense that the *Admiraal de Ruyter* was finished in 1796 and that another (unnamed) vessel was sold in 1804. Of two *pinkschepen* that were on the stocks in 1794 (p. 229) the fate is known. One of these was later named “Castor & Pollux”, it sailed in 1801/1802 as the Hamburg owned “Agatha & Cecilia” to Batavia and Canton, returning with a cargo of tea to Cuxhaven in 1803. In 1804 the ship was sold in Hamburg to somebody unknown. (Eyck van Heslinga (1988, pp. 159-161 & p. 229). The other was named “Vrede & Rust”, it had been given in loan to the navy of the *Bataafse Republiek*, was returned to the *Aziatische Raad* (Asiatic Council) in 1801, dispatched to Batavia in 1802 where it stayed and was broken up in 1804 (Eyck van Heslinga (1988), p. 59, 114, 132, 229 and pp. 256-257 (Bijlage 9b).

⁵⁵ NA 3.02.33/25 letter dd. 22.05.1795 by the directors of the VOC to the (state)committee for the affairs of the VOC; also Eyck van Heslinga (1988), ch. 2 (esp. p. 38 & note 8). For a more extensive appraisal of the VOC as large-scale technological enterprise, see Jong, Johan de (2010), ch. 3.3 & 5.3

⁵⁶ The concepts of hybrids and hybrid networks were introduced by Latour (1993)

⁵⁷ The Middelburg shipyard of the Zeeland chamber of the VOC will assume pride of place in the third chapter of this volume.

(from 1742 onwards) can be characterized as examples of an *immutable mobile*, a term coined by the philosopher of technology Bruno Latour.⁵⁸ In the second section, I consider the working lives of the ships that had been built on the yards of the VOC; then it will emerge that *retourschip* itself was also hybrid in character – or rather that it displayed a double hybrid character. For one, it was hybrid because it was the materialized result of the hybrid network of humans and non-humans that we considered earlier; it was also hybrid because of the activities it engaged in. This will be shown by interpreting the *retourschip* as a mutable mobile which played different roles when leaving Oostenburg (or the establishments of the other chambers) on its outward journey and returning to its port of departure on its homebound trip. In the final section, I argue – through combining the ideas developed in the earlier sections - how each *retourschip* formed a mirror image of the VOC as a whole.

1.1 Immutable drawings and accumulation at Oostenburg

Organization

Oostenburg in Amsterdam was the largest shipyard of the VOC; between 1660 until 1799, about 500 merchantmen were produced at that site out of the total production of 728 ships by the VOC chamber Amsterdam.⁵⁹ It consisted of three artificial islands, on one of which imported goods from Asia were stored in the *Zeemagazijn*, along with nails, ropes and cables for the ships. On a second island were several workshops, where parts for ships were produced. The shipyard itself, with its three slipways, a forge, a steam kiln for bending timbers and some more workshops, was housed on the third island. Organisation and logistics at Oostenburg were as large-scale and complex as the yard itself. During the 1750s, the yard employed 1100 workers and 180 staff members, supervisors and commanders. They were divided over six main departments: administration, artisan departments, storage, transport, vessels

⁵⁸ Latour (1986), p. 6 “In sum, you have to invent objects which have the properties of being *mobile* but also *immutable*, *presentable*, *readable* and *combinable* with one another” (italics in original). Latour then names these objects “immutable mobiles” and again in Latour (1987) p. 227 “... a long network that generates what I will call **immutable and combinable mobiles**” (bold in original). Again this is then abbreviated to “immutable mobiles”.

⁵⁹ The establishments of the other chambers were organized along similar lines, although on a smaller scale. For instance, the Middelburg yard had about half the workforce of Oostenburg and Enkhuizen about one-eighth (which is in accordance with the relative importance of the chambers), cf. Bruijn e.a. (1979-1987) Part I, p. 31.

Fig. 1.1 The yard Oostenburg of the Amsterdam chamber of the VOC. In the foreground a *retourschip* is being built, in the middle distance several workshops can be seen and at the far end the large *Zeemagazijn* is visible. (Rijksmuseum Amsterdam RP-P-1911-3454)

and a security system. Other sources mention that in 1762 there were 156 staff and supervisors employed and shortly before 1791 the number of workers is given as 1319 of which 245 had been recently dismissed. If one considers that – until the beginning of the nineteenth century – an enterprise, employing a few hundred workers, was already very large, these numbers indicate that the Oostenburg yard ranked with the famous Venetian Arsenal as a huge industrial enterprise. The organisation as a whole displayed a pyramidal structure, with three *boekhouders* (financial controllers) at the top and tapering out towards an intricately structured base with – amongst others – fifteen separate artisan production units. Others sources mention two *boekhouders*, one of which was also called *equipagemeester*.⁶⁰ The

⁶⁰ On the size of Oostenburg, Gawronski (2003), pp. 133-135; on the workshops, Bruijn e.a. (1979-1987) Part 1, p. 28; on staff numbers, Bruijn e.a. (1979-1987) Part 1, pp. 29-30,

equipagemeester was responsible for the production and fitting out of ships, both old and new. At the level of the workfloor, the shipyard can be interpreted as a system of horizontally organised, independent and specialized units. We can see an example of its factory-like production system in the standardized and specialized production of masts. At least from 1697 onwards, the dimensions of the masts and yards to be used with the various charters of *retourschepen* were given in considerable detail, and if we consider that masts and yards were also shipped to Batavia on a regular basis, the conclusion must be that the numbers produced were such that the VOC was able to keep a permanent supply of standardized masts and yards.⁶¹

This fits with the description by the archaeologist Jerzy Gawronski of the organization at Oostenburg as “almost modern, in view of the standardized and efficient assemblage of mass-products in wood” in contrast to the (assumed) oligarchic, hierarchical bureaucracy of the *Heeren XVII*.⁶² The use of the word “modern” here probably refers to the way manufacturing became organised during the nineteenth century and it may also refer to the use of interchangeable parts. Apart from personnel for its shipbuilding operations (which will be discussed in more detail later) the yard employed specialized workmen for taking out the ships, for loading and unloading and for working on board of the yachts made available to the directors.⁶³ The way the yard operated points to a rather sophisticated system of division of specialized labour, which was in operation quite some years before Adam Smith wrote “*An inquiry into the nature and causes of the Wealth of Nations*”. Smith wrote that “the division of labour, (however,) so far as it can be introduced, occasions, in every art, a proportionable increase of the productive powers of labour” even when such division could not be taken to such extremes as in his

Gaastra (2001/2007), p. 163 and Lucassen (2004), p. 19 and 29, quoting Gawronski (1996). Gaastra mentions 600 employees for the shipyard in Middelburg (Zeeland) and 150-200 for the yards of the smaller chambers and finally. On the comparison with the Venetian Arsenal, see Lucassen (2004), p. 12 where he quotes Pollard *The Genesis of Modern Management: a Study of the Industrial Revolution in Great Britain* (London 1965). In addition, Davis (1991), pp. 12-13 gives the combined number of shipwrights, caulkers and mastmakers at the Arsenal as between 1000 and 1200 towards the end of the seventeenth century. On the artisan units, Gawronski (2003), p. 135. On the *boekhouders*, Gawronski (2003), p. 135 and Bruijn e.a. (1979-1987) Part 1, p. 29.

⁶¹ For the transport of masts and yards to Batavia, the VOC even built and used specially equipped ships, see Bruijn e.a. (1979-1987) Part 1, p. 90 and Jong, Johan de (2010), chapter 3.1.2.

⁶² Gawronski (2003), p. 135. Gawronski goes on to say that “... the nineteenth century industrial technology of steam and steel would have fitted well with the eighteenth century production system of the VOC yard”.

⁶³ On specialized workmen, see Bruijn e.a. (1979-1987), Part 1, p. 29.

example of the pin-factory.⁶⁴ Looking at the fact that the shipwrights at Oostenburg were capable of building a *retourschip* within six months' time suggests that the division of labour that was in place did indeed account for a short production time. In the next sections, it will be argued that the accumulation of knowledge in interaction with other (non-capital based) accumulative processes was instrumental in the developments regarding ship design, shipbuilding and shipping within the VOC.

Know-how and design

Since the days of Aristotle and Plato, the concept of knowledge (*epistème*) has been associated with the thinking mind of the philosopher while the concept of (technological) skill (*technè*) was linked to the tinkering hand of the artisan. This distinction lives on until the present day, as is shown by the popular view that formal, scientific knowledge is developed in the minds of scientists and that technology can be seen as the application (by technicians or engineers) of such knowledge. Whether such a distinction was justifiable in the days of Aristotle is certainly debatable, and few academic analysts are willing to defend this "linear model" today.⁶⁵ A full discussion of this topic would carry us beyond the scope of this chapter, but here we should acknowledge that during the seventeenth and eighteenth century (between the so-called "Scientific Revolution" and the so-called "Industrial Revolution") the development of knowledge relied as much on the practicalities of experiments and material production as on theory and intellectual speculation or reasoning; both types of activities were often undertaken by one and the same person. This implies that we should read the term "knowledge" (as mentioned in the preceding section) in a far less restricted way than is often the case and that we should realize that it overlaps with and is overlapped by what is commonly called "skill".⁶⁶

If we look more specifically at the design- and building process regarding the VOC's eighteenth-century *retourschepen*, we come to realize that handy knowledge and mindful skills were intricately interwoven. A separation between the designing phase and the building phase of ships only started to become visible during the second half of the eighteenth century after the introduction of measured drawings, but even then, both processes were performed by (local) master shipwrights, with the finalization, adaptation and appropriation of the design taking place during the (local) building of a ship. In designing and building, shipwrights made use of the

⁶⁴ Smith's quote is taken from Smith (1843), p. 3

⁶⁵ Edgerton (2005)

⁶⁶ In the preface to *The Mindful Hand* (2007), pp. xiii-xxvii, Lissa Roberts and Simon Schaffer have written extensively on the inseparability of skill and knowledge.

interwoven formal and practical aspects of what we may call “know-how”. The use of this term frees us from having to refer to “skill & knowledge”, which still might unintentionally suggest that a meaningful distinction can be made between (practical) skills on the one hand and (formal) knowledge on the other hand. Therefore, we use the term “know-how” throughout this chapter, as it encompasses both the more practical and the more formal aspects of “knowing”.

The shipbuilding enterprise of the six chambers of the VOC was transformed over the years into one centralized large-scale technological system through the development of increasingly standardized designs and building methods. Originally the company relied on existing Dutch shipbuilding expertise which meant that the master shipwrights at its six separate yards had quite some scope to design and build the ships as they saw fit. Particularly during the seventeenth century, the VOC used many types of ships of a rather bewildering variety, so much so that even contemporary writers sometimes seemed puzzled. Van Dam mentioned his *uytterste bevreemdingh* (utter astonishment) about the continuous changes that were made year upon year in the charters of the ships when the chambers followed *hare eygen speculatiën en fantasiën* (their own speculations and phantasies) despite the penalties that had been introduced to prevent this from happening. He considered it highly amazing that it took almost 100 years before the chambers started to follow the rules that had been laid down.⁶⁷ It took until 1697, about seventy years after the start of its shipbuilding operations, the VOC effectively started on the path towards effective standardization. On 4 April 1697 - after extensive consultations with the master shipwrights of the six yards of the VOC - the *Heeren XVII* decided on a definitive design of the three charters of *retourschepen*.⁶⁸ As far as the form and the dimensions of the hull were concerned, a procedure was put in place to check at nine equidistant frames on five points each the prescribed width and draught.⁶⁹ However, during the first decades of the eighteenth century, an ongoing process of negotiations took place within the VOC-network, leading to a repeated adaptation of the standardized design of the *retourschip*, in response to changing needs of local VOC-chambers and to shifting shallows near local ports. Storms at the Cape of Good Hope and in the Indian Ocean however made it clear that – while the changed design might have succeeded in satisfying directors and in making local ports more accessible - it had compromised the seaworthiness of the *retourschepen*. Several attempts were made to address these issues, whereby even the States of Holland and the States-General of the Republic became involved, because - as it so happened -

⁶⁷ Van Dam (1701/1927), Part 1.1, p. 456

⁶⁸ Van Dam (1701/1927), Part 1.1, pp. 476-480

⁶⁹ Van Dam (1701/1927), Part 1.1, pp. 497-500

the monopoly of the VOC had to be renegotiated at the time. The outcome was that the design of VOC's *retourschepen* was adapted in a more rigorous way than before.⁷⁰

In 1742, the English master shipwright Charles Bentam, who was employed at the yard of the Amsterdam admiralty, was asked to design three new charters of *retourschepen* for the VOC. Through the measured drawings of his designs, he connected the VOC-shipyards with the English naval designing and shipbuilding network. He added foreign expertise and experience to the know-how that had already been accumulated within the shipyards of the VOC and he added a layer of calculation that was used to work out the frames of his designs; his architectural technical (or measured) drawings became an inseparable part of VOC's shipbuilding network. During the seventeenth century, in England and France technical drawings were increasingly used to codify the experiential knowledge of shipwrights. Over time, these drawings grew in importance and they tended to encompass an increasingly large part of the design: not only was the hull inscribed into drawings, but also details of the construction, of the rigging, and of the form of the sails.⁷¹ Whether the development of drawings as such led to better designs and an improvement in the characteristics of ships remains open to question, but these drawings made it possible to separate the design process from the building process, to increase control of the building process and to transfer (both through space and time) the design to other localities where it could be materialized by other shipwrights than the original designer. In the course of the eighteenth century, the phenomenon of using technical drawings in ship design found its way into the Republic. This had occurred on the one hand through local master shipwrights devising their own local systems of technical design drawings⁷²

⁷⁰ For a more extensive overview of the events surrounding the 1742 adaptation of VOC's ship design, see Jong, Johan de (2010), chapter 3.

⁷¹ Epstein (2006), pp. 17-19

⁷² In the 1720s the shipwright Gerbrand Slegt was experimenting with an early form of technical drawings in Amsterdam. At the Rotterdam admiralty, the master shipwright Paulus van Zwijndregt developed a method of technical drawings that must have originated before 1725. In that year he built the vessel *Twikkelo* for the Rotterdam admiralty and a set of sophisticated technical drawings of this ship survive, as do drawings of later designs by Van Zwijndregt. His method was different from the English system of technical drawings, but there were some similarities with early French methods. However, how exactly Van Zwijndregt developed his method remains unclear. His sons Leendert and Pieter, master shipwrights at the admiralty and the VOC respectively, further developed his system of drawings. At the same time, other shipwrights in Rotterdam, such as the private shipwright Cornelis de Ruiter, also employed technical drawings during the design and building process. During the 1740s and 1750s, the shipwright Willem Udemans Jr. (assistant master shipwright at the Middelburg shipyard of the VOC) developed a system of technical drawings. His method was different from the English method and it may have been

(people such as Pieter Van Zwijndregt, master shipwright at the Rotterdam yard of the VOC and Willem Udemans Jr, assistant master shipwright at the Middelburg yard of the VOC); on the other hand through the employment of English shipwrights (Charles Bentam being one of them) with their designs and building methods at the yard of the Amsterdam admiralty.⁷³

Through the introduction of the new designs with their measured drawings, the six (until then) quasi-independent centres of VOC's shipbuilding activities were increasingly connected into one large centre, although – as we will see in the third chapter – local shipwrights managed to regain part of their independence by introducing new or improved designs, and getting these accepted by the VOC as a whole. In the centre of VOC's (by now unified) network several aspects related to the ship design had found a place, such as existing know-how on ship design and shipbuilding, know-how about maritime, natural and nautical aspects of the areas the ships had to operate in, know-how about the purpose of the ship to be designed, and also financial constraints and requirements put forward by the *Heeren XVII* and/or the local VOC chambers. As will be discussed in the next section, the accumulation of materials, needed to materialize the design at the shipyards was informed by and dependent on the know-how of the master shipwrights. From 1842 onwards, a set of three interrelated design drawings, inscribed onto paper, formed the complete design for each of the three charters. It was generated in the centre of the network and it was able to be spread outwards, at the same time immutable and mobile: immutable, because the designs were – for the first time in commercial Dutch shipbuilding – established as a paper artefact that could stay unchanged for years and at the same time mobile, because it could easily be moved to other localities to be materialized. However, as will be explained later in this section, immutability is often not absolute but it can be flexible to some degree. Spatially this meant a move to the six different shipyards of the VOC, and at each yard a move to the lofts where the templates were produced, followed by a move (accompanied by the templates) to the actual yard where the design was materialized into an artefact such as a 150 ft. *retourschip*. The network in which the design was inscribed turned into a constructive network, disciplined by the design itself, and relying on imported building methods, as will be shown in the section on methods. Timewise, the immutable and mobile character of the drawings made it possible to use the

influenced by the French or by Van Zwijndregt, but it is nevertheless different from these methods. The emerging Dutch systems of technical drawings were different from the English and French systems, in that the Dutch drew a smaller number of mainframes, used different mathematical systems to relate the three views to one another and used a different system of numbering. (Cf. Hoving and Lemmers (2001), Ch. III & IV)

⁷³ However, the introduction of technical design drawings at naval shipyards in the Republic was generally less of a success-story, see Jong, Johan de (2010), ch. 2

Fig. 1.2 Technical drawings of a 150-ft. *retourschip*. According to Kist (1992), these are probably the slightly modified plans dating from 2 February 1742.

(Collectie Het Scheepvaartmuseum Amsterdam S.0247 [vrl.nr. 14664] - Spantenraam, waterlijnen, achter- en zijaanzicht van een schip van 50 stukken, afmetingen 150' x 41' x 18'¹/₂". Ch. Bentham, 1742)

design consistently during a timeframe stretching from 1742 to 1795. The *retourschip* technology remained fundamentally unchanged for over half a century, concerning both its basic design and its accompanying method of production. This means that what started out as an innovation in design and building methods was transformed – through its immutable and mobile character - into a “technology-in-use” that produced large numbers of highly standardized *retourschepen*.⁷⁴ Before the introduction of drawings, the VOC had a system of supervision in place whereby ships built at a certain shipyard were checked by other shipwrights after completion. That system was continued after the new designs had been established, although the new design and the building procedures associated with it, left little room to make modifications during the building of the ships. This state of affairs is borne out by the fact that one of the controlling shipwrights questioned whether it made sense to continue with the existing practice of control, “(...) now one has so many moulds that it is impossible to make any mistakes”. This suggests that the immutable design was effectively and accurately translated into the intended mobile artefact.⁷⁵

Materials

Oostenburg (and on a somewhat more modest scale the other shipyards as well) can be thought of not only as a production site, but it can also be interpreted as a junction of hundreds of supply lines, through which raw materials and goods were shipped in, accumulated, appropriated and transformed into complete (and increasingly standardized) merchantmen. The description of the three officially authorized charters of ships for the VOC and details of their construction (as was decided in April 1697) and of the materials to be used in their construction is presented in Van Dam’s *Beschryvinge*, chapter 17.⁷⁶ It has been suggested that most of the content of this chapter was written by the master shipwright at Oostenburg instead of by Van Dam, as the language used seems to be far more workman-like than the formal language used by Van Dam in the other chapters.⁷⁷ This makes it quite plausible that the description of procedures and of the (preferred) use of

⁷⁴ For the importance of “technology-in-use” see Edgerton (2006/2008), pp. xi-xxiii

⁷⁵ The quote has been attributed to the shipwright H.C. de Groot in a letter dating from 1742. In Dutch it reads “(...) *men nu soveel mallen heeft die beletten dat men met mogelijkheid geen abuysen kan begaan*”. The quote is given in Hoving & Lemmers (2001), p. 49. On the system of supervision, see Jong, Johan de (2010), pp. 21-22.

⁷⁶ Dam, Pieter van (1701/1927), Part 1.1 p. 476, also Boxer (1963), p. 83

⁷⁷ The issue of the “workman-like” language is mentioned by the editor of the printed edition of Dam, Pieter van (1701/1927) Part 1.1, p. 453, footnote 3.

materials reflects what actually happened (or at least what was meant to happen) at the shipyards of the VOC.

As far as materials were concerned, wood was the most important raw material used in building ships. Oak for keels was imported from Berlin or Silesia, wood for stems, frames and the structural part of the stern came from Oldenburg or Münster. Heavy deck beams were made from Rhineland wood, lighter deck beams from wood from Münster, or - if not available - from wood from Berlin or Rhineland. Wood from Berlin and Silesia was again used for the inner keel; knees were made of wood from the Weeser or Eyder area. Whales were made of Berlin wood, or - if not available in sufficient length - from Rhineland wood; the curved parts of the whales came also from the Rhineland. In general, wood from the Münster area was considered to be superior to that from the Rhineland area. All planks came from Berlin or Hamburg. Pinewood was used for masts, yards and decks, and cheaper fir for the galley, cabins and other accommodation. Oak kegs were manufactured in the Zaan area. The detailed descriptions in Van Dam's book concerning which type of wood should be used, and more specifically from which area, for certain parts of the ships suggest an extensive experiential know-how of the master shipwrights, built up and handed down over many years. In addition, there are suggestions on the best time to have the trees cut down, and on how to prevent rot setting in in tropical conditions.⁷⁸ Not only wood had to be imported and stockpiled. Raw materials like iron, hemp and resin and products like sailcloth came mostly from abroad as well. In the case of iron nails, there was a preference for having them made locally from Swedish iron, which was considered much stronger and easier to handle than nails from Liège in the Southern Netherlands. Anchors were made from an alloy of Spanish and Swedish iron. Dutch hemp was used for making ropes; sails were constructed from Dutch or French sailcloth. Resin from France, mixed with sulphur from Sicily, was made into a coating as a remedy against shipworm. Tar for treating parts of the hull was imported from Russia.⁷⁹

Therefore, prior to the construction of the ships, a knowledgeably informed material process of accumulation had to take place that relied heavily on the existing Dutch trade patterns that had been established during the sixteenth and early seventeenth century. The geography of material accumulation can be placed within the context of Dutch trading relations in general, of which the so-called *moedernegotie*, the trade through the Øresund with the Baltic, formed the backbone. For instance, the depletion of forests in Western Europe necessitated a shift towards Northern and (in the case of the VOC) towards Eastern Europe. Trade with France and Italy belonged to the so-

⁷⁸ Dam, Pieter van (1701/1927), Part 1.1 pp. 453-456

⁷⁹ Dam, Pieter van (1701/1927), Part 1.1 pp. 453-456 and Kampen, S.C. van (1953), pp. 50-51

called *Westvaart*, which grew in importance during the seventeenth century; trading with Russia was carried out via the port of Archangel at the White Sea. In effect, it can be discerned that accumulating sufficient materials of prescribed quality at VOC's shipyards depended heavily on an existing, extensive and expanding pattern of trade that existed alongside the VOC, and which was – looking at the volume of trade – always more important than VOC's trade with the East Indies.⁸⁰

Labour

In its construction, the *retourschip* was an international phenomenon, built by local Dutch shipwrights from foreign materials imported by the VOC, at one of the six specialized VOC shipyards; after 1742, its character became even more international through the use of an "English" design. Like the materials used to build the ships, sailors and soldiers employed by the VOC largely came from beyond the Republic's borders (hailing predominantly from across north-western Europe).⁸¹ The shipwrights, carpenters and other workers at its yards, however, were recruited locally and their jobs were often handed down from father to son. Although the VOC was instrumental in creating an international labour market with possibly the early emergence of a proletariat, these aspects did not apply to the workforce at its yards. Even accounting for the highly organized division of labour at the yards, the high degree of organization through the guild and the political awareness that went along with it – to which one should add the continuing high demand for skilled shipwrights - made it possible for the shipwrights to retain a degree of control at their workplace. Members of the shipwrights' guild, whether boss or labourer, tended to act in a confident, self-assured way, because they were in a rather strong position: they had a reasonably well paid job for most of the year

⁸⁰ On the importance of the *moedernegotie*, see Haan, Hans den (1976), chapter 2. He mentions the depletion of forests on p. 45. On the *Westvaart* and the trade with Russia, see *ibid.*, pp. 46-56. On the importance of trade patterns, see Vries, Jan de & Woude, Ad van der (1995/2005), p. 577. In the numbers they give in table 10.13, the financial gains from trading within the East Indies do not show up, which amounted to about 50% of VOC's trade within the Republic (cf. table 10.5 and 10.6). The absolute and relative importance of VOC's trade increased considerably during the course of the seventeenth and eighteenth century.

⁸¹ Gastra (2001/2007), p. 81 gives the percentage of foreigners as 60% in the case of soldiers and 40% in the case of sailors. These numbers are an average over the lifespan of the VOC. These percentages tended to increase in the course of the eighteenth century, for 1770 the numbers are 80% and 50% respectively as mentioned in Lucassen (2004), p. 19. In the next chapter it will become clear that the influx of foreign sailors and soldiers was thought to be the root cause of health problems that confronted the VOC during the 1770s.

and could count on financial support during sickness and old age.⁸² Even with a subsequent separation in place between the design and the building of the *retourschip* (see below), the complexities of the building process itself still prevented a de-accumulation of know-how that would have led to a proletarianization of shipwrights.⁸³

The master shipwright at Oostenburg supervised eleven foremen for the shipwrights and five foremen for painters, chip collectors, woodworkers, borers and plankers. In his supervision duties, the master shipwright could rely on the help of a foreman and an assistant. Other specialized branches at Oostenburg were supervised by the *equipagemeester*, again via foremen. This concerned specialist jobs as mast making, small boat building, joining, block-making, sail-making, the smithy, the ropewalk and the gunnery. This demonstrates the horizontal division of the labour mentioned earlier, whereby the results of each specialized unit were ultimately accumulated into each single new *retourschip*.⁸⁴ Working conditions at the VOC-yard in Amsterdam were relatively favourable compared to those at the many private yards in the city. During the course of the eighteenth century, the number of private shipyards was between thirty and thirty-five, the number of yards specializing in breaking up ships amounted to about ten, the number of yards building small boats was approximately fifteen and there existed about five yards specialized in the production of masts.⁸⁵ Although the basic salary for VOC-shipwrights was slightly lower than for privately employed shipwrights, if one worked for the VOC one had the advantage of a secure job. Workers at the VOC yard could not be dismissed without a good cause, they were entitled to a good redundancy pay and they were paid a good pension during old age.⁸⁶ Furthermore, VOC shipwrights were admitted to the shipwrights' guild even if they had not yet reached the status of master shipwright, an admission that gave access to the social security provided by the guild. About the smaller VOC-yards much less is known than about Oostenburg because of the loss of the resolution books of the four smaller chambers. Some details, concerning the yard at Rotterdam are known, and they suggest that organization,

⁸² On the shipwrights guild, see Deurloo (1971), *passim*

⁸³ On the emergence of a proletariat, see Lucassen (2004), p. 33

⁸⁴ Bruijn e.a. (1979-1987) Part 1, p. 29

⁸⁵ On the number of shipyards, see Deurloo (1971), pp. 9-10.

⁸⁶ Regarding the concerns by the directors of the VOC for the wellbeing of the workforce at its shipyards during the winding down of the VOC between 1795 and 1799, see for instance NA 3.02.33/24 letter dd. 12.03.1795 by the directors of the VOC to the Provisional Representatives of the People of Hollands. Even when from March 1796, all "extraordinary" activity on the shipyards of the VOC had come to a halt (which meant that only the absolute necessary activities could be continued), one tried as far as possible to divide the remaining workload over as many workers as possible by letting them work part-time, cf. Eyck van Heslinga (1988), pp. 53-54.

knowledge, materials, labour and methods were accumulated in much the same way as was the case at Oostenburg.⁸⁷

Methods

The original building method used at the northern shipyards in the Republic (which in the case of the VOC meant Amsterdam, Hoorn and Enkhuizen) was the “shell first”- method, as described by Nicolaes Witsen in *Aeloude en hedendaegse scheeps-bouw en bestier*.⁸⁸ It implied that first the keel was laid down and the stem and stern put into position. The next step consisted of fitting a number of timbers that were to form the bottom floor of the ship. The third step consisted of positioning a few low moulds on to floor to assist in constructing the transition from the bottom of the vessel to the bilges of the vessel. When that stage had been completed, preliminary frames were positioned on the bottom floor and between the bilges, outlining the vertical lines of the hull. Horizontally across these moulds, the planks forming the hull were fitted. Once the hull had been completed, the definitive frames were put in place, the form of which had to fit in with the hull as it had been created. These procedures offered the shipwrights, engaged in the building process, ample scope to (re)design a ship while building it. In the southern half of the Republic (which in the case of the VOC meant Rotterdam, Delft and Middelburg) a different system was in use. There, a method was used that was described by Van Yk in *De Nederlandse Scheeps-bouw-kunst open gestelt*.⁸⁹ After the keel had been laid and the stem and stern had been erected, the next step consisted in the positioning of two identical main frames, one approximately halfway⁹⁰ between stem and stern and a second frame before the first, at approximately a quarter of the distance between that frame and the stem. The next step consisted of fitting a ribband from stem to stern along the frames, providing the outline of the hull. If the shipwright was satisfied with the shape, then a third frame was put in place on the point where the stem met the keel. This frame was similar in shape to the two main frames but

⁸⁷ On the situation in Rotterdam, see Grimm, Peter (1994), pp. 17-23 and Kampen, S.C. van (1953), p. 105. Van Kampen carried out research in the Municipal Archives of Rotterdam (G.A.R.), especially in the so-called *Gifteboeken* and the *Archief Fabrieksmeesteren*.

⁸⁸ Two editions of this book were published, the first (*Aeloude en hedendaegse scheepsbouw en bestier*) in 1671, the second enlarged one (*Architectura navalis et regimen nauticum Ofte Aaloude en hedendaagsche scheeps-bouw en bestier*) in 1690. In both editions, chapter 11 contains the description of the building process.

Witsen was a magistrate and burgomaster of Amsterdam, and also one of the directors of the Amsterdam chamber of the VOC.

⁸⁹ Yk, van (1697), esp. ch. XII, XII and XIV. Van Yk was master shipwright in Delft.

⁹⁰ A formula was used to find the exact spot; in the formula, the fall of the stem was also taken into account.

slightly narrower. Where the stern met the keel a fourth frame was put in place; this frame defined the shape of the hull at the stern. Working from these four frames the rest of the horizontal planking was fitted. This procedure gave the shipwright still quite some leeway to change the form of the hull. After completion of the hull, the remaining frames were put in place, which had to fit in with the hull as it stood; a process that was quite similar in character as the northern method.⁹¹

The new system of shipbuilding copied the building procedures in use at English naval shipyards. After the laying of the keel, the “floors” of the frames were put in place. These floors conformed to the form of the complete frames. On top of these floors, the main frames (also called station frames) were put in place, in two halves. The two halves were linked and locked between the keel and a so-called “chock” on top of the bottom of the frame. The floors and the main (or station-) frames had been constructed beforehand according to templates, derived from the technical drawings. That stage being completed, a few ribbands (small flexible planks) were mounted horizontally across the frames and then auxiliary frames were placed between the main frames; finally the planking of the hull was completed. In a sense, one could say that – within the building network – the main frames exercised control over the definitive form of the hull, as well as over the shipwrights. Working under the master shipwright, shipwrights were obliged to follow the new designs closely and to use the prescribed form of all main frames (depending on the size of the vessel, between sixteen and twenty-four) exactly as they were inscribed in the design, which led to a decrease in their independence. This shows that the English system of designing and building not only made it possible to control the building of the ship itself right down to the smallest details but also to “control the shipwrights right down to the smallest details”.⁹² A hybrid network encompassed the constructors, the construction method relating to the artefact under construction and, most importantly, the artefact itself. In the original system of shipbuilding, with no drawings available to record accurately what happened (or should happen) during the building process, the building of a second ship of the same dimensions and for the same purpose invariably led to variations in the materialization. This was (to a large extent) prevented by the introduction of the new system.

The historian of technology David McGee wrote that until the mid-nineteenth century, the use of “architectural designs” in ship design was restricted to naval shipbuilding, and that such “plans were used almost solely for the construction of warships”. Drawings were used in (naval) shipbuilding

⁹¹ For a comprehensive and illustrated overview of both methods, see Hoving & Parthesius (1991); also Jong, Johan de (2010), pp. 47-48 & 75-77

⁹² Hoving & Lemmers (2001), p. 33

because “they promised to save money in construction”.⁹³ The same reasoning can of course be applied to the building of commercial vessels as well, if the number of vessels that is being built is large enough to offset the costs of the elaborate construction of the drawings. The VOC as owner and builder of (almost all of) its own ships – in contrast to the English East India Company that rented its ships from private ship-owners – can be thought to have had an interest in keeping down the cost of building its ships. This could be realized by a process of centrally controlled standardized production of standard ships, which – as we saw earlier – was already well underway before the introduction of technical design drawings. We may therefore suggest that the fact that the innovation of using technical drawings within commercial shipbuilding succeeded at the VOC was – at least partly – linked to its factory-like production of large numbers of similar vessels, making it worthwhile to invest in the time-consuming procedures of drawing measured plans. The obligation to use prescribed frames when building the ships made it almost impossible to deviate from the design, unless when shipwrights explicitly started experimenting. The responsibility for controlling whether the master shipwrights followed the prescribed designs was to a large degree delegated to the design itself: inscription turned into prescription. Control over complying with the design changed from supervision carried out by other shipwrights after completion of the ship, to the impersonal frames prescribed by the immutable and mobile design during the actual building process.

Therefore, the master shipwrights became subordinate to the design and – as a consequence of the new building methods – the shipwrights at the yard became subordinate not only to both the master shipwright but also to the design. This could give the impression that the local master shipwrights at the six yards of the VOC were reduced to just implementing given designs, suggesting that their know-how became less important. However, not only were the master shipwrights consulted during the process that culminated in the new designs,⁹⁴ there is sufficient evidence that at least some of the master shipwrights were actively involved – both on a practical and on a theoretical level – in adapting the existing designs to increase their seaworthiness. This happened for the first time in the late 1740s when the Rotterdam master shipwright Pieter van Zwijndregt made some proposals for change. On 31

⁹³ On the use of architectural designs in naval shipbuilding, see McGee (1999), p. 222. On warships, see McGee (2003), p. 35. On the saving of money, see McGee (1999), p. 226.

⁹⁴ A committee consisting of shipwrights and skippers discussed and commented upon the designs drawn by Charles Bentam. The committee consisted of the master shipwright of the VOC shipyard in Amsterdam yard (Blok), the master shipwright of the VOC shipyard in Middelburg (Raas) and his assistant (Bakker), two private shipwrights (Goudrok and Van Dalen), three skippers (Van Thiel, De Boer and Belleveau) and two retired skippers (Reebok and Oterlijk). See Jong, Johan de (2010), pp. 70-71

October 1748, the governor-general in Batavia wrote a letter to the *Heeren XVII*, with proposals to change the design of the *retourschepen*. In his letter, he referred to an advice that was sent to him from the Republic and which was apparently accompanied by a ships' model.⁹⁵ He had the advice checked by some shipwrights who added a short treatise on the use of proportionality in ship design in which they referred to methods used in Rotterdam.⁹⁶ The main proposals were concerned with a widening at the stern of the 150 ft.-charter, with a lengthening of the 136 ft.-charter by 4 feet and with a fuller design of the stern of all charters, in order to improve sailing characteristics in rough seas. In the treatise, mention was made of experiments that had been carried out, which - in all likelihood - must have been done by Pieter van Zwijndregt.⁹⁷ On 22 September 1749, the *Heeren XVII* adopted most of the "Batavia"-proposals and in addition, on 28 November 1749, a new list was drawn up, containing adapted dimensions of masts, spars, sails and rigging.⁹⁸ A more local adaptation occurred when it turned out that the new design had difficulty in coping with the local estuaries and shallows between Rotterdam and Delft and the open sea. In 1763, the chamber Rotterdam put forward a proposal to decrease the effective draught of the 140 ft.-charter by about 1½ feet, and to compensate for the loss of carrying capacity the design had to be widened at the bilges and the stem and stern were made wider (i.e. less sharp). The other chambers opposed these changes, stating they would mean a return to less seaworthy earlier designs. However, the *Heeren XVII* gave permission to the each of the chambers Rotterdam and Delft to build one ship of the adapted design as an experiment. Probably these two chambers continued building their ships according to the modified designs, although the designs, as adapted in 1749, remained in force and had still to be used by the other four chambers.⁹⁹ Another adaptation was instigated by the master shipwright Willem Udemans at VOC's Zeeland yard in Middelburg when he and his son (Willem Udemans Jr) tried to incorporate new requirements and new insights (such as how to safely navigate the South China Seas) into their design of a three-decker, which again showed the interdependence of mind

⁹⁵ The governor-general at the time was Van Imhoff who had played an important role in the introduction of the 1742 designs. Jong, Johan de (2010), ch. 3.2 Van Imhoff's letter is in NA 1.04.02/2078

⁹⁶ One of these was the shipwright Verleng who resided in the East at the time, probably at the VOC (repair) yard at Onrust near Batavia.

⁹⁷ For more details, see Jong, Johan de (2010), ch. 4.3.1. The circuitous route that Van Zwijndregt used, in getting from Rotterdam to Amsterdam via Batavia looks remarkably similar as the route that will be encountered in the next chapter when in the late 1690s skippers used such a route to make their opinions heard on the use of apparatus for seawater distillation.

⁹⁸ Kist (1992), p. 69, NA 1.04.02/7377 dd. 22.9.1749 & 28.11.1749

⁹⁹ Jong, Johan de (2010), ch. 4.3.1

and hand.¹⁰⁰ As we will see in the third chapter, it took several years of (sometimes acrimonious) theoretical and experiential argument before a settlement could be reached through the intervention of a regional society.

Immutable mobiles

Looking at the way in which the new design summarized - in a portable and succinct way - the accumulation of diverse modes of know-how, requirements, disciplined labour and methods, we may interpret it as an “immutable and combinable mobile”, as proposed by Bruno Latour. In general, an immutable mobile contains descriptions of relevant know-how and procedures, either in the form of words, maps or charts, templates, diagrams or drawings. Immutable mobiles are two-dimensional inscriptions that have the advantage of being mobile and immutable (while on the move), they are flat, their scale can be modified at will, and they are reproducible. Immutable mobiles can be recombined with one another, they can be superimposed on one another, they can be made part of a written text and – as they are two-dimensional – they can be merged with geometry.¹⁰¹ The last point is especially important in the case of a ship design where three (sets of) two-dimensional drawings are needed to form a three-dimensional design and to construct a three-dimensional artefact. In the case of the new manner of ship design and shipbuilding at the VOC, the new design reconfigured the relations between organization, know-how, materials, labour and methods and it forged a new and strong link between the six separate, local shipyards of the VOC. The inscription of the design onto paper translated accumulated know-how into an immutable mobile, and – using accumulated materials, disciplined labour and new methods – the design was then transformed into the ships themselves. An immutable mobile functions as an essential go-between in transforming know-how into artefacts. It transports the design (containing accumulated know-how) to various localities over time, it is mobile because of this ability to travel through time and space and immutable in the sense that it stays intact while being moved. However, once such a design has been inscribed, it turns out that details can be changed in a controlled way, producing an adaptation of the original immutable mobile, which may in due course again show openness to flexibility. This was in fact shown by the changes (sometimes small and localized, sometimes more far reaching and of a general nature) that local master shipwrights of the VOC introduced to the original design. Although the possibility to adapt the design may seem at odds with the adjective “immutable” we can already detect a degree of flexibility within Latour’s own introduction of the concept, and within the examples he gives. So

¹⁰⁰ Jong, Johan de (2010), ch. 4.3; this volume ch. 3

¹⁰¹ On the merging with geometry, Latour (1986), pp. 18-20

while an inscription on paper may indeed be considered immutable, it is not set in stone or carved in wood.¹⁰²

The presence of technical design drawings of ships, dating from the eighteenth century, in libraries in the twenty-first century signifies both their mobility and their immutability.¹⁰³ But then again, this does not imply that designs are immune to modification or re-interpretation. On the contrary, precisely the fact that the design was inscribed made it possible to write comments in the margin and change details as a result of changing requirements or experiences of users, leading to a (re)new(ed) immutable mobile. (This very chapter shows how such an inscription can be used in a way totally unforeseen by the original producer.) Therefore, a degree of flexibility is inherent to an immutable mobile.¹⁰⁴ Although one should realize that such flexibility exists when moving from one manifestation of an immutable mobile to the next, it nevertheless feels appropriate to use the word immutable to describe that within a given manifestation the content is indeed unassailable. As far as the adjective “combinable” is concerned, Latour pointed to the combination of several separate immutable mobiles but in the case of technical drawings for a ship design, combinability is an essential part of the design itself because of the fact (as we just noticed) that the three two-dimensional drawings that make up each design need to be combined to produce the three-dimensional artefact. The immutable mobile made it possible to better master the design and the underlying know-how, helping to “accelerate the accumulation cycle”.¹⁰⁵

Latour wrote that calculations relating to an immutable mobile are performed in a specific centre of calculation, that such calculations are additional to an already existing immutable mobile and that they belong to the next degree of abstraction. This points in the direction of an increase in abstraction. Although Latour implicitly acknowledged that some calculation could already be needed in the construction of the immutable mobile itself, when he writes on the modification of the scale of inscriptions, he seemed to

¹⁰² For Latour’s example of the construction of the map of Sakhalin, see Latour (1986), pp. 5-6 and Latour (1987), pp. 215-219. The example of pre-printed observation forms supposedly used by the astronomer Tycho Brahe as one of the first (if not the first) form of an immutable mobile, has been challenged by Gorman (2001) <http://www.stanford.edu/group/STS/immutablemobile.htm> For more on the (im)mutability of maps or charts, see chapter 4 of this dissertation.

¹⁰³ Such as in the library of the *Nederlands Scheepvaartmuseum* in Amsterdam (which contains Bentam’s design for the third charter of the VOC *retourschip*) and in the library of the University of Utrecht (where the *Moll Collectie* contains naval designs by Slegt, Van Zwijndregt, Bentam and Davis)

¹⁰⁴ Regarding the flexibility of the immutable mobile, in another context, the term “fluid mobile” has been coined by M. de Laet & A. Mol (2000).

¹⁰⁵ This aspect of acceleration is mentioned in Latour (1987), p. 228.

overlook the possibility that – once an original immutable mobile has been established – further calculation could be needed on the path towards producing an artefact on the basis of this immutable mobile. So while Latour was engaged in describing a process of increasing abstraction, taking his immutable mobile as his point of departure, the process of constructing artefacts with the help of immutable mobiles – and in doing so, being engaged in a process of increasing concretization – seems to be missing in his reasoning.¹⁰⁶

Fig. 1.3 Model of a *retourschip* of 150 ft. in camels; this model was probably built by Charles Bentam, who designed the series of new *retourschepen* for the VOC in 1742 (Rijksmuseum Amsterdam NG-MC-502)

In the particular case of ship design we can already discern a process of calculation in the scaling down of the dimensions of the proposed ship to make it fit on a convenient sized piece of paper, and we can imagine the amount of mathematical calculations that are needed to design the mainframes in such a way that the three separate two-dimensional drawings

¹⁰⁶ On centres of calculation, see Latour (1987), pp. 232-237; on the modification of the scale of inscriptions, see Latour (1986), p. 19

fit seamlessly together into a three-dimensional artefact. The actual building of the ship entailed another stage of calculation, performed at a local (and not at a central) centre of calculation, i.e. the local loft where the design was faithfully enlarged to its proposed dimensions and made into templates that could be used over and over again. We may interpret these templates as other examples of the same immutable mobile, although in a sense more “artefact” and less flexible, as they were no longer written or printed on paper but were made of wood to render them more durable. Their immutability was therefore increased and their flexibility decreased while their mobility was limited to the yard itself. That means that on the one hand there is a movement within a centre of calculation towards more abstract and scaled-down immutable mobiles, moving away from the actual artefacts, and on the other hand there is also a movement back to the shop floor by rather concrete and full scale versions of the original immutable mobile, to facilitate and control the transformation of the design into a ship. In addition to the flat, two-dimensional design drawings each shipyard of the VOC was also supplied with scaled-down three-dimensional models of the design. This suggests that perhaps the transformation from drawings on paper to a ship built of wood was considered as not completely straightforward.¹⁰⁷

In the case of the design of *retourschepen*, we can therefore discern immutable mobiles on three levels of abstraction; the most abstract and most universal of which is the original two-dimensional drawn paper design, which was translated into scaled-up wooden templates to facilitate the construction of the three-dimensional artefact, a transformation that was assisted by a three-dimensional scaled-down model. This last immutable mobile can be considered as being the most immutable, the least flexible and the least mobile. In contrast to Latour’s rather strict definition of what constitutes an immutable mobile, which he applies to explain “science in action”, it seems to be more appropriate here to introduce a continuum between the “ink-on-paper” immutable mobile proper and a more experiential immutable mobile (such as the templates) leading up to the final artefact. It was in fact this more experiential mobile (and the mainframes derived from it) that was instrumental in disciplining the shipwrights engaged in the building process.¹⁰⁸ These layers of mobiles may also be more in keeping with Latour’s concept of hybrids, hybrid networks and quasi-objects, concepts that – through circulation and negotiation – link non-humans and nature with

¹⁰⁷ Two of these models – made by Charles Bentam – survive in the collection of the Rijksmuseum at Amsterdam, one of a 150-ft. charter (NG-MC-502) and one of a 120 ft.-charter (NG-MC-MC 503). (Hoving & Lemmers (2001), pp. 41-42.

¹⁰⁸ On the disciplining by drawings, see also Alder (1997), pp. 282-283

humans, culture and society.¹⁰⁹ The hybrid network that existed at the shipyards encompassed a gradual process that started with the drawing and calculating of the design, led to the building of a what was to become a *retourschip* – guided and controlled by the immutable mobiles of the design – and culminated in the production of that ship that was neither an objective “thing-as-such” because it was were produced through a hybrid network, nor was it the shapeless result of social categories because it possessed definite thing-like qualities. We may therefore call such a ship a “quasi-object” (or a “quasi-subject” for that matter) because it showed clearly “the non-separability of the common production of societies and natures”.¹¹⁰ As we will see in the next section, it was through the different roles that it played in its working life (thereby displaying another layer of its hybridity) that the ship became a real *retourschip*.

1.2 Mobile ships – hybridity and accumulation on the high seas

The retourschip

The design and building of a *retourschip* as described before, shows the workings of the VOC as a large (technological and early capitalistic) enterprise within the Republic, in its accumulation of know-how, its use of foreign materials, of prefabricated parts and of a local workforce, resulting in a single, complicated artefact based on the immutable mobile of its technical design drawings. We saw that *retourschip* was the material outcome of an extensive network, a network that was hybrid in character because it contained both human and non-human actants, none of which were fully subservient to the others; whereby (as we will see) the *retourschip* itself was hybrid in character as well. Once the ship had been built (as quasi-object because it was the result of the inseparability of nature and society), it then continuously and seamlessly connected nature and society on its trajectory between the Dutch Republic and the East Indies (and back again), negotiating the high seas and serving the commercial interests of the VOC. It was on and through this trajectory that the ship became what it was meant to be, a *retourschip* that was at the same time mobile and mutable; mobile because – on average – it travelled for years halfway across the globe, mutable when we consider the difference in what was accumulated in its hold on the outward and on the homebound journey, and mutable also when we see how different routes were chosen on the outward and homebound voyage, how its crew differed on the

¹⁰⁹ The concepts of hybrids, (hybrid) networks and quasi-objects have been developed by Latour (1993).

¹¹⁰ Latour (1993), p. 141

Fig. 1.4 A retourschip of 150 ft. at anchor, probably at Colombo around 1785, drawing by Jan Brandes (Rijksmuseum Amsterdam NG-1985-7-2-38)

way out and on the way back, and mutable in the different purposes it served going and coming. It was this mutability, housed in a ship whose design was (as we have seen) immutably flexible - in a dynamic balance between innovation, standardization and adaptation - that allowed for the very

circulation by which the VOC (as centre of accumulation served by its ships) could become strong.¹¹¹

A *retourschip*, as was usual the case with large ships at the time, had two complete decks, the lower of which was called *overloop* (orlop or gundeck) and the higher *verdek*. The lower hold, below the *overloop*, was used for stowing goods and provisions, the space between *overloop* and *verdek* contained accommodation for sailors and soldiers. On top of the *verdek*, another deck was constructed in two parts, the front part at the stem called *bakdek* and the rear part after the mainmast called *halfdek*. On this *halfdek*, the cabins for the officers, merchants and passengers were located near the stern of the ship. Part of the *halfdek* near the stern could be raised into a slightly higher deck, called the *campagne*. The lower part in between the *bakdek* and the *halfdek* was called the *kuil* (waist). In the late eighteenth century, this deck in two halves was turned into a complete deck, called *bovendek* (upper deck). This adaptation was accepted after a long drawn out process of negotiations (which will be extensively discussed and interpreted in the third chapter). The master shipwright at the Zeeland yard of the VOC in Middelburg who proposed this adaptation used the flexibility that existed within the original plans or possibly stretched this flexibility even further than originally had been envisaged.¹¹² The sailing plan was made up of a three-mast configuration, the masts being high to take as much advantage of the light winds in the tropics as possible. The yards carried high and rather narrow sails. Only the foresails and the mizzen sail were of a fore-and-aft configuration, the main sails being square.¹¹³

Every *retourschip* carried building blocks for the construction of an empire, both outward bound toward the East Indies and homebound back to the Republic. On the outward journeys, quite often actual building blocks were transported, because on these trips the ballast was made up of large quantities of bricks, ordered by the VOC's officials in Batavia to build the company's premises overseas.¹¹⁴ However, other materials, goods and persons can be interpreted as (metaphorical) building blocks as well. Bullion and coins, soldiers and sailors carried on the way out, and spices, coffee, tea,

¹¹¹ On thing-like qualities, see Latour (1993), p. 55

¹¹² On this negotiated change, see Bruggen, B.E. van (1976-1978), p. 32, Bruijn e.a. (1979-1987) Part I, pp. 47-49, Loeve (2001), passim, Jong, Johan de (2010) pp. 104-107 and this dissertation, chapter 3.

¹¹³ Bruggen, van (1976-1978), pp. 42-44

¹¹⁴ In the local museum in Geraldton (Western Australia), one can still marvel at the original prefabricated, classicistic gateway, the building blocks for which were carried as ballast in the bilges of the ill-fated *retourschip* Batavia in the year 1629. In the maritime museum in Fremantle (Western Australia), the reconstructed original stern of the *retourschip* Batavia sits on yellow cobblestones, also carried as ballast. Cf. Dash (2002), p. 69.

textiles and porcelain carried on the way home, all contributed to the building of VOC's empire. This interactive hybrid role played by the *retourschip* within the VOC will be discussed next.

Outward-bound

Before a *retourschip* could set sail, it had to be completely manned, equipped and stocked up for the journey to the East. Alternative means for the provision of ample fresh drinking water will be discussed in the second chapter. In addition, navigational tools had to be made available. These tools included navigational instruments such as octants (imported from England), charts that were – in most cases - supplied by the cartographic department of the chamber Amsterdam of the VOC and extensive and detailed route-descriptions.¹¹⁵ The VOC committee for secret affairs was entrusted with the task of determining and prescribing the best sailing routes for the fleets. These routes were dependent on the time of departure and on the direction of travel; they were based on the accumulation of know-how and experiences of the skippers of the VOC. Skippers were obliged to keep an extensive log and upon his return, every skipper was obliged to hand in his log. These logs served two purposes: firstly they could be used to see whether skippers had stuck to the prescribed rules and regulations, and secondly their experiences found their way into the descriptions and onto the charts produced by or for the VOC.¹¹⁶

A result of this accumulated know-how can be seen in the detailed description of the outward route from the Republic to Batavia. After travelling either through the English Channel or around the north of Scotland, the *retourschepen* had to follow the so-called *wagenweg* (waggon way) or *karrepad* (cart track), a route that guided them across the equator in the Atlantic Ocean whereafter the ships sailed towards the South American coast. After rounding the Cape of Good Hope (where a stopover became obligatory from 1616 onwards), skippers were then obliged to steer an easterly course towards *Hollandia Nova* as the west coast of Australia became known at that time. This route (prescribed from 1617 onwards) was based on the discovery of Hendrick Brouwer, who explored it on a voyage to the East Indies in 1610 when he discovered the westerly trade winds between latitudes 35° and 40°S. These strong and constant winds could save considerable time in comparison with the more westerly routes that had been used before. Having sailed a

¹¹⁵ For more on charts and mapping, see chapter 4 of this volume.

¹¹⁶ On the import of instruments, see Mörzer Bruyns (1998) and Mörzer Bruyns (2003), esp. chapter 5. The committee for secret affairs is mentioned in Bruijn e.a. (1979-1987) Part 1, pp. 16-17. On surviving charts, see *VOC-glorie: stug, verbleekt en overal gaatjes*, newspaper article in NRC-Handelsblad 29 June 2010.

sufficient distance (approximately 4000 nautical miles) eastwards, the ships then had to change to a northerly course to arrive at the island of Java.¹¹⁷ On its outward voyage, a *retourschip* carried large amounts of silver and gold (both as coins and in bullion) to be traded for spices, coffee, tea, textiles and porcelain. The important position of Amsterdam in the international silver and gold trade was of great assistance in the accumulation of these precious metals, which points again – just as in the case of the *moedernegotie* that was mentioned earlier – to the interconnection of different patterns of trade. Each ship also carried food and drink for several months, calculated to be sufficient for an extended journey to the next port of call, which was usually the Cape of Good Hope. This food (including salted meat) was stored at Oostenburg, where a slaughterhouse existed at the *Zeemagazijn*. A standardized amount of ammunition, related to the number of cannons aboard, had also to be loaded; this ammunition was stored at Oostenburg as well.

In addition to its load of bullion and coins, supplies and ammunition, a *retourschip* also transported dozens of soldiers and it was manned by far more sailors than were actually needed for its voyage. In the first half of the eighteenth century, a typical *retourschip* of the largest charter carried up to 120 soldiers and about 160 sailors on its outward voyage; in November 1750 the standard size of the crew had been established as 300 on ships of the first charter and as 225 on ships of the second charter, although ships leaving before the first of January might sail with a crew of up to 350, respectively 260.¹¹⁸ On the return voyage however, it hardly carried any soldiers at all and the number of sailors on board was reduced to less than 110. The soldiers materialized the powers that were bestowed on the VOC by the States-General to act as a state overseas, and they were obliged to stay in Asia for at least five years. The power embodied by the soldiers was vulnerable, though, through their high mortality in the East Indies, and therefore new soldiers had to be shipped out on a very regular basis. The surplus of sailors on every outward voyage made it possible that sufficient crewmembers would be left for a competently manned return voyage because sailors were almost as vulnerable

¹¹⁷ On the *wagenweg/karrepad*, see Voorbeijtel Cannenburg, W. (1953), pp. 467-471 and Bruijn e.a. (1979-1987) Part I, pp. 64-66. On Brouwer's route, see Bruijn e.a. (1979-1987) Part I, pp. 70-72 and <http://www.nla.gov.au/exhibitions/southland/Trade-Seynbrief.html> For more on the role the *wagenwg* can be seen to have played, see chapter 4 of this dissertation.

¹¹⁸ NA 1.04.02/170 dd. 18.11.1750, reconfirmed in 1771 (NA 1.04.02/180 dd. 02.10.1771). In a crew of 350, there were 200 sailors and 150 soldiers, and in a crew of 260 two-thirds were sailors and one-third soldiers. Moreover, it says in the minutes that “the chambers are allowed to equip their ships with so many extra crew members as space allows” (“*de Cameren by dezen te qualificeeren om boven het bepaalde getal zo veel meerdere Manschappen op iederen Bodem te plaatsen als deszelfs ruymte sal kunnen toelaten*”). In chapter 2, problems associated with too large a crew are extensively discussed.

as the soldiers. As far as sailors were concerned, the inevitable death toll on the way out and the probability that some of them would desert during the outward journey had to be taken into account.¹¹⁹ Even more important was the fact that almost all ordinary sailors had to stay in Asia to serve a three-year contract by operating ships in the intra-Asian traffic, an occupation they might not survive.¹²⁰ Sailors therefore contributed to the building of VOC's commercial empire in the East Indies, not only by operating its *retourschepen* to and from the Republic, but also by contributing to the operation of the local intra-Asian fleet that linked the various factories of the VOC. For the shipping operations in the East Indies, non-*retourschepen* were sailed across with the intention of operating in the East on a permanent basis; the same happened to old *retourschepen* that stayed in the East after several return-trips and even *retourschepen* might have to serve in the intra-Asian traffic in between outward and homebound voyages.¹²¹ In fact this last use of a *retourschip* highlights another aspect of its mutability.

It is possible to see the people, accumulated on board of the *retourschepen*, as belonging to two different classes, a class of dispensables (such as soldiers and ordinary sailors) and a class of indispensables (such as merchants, ships' officers, artisans and VOC officials). The rate of return for officers varied between 70 and 80%. In order to be appointed as a ships' officer, one needed to have certain qualifications although the rules were quite different at the six chambers of the VOC. For instance, from 1619 onwards a prospective ships' officer had to pass an exam before he could be employed by the Amsterdam chamber, but it was more than a century later (in 1737) before a similar rule was applied by the Rotterdam chamber. Over time, the content of these exams became increasingly difficult. It took until 1751 before prospective skippers had to sit for a formal exam; before that time skippers just rose through the ranks of officers. In order to pass these exams, one needed to show that one was an experienced seafarer, and that one possessed sufficient (theoretical and practical) know-how regarding navigation. Especially theoretical know-how could be gained by studying books on navigation or by attending classes given by private teachers. The class of dispensables can be considered as an early example of a national, international and even global proletariat, as these dispensables were not only recruited from rural districts of the Dutch Republic, northwest and central

¹¹⁹ Bruijn e.a. (1979-1987) Part 1, pp. 161-167 gives a rate of mortality of between 7% and 15% on the journey from the Republic to Asia, well above the rate of mortality of 4% that was to be expected in the Republic.

¹²⁰ Bruijn e.a. (1979-1987) Part 1, pp. 169-172 estimates that between half and two-thirds of those staying in the East Indies to serve their contracts, died before they could return.

¹²¹ On the intra-Asian traffic, see Parthesius (2007), Rossum, van (2011) and Rossum, van (2014), pp. 58-67

Europe, but – during the latter decades of the eighteenth century – also from Asia.¹²² No qualifications were needed if one was to be employed as an ordinary sailor or soldier. Estimates suggest that the VOC – during the two centuries of its existence – recruited half a million sailors and soldiers from the rural districts of the Dutch republic and half a million foreigners. The dispensability of the dispensables is shown by their rate of return, which was between 19 and 30% as far as soldiers were concerned, and between 40 and 60% for ordinary seamen.¹²³

Until 1742, the person ultimately in charge of the *retourschip* during the voyage, both outward bound and homebound, was not the skipper but the senior merchant and his deputy, the under-merchant. While the skipper was still responsible for matters of navigation and sailing, the merchants could order the skipper to stay in port or to make sail when the interests of the company required. This arrangement of the way *retourschepen* were operated mirrors the impression that profitable trade was the first and utmost consideration as far as the VOC was concerned. In 1742, this rule was abolished; from then on the senior merchant (and his deputy) “were no longer part of the ship’s government but sailed as a passenger”.¹²⁴ However, from then on (as will be shown in the second chapter) skippers became subject to an expanded set of increasingly centralized and standardized rules and regulations prescribed by the *Heeren XVII*.

Homebound

On the return voyage the *retourschepen* were heavily loaded, if not overloaded with spices and other merchandise. The amount of cargo that the *retourschepen* could actually carry on the (return)voyage had been a matter of much debate in the seventeenth century. In the late 1680s, Hendrik Decquer, a director of the Amsterdam chamber, published *Middelen om uit te vinden de ware lading der schepen na hare grootte* (Means to establish the true cargo of ships according to their size); in this book he showed – by mathematical and experiential means – that the so-called “common calculation” by which the carrying capacity of ships was calculated was applicable to VOC’s *retourschepen* as well.¹²⁵ He also drew up an extensive list (consisting of 673

¹²² Rossum, van (2011) and Rossum, van (2014), ch. 3

¹²³ On these numbers, see Lucassen (2002), pp. 14-15, Lucassen (2004), p. 16 and pp. 20-24, also Gaastra (2001/2007), pp. 88-91

¹²⁴ Dash (2002), pp. 3-4, Bruijn e.a (1979-1987) Part I, p. 210,

<http://www.vocsite.nl/geschiedenis/functies.html>

¹²⁵ Decquer (1688/1690), passim, Bruijn e.a. (1979-1987) Part I, pp. 43-44, Jong, Johan de (2010), p. 24 & pp. 86-87.

BY L A G E, N ^o . 10.			
Ammunitie en Scheeps-behoeften.			
Art.		ponden.	cu. v.
1	Alles alle voortren door den anderen	—	—
2	Baskruys in vaertjen van 100 pond	1000	4
3	Baskruys in vaertjen van 50 pond	1000	118
4	Baskruys in vaertjen van 5 pond	1000	46
5	Baskruys in vaertjen van 5 pond	1000	50
6	Baskruys in vaertjen van 100, 50, en 5 pond yder door een	1000	1168
7	Canon van yzer van 1 pond balis	1 fluk	60
8	Canon van yzer van 2 pond balis	2 fluk	68
9	Canon van yzer van 3 pond balis	3 fluk	72
10	Canon van yzer van 4 pond balis	4 fluk	76
11	Canon van yzer van 5 pond balis	5 fluk	80
12	Canon van yzer van 6 pond balis	6 fluk	84
13	Canon van yzer van 8 pond balis	8 fluk	88
14	Canon van yzer van 12 pond balis	12 fluk	92
15	Canon van yzer van 18 pond balis	18 fluk	96
16	Canon van yzer alle calibren door den anderen	1 fluk	100
17	Cogels van yzer 1 ponds	100 fluk	8
18	Cogels van yzer 2 ponds	200 fluk	16
19	Cogels van yzer 4 ponds	400 fluk	32
20	Cogels van yzer 6 ponds	600 fluk	48
21	Cogels van yzer 8 ponds	800 fluk	64
22	Cogels van yzer 12 ponds	1200 fluk	96
23	Cogels van yzer 18 ponds	1800 fluk	144
24	Cogels van yzer 24 ponds	2400 fluk	192
25	Cogels van yzer van 1 tot 24 pond door een	100 fluk	237
26	Cogels yzer knuppels 2 ponds	100 fluk	140
27	Cogels yzer knuppels 3 ponds	100 fluk	156
28	Cogels yzer knuppels 4 ponds	100 fluk	172
29	Cogels yzer knuppels 6 ponds	100 fluk	204
30	Cogels yzer knuppels 8 ponds	100 fluk	236
31	Cogels yzer knuppels 12 ponds	100 fluk	304
32	Cogels yzer knuppels 18 ponds	100 fluk	408
33	Cogels yzer knuppels 24 ponds	100 fluk	512
34	Cogels yzer knuppels van 2 tot 24 pond door een	100 fluk	1658
35	Cogels, 100 enkelt ronde kogels als allehande dubbelde kogels of knuppels door malkander	100 fluk	100
36	Cogels yzer tot halven	100 fluk	10
37	Cogels loode musketen in vaertjen van 100 pond	2000 fluk of 100 pond	105
38	Cogels loode draat-kogels, yder yder 2 fluk in vaertjen van 100 pond	1000 fluk of 100 pond	105
39	Carredock wit in kaffen	11 rollen in een kas	156
40	Carredock roet in kaffen	11 rollen in een kas	156
41	Clavendock in kaffen	1 fluk	48
42	Everdock breed in kaffen	2 rollen in een kas	156

BY L A G E, N ^o . 10.			
ponnen. cu. v.			
60	Ant.		
651	Papier alle de vooren hande voortren door den anderen	17 riemen in een kas	490
652	Parrings Biltoufe in kaffen	1000 fluk	80
653	Pady, niet Virtualie drooge.	—	—
654	Potten Stamf ledig	4 fluk	8
Q.			
R.			
655	Rogge-vellen, niet Huyden.	2 kaffen of 10 fluk	372
656	Rakken Japuitische	—	—
657	Rottings, altes Bind-rottings	100 bollen	950
658	Ruins, niet Verwen.	—	—
S.			
659	Salpeter, niet Ammunitie.	1000	3437
660	Schildpads-hoorn in kaffen	—	—
661	Segel-lak, niet Lak om te regelen.	—	—
662	Schepers, niet Ammunitie en Schepers-behoeften.	—	—
663	Serp-Straffe	2 kaffen	300
664	Sjanees Ceylonse	100 Couron Ceylonse N. een Cour 120 pa.	1123
665	Syde-Bengalfe	1000	1123
666	Syde-Tonquinfe	1000	1064
667	Syde-Sinsefe	1000	1064
668	Syde-Portandfe	1000	1128
669	Syde de vier voornomde voortren door een	1000	1095
670	Snee-kolen	1 hoet	3775
671	Syker Candy Bengalfe in potten	544 in 4 potten	720
672	Syker Candy in kaffen	1000	320
673	Syker poeyer in zakken	10000	10000
674	Syker poeyer in kaffen	10000	12444
675	Syker poeyer in zakken en kaffen door den ander	10000	1128
T.			
676	Tanden van Elephanten	—	1000
V.			
Visjes gedroogde, niet drooge Virtualie.			
W.			
677	Wach in zakken	1000	1000
678	Wol, niet Haiz.	—	—
679	Wol van Schapen, niet Ammunitie &c.	—	—

Fig. 1.5 First and last page of the eighteen pages of specifications drawn up by Hendrik Decquer published in *Decquer Middelen om uit te vinden de ware lading der schepen na hare grootte* (Amsterdam (?), 1688/1690). Pictures taken by the author at the National Archives (NA 1.10.48/22) on 15 January 2015.

different items) in which he had calculated the weight and the volume of (a standardized amount of) all goods that had to be transported for the Company, ranging from *Ammunitie en Scheeps-behoeften* (ammunition and ships necessities – including saltpetre which was exported from Bengal to the Republic to be used in the production of gunpowder) via several other categories such as *Cattoene Lywaten* (Cotton cloths), *Speceryen drooge en ondrooge* (Spices, dry and not dry – among which pepper and the four spices on which the VOC exerted its monopoly: cloves, cinnamon, nutmeg and mace) and *Virtualie vette en ondroge* (Provisions, fatty and not dry, which included water¹²⁶) to a rest category that contained for instance elephant tusks. He also provided drawings to show how cargo (either in barrels, parcels, crates or boxes) should be stowed in the most advantageous way.¹²⁷

¹²⁶ For the transport of water and its associated problems, see chapter 2 of this volume.

¹²⁷ The list is in Decquer (1688/1690) as *Bijlage N^o 10* and the drawings as *Bijlage N^o 9*. Decquer's method was apparently also used by the States-General to prescribe how to the carrying capacity of ships of the West Indian Company should be calculated, according to a

Of course, the list must have been adapted and added to over time – for instance, Decquer did not mention coffee, tea and porcelain.¹²⁸ Over and above the amount of “official” cargo crewmembers tended to take private cargo (both permitted and not-permitted) on board as well.¹²⁹ Moreover, ships could be in a poor condition because of their stay in the tropics, especially if they had been used for traffic within Asia between their outward bound and homebound journey. Quite remarkably, no major (structural) repairs were carried out in Batavia.¹³⁰ As mentioned earlier, the homebound crew was much smaller than the crew on the outward trip. The combination of a smaller crew on a heavily loaded ship in a (quite often) poorer state of repair than outward bound made the voyage back to the Republic more dangerous than the voyage to the East Indies; the number of ships that perished on the voyage home was at least twice the number of the ships wrecked on the outward voyage. In addition to diseases such as scurvy and (from time to time) typhus that were rife on both the outward and homebound voyage, tropical diseases such as beriberi and malaria demanded an extra toll on the homebound voyage.¹³¹ Returning home, the *retourschepen* sailed from the Sunda Strait (between Java and Sumatra) towards the east coast of Madagascar, taking advantage of the prevailing south-easterly winds, and then on to the Cape of Good Hope. Because of the winds and currents along the western coast of Africa, the ships were then able to follow the African continent more closely than had been possible on the outward leg of the journey, as had been borne out by the accumulated know-how based on earlier voyages.

On the outward voyage the *retourschip* had acted as a building block for the construction of VOC’s empire overseas. Whereas on this journey the ships acted as people carriers (apart from their ballast and a considerable amount of precious metal), for the homebound voyage the ships changed character and turned into cargo carriers, manned by as minimal a crew as possible and as much cargo as possible. Now the *retourschip* was a floating, overloaded warehouse full of spices, coffee, tea, textiles and porcelain generating large profits for the company and in that way again acting as a building block, now for the construction of the VOC’s empire in the Republic.

note (dated 8 Aug 1730) inserted in the copy of Decquer’s book at the library of the University of Amsterdam (Bijzondere Collecties). In the late twentieth century, Decquer’s formula was again used in the *Dutch Asiatic Shipping* project to calculate the carrying capacity of all ships, cf. Bruijn e.a. (1979-1987) Part I, p. 44. This again shows how an immutable mobile can travel through time and space.

¹²⁸ On the importance of the tea-trade for the VOC in the second half of the eighteenth century, see chapter 3 of this volume.

¹²⁹ Bruijn e.a. (1979-1787), Part I, p. 188

¹³⁰ On repairs, see Bruijn e.a. (1979-1987) Part I, p. 90.

¹³¹ For actual numbers regarding the homebound risks, see Bruijn e.a. (1979-1987), Part I, p. 75 (Table 13) and p. 91 (Table 22).

BYLAGE, N°. II.

Manifest van alle de waaren en beboesten, die in 't hol van 't Schip Spierdyk, in den jaare 1686 ryt India herwaarts vertrekkende, geladen en geborgen zyn geweest, met aanwysinge wat plaats alles heeft, of kan beslagen en gewogen hebben.

	ponden.	cub. voeten.
3490 pond Mochra of florette garen in 23 balen	3877	332
1972½ — Bengaalse ruwe zyde in 130 balen	22154	1775
1290 — Persiaanse ruwe zyde in 13 balen	1455	110
3140 ps. Guinees lywaat gebleekt ord. in 157 pakk.	36338	1947
180 — gebleekt Guinees lywaat in 6 pakken	1830	75
840 — ruw Guinees lywaat in 42 pakken	10200	655
620 — bruyn blaauw Guinees lywaat in 31 pakken	7688	360
120 — bleek blaauw Guinees lywaat in 6 pakken	1488	70
1600 — Salempouris gebleekt ordinaris in 20 pakk.	7250	390
320 — Salempouris lyne gebleekt in 4 pakken	1180	49
320 — Salempouris ruwe in 4 pakken	1508	97
800 — Parcallen ordinaris gebleekt in 5 pakken	1439	65
800 — Bethilles Allegias in 8 pakken	3032	184
200 — Bethilles Sestergantyn in 2 pakken	758	40
240 — gekeperde Gingans in 2 pakken	740	28
750 — Roemaals d'Estia in 3 pakken	1031	52
640 — Negros kleeden in 4 pakken	1184	95
320 — Seyldoek ruw van de Kust in 8 pakken	2172	132
200 — Chits gefchilderde van de Kust in 1 pak	250	12
12094 catty Chineeze ruwe zyde in 199 pakken	15442	1306
300 ps. Mouris roode	825	53
19866 — Macis of Fouly in 129 heele fokkels	22130	1788
462 — ditto in halve fokkels	536	49
17600 pond Cancel in 220 balen	20557	1760
5200 stuks geconlyte Noten Muscaten in 2 amen	848	26
40510 pond Sillidase Erts in 122 stuks divers vaat-werk	44075	1082
600 — Benjuyn Cabessa in 2 kassen	790	26
5202 — Radix China en Galiga in 50 kisten	7891	432
40 catty Tonquinse Muscus in 1 kist	112	4
1083 — Chineeze Thee in 20 kanassers	1732	124
500 — witte Peper in 5 zakken	619	29
35195 pond Siam Sappanhour in 1668 stuks	35195	1883

Deeze vooren staande koopmanfchappen zyn gebaleert en gefust vervoert, en hebben te zamen gewogen en in ruymte weggenomen 256326 p. 15040 c.v.

129440 Catty swarte geharpte Peper	155328 p. 6990 c.v.
136000 pond Bengaalse Salpeter	136000 - 2394
75000 — Garioffel Nagelen	75000 - 4200
60000 — Noten Muscaten	60000 - 2040
440 — Hollandze Harpuys	508 - 16

426836 - 15640

Deeze laatst gestelde waaren en koopmanfchappen zyn los gestort vervoert, en hebben te zamen gewogen en in ruymte weggenomen 683162 - 30680

T

By

Fig. 1.6 List of the cargo, carried in the hold of the *retourschip* Spierdijk, as published in Decquer *Middelen om uit te vinden de ware lading der scheepen na hare grootte* (Amsterdam (?) 1688/1690). Collection of the Universiteitsbibliotheek Amsterdam (UvA) Bijzondere Collecties (OTM OF 63-315)

This change in character shows a significant mutability of the ships in the way they were used, a mutability that was closely connected with the different character of what was accumulated below decks in the *retourschepen*. However, in addition to the carrying of cargo, during the late eighteenth century *retourschepen* started to export people from the East Indies as well. A rising death toll occurred among Europeans in the East Indies during the course of the eighteenth century, and this not only made the employment of Asian seamen on the ships performing the intra-Asian traffic of the VOC even more necessary than had already been the case (in addition to the already large numbers of local ships and skippers employed in that traffic) but it also led to the employment of Asian seamen on some of the *retourschepen* bound for the Republic, seamen who then returned on the next outward-bound fleet.¹³²

Upon arrival in *patria*, the value of the cargo was almost three times as valuable as the amount of bullion, coins and other goods shipped out.¹³³ An example of such a cargo is given in figure 1.5, which shows a list of the cargo in the hold of the vessel *Spierdijk*, on its 1686/87 voyage from the East Indies back to Republic to the value of 329,500 guilders (as valued at the time).¹³⁴ After the return of the *retourschepen*, another phase in the accumulation process got underway: the cargo was transferred to the *Zeemagazijn* (and the smaller storehouses of the other chambers) while waiting for the auctions to take place. The incoming cargo was the result of a complicated and extensive ordering process that had begun three years earlier. Each year in spring, the *Heeren XVII* would make a preliminary decision on the number of ships that was to be dispatched in the coming shipping season. In late summer or early autumn, the returning fleet appeared in the roadsteads and in September the *Heeren XVII* decided upon the auctioning of the goods in the six chambers, concerning both dates and conditions. They also made a final decision on the number of ships, the number of personnel and the amount of goods that had to be sent out during the coming shipping season (i.e. from September of that year until June of the next year). In doing so, they responded to remarks that had just come in from Batavia. At the same time, they would also settle provisionally the value of precious metal that should be sent to over, what

¹³² Lucassen (2004), pp. 20-24, Rossum, van (2011) and Rossum, van (2014), ch. 3

¹³³ On the value of the cargo, see Gastra (2001/2007), p. 137 (Tabel 19) and p. 147 (Tabel 21).

¹³⁴ The list was published by Hendrik Decquer as an example in his book *Middelen om uyt te vinden...* (1688/90).

In the next chapter we will encounter the *Spierdijk* again as the first ship that left for the East Indies with a *waterwerk* (a seawater distilling apparatus) on board. Details on the 1686/87 voyage of the *Spierdijk* can be found at <http://resources.huygens.knaw.nl/das/detailVoyage/96735>

goods (and in what quantities) should be ordered from overseas. Final decisions on these matters were taken after the results of the auctioning became known, which was usually not before November. However, during the eighteenth century it became increasingly the case that the *Heeren XVII* made a final decision on goods and quantities during the next spring.¹³⁵ This meant that the time between the ordering of goods and the arrival of these goods could easily be more than two years. If a request for goods could be made in the autumn of any given year, then the ships carrying the order would arrive in Batavia between August and September of the next year, which made it possible to send the requested goods to the Republic with the fleet that left from November onwards, arriving back in *patria* in the late summer or the early autumn of the year after. This meant that it took at least two years at a minimum before an order arrived back in the Republic. However, sending definite orders in spring meant that the ships carrying the order would arrive in Batavia as the returning fleet was about to leave, implying that the dispatch of these orders had to wait for the returning fleet of the next year; this meant that it took about two and a half years before the goods that had been ordered arrived. These complicated and time-consuming processes meant that accumulation and storage on a large scale had to take place within the *Zeemagazijn* at Oostenburg and within the other, smaller storehouses of the VOC to be able to continuously satisfy customer demand.

1.3 Ships as mirror images of the company

In the section “Immutable drawings” we saw that the great number of complicated and interwoven accumulation processes (concerning organization, know-how and design, materials, labour and methods) that were linked to and by the building of large numbers of increasingly standardized *retourschepen* for the VOC culminated in the introduction of measured technical drawings in the early 1740s. Then the shipyards of the VOC became even more connected than already had been the case when ships were built according to a set of standardized specifications, laid down by the directors of the company, constructed out of preferred materials and inspected by a number of shipwrights from other yards of the company – albeit it only after a ship had been completed. Now the new design and building methods left far less room to deviate from the standard that had been set by the directors, unless – as we saw in this chapter and as will see later – such a deviation was

¹³⁵ From the 1750s onwards, preliminary decisions on numbers of ships were referred to a committee (the *Haags Besogne*) meeting in The Hague in spring. For more details on the timeframe of the ordering process, see Gaastra (2001/2007), pp. 151-155.

explicitly accepted through sometimes lengthy negotiations. The new standard ships had – through the new design system – become much more stable and far less mutable.

The set of drawings for a new design of *retourschip* has been interpreted as an immutable mobile (or rather as a succession of three immutable mobiles). Immutable because of its unchanging stability and mobile because it could travel across the Republic to all shipyards of the VOC. When we compared the three versions of the immutable mobile that were used (“scaled-down two-dimensional design on paper” - “real-size two-dimensional wooden templates” - “scaled-down three-dimensional wooden models”), it was argued that an increase in immutability and inflexibility was connected to a decrease in mobility. Because immutability implied stability but not absolute rigidity, the flexibility inherent in the character of the original (paper) immutable mobile granted local shipwrights both space and opportunity to adapt the existing design to changes in requirements, constraints and insights, and to embody these changes in the original design drawings. The hybrid network that existed at the yards produced ships that were also hybrid in character, which were therefore called “quasi-objects”. In the section “Mobile ships”, I argued that a *retourschip* (the material product of an immutable mobile design) can be interpreted as a mutable mobile that displayed a hybrid character which was in keeping with the hybrid nature of its construction. The two voyages that made up a roundtrip displayed a different character. On the way out, the ships carried an accumulation of building blocks of three different types: physical building blocks, bullion, coins and (probably most importantly) dispensable persons needed to maintain the VOC’s monopoly overseas and to run its overseas shipping operations. Therefore, on the outward journey a *retourschip* can be characterized as being predominantly a people carrier. On the way home, each *retourschip* carried a complicated accumulation of highly diverse goods, products and produce to serve the interests of the company in the Republic. Room to transport this merchandise was created by running the ships with a minimal crew, which had the added bonus of requiring fewer supplies than on the way out. On the homebound voyage the character of the ships therefore changed into that of a cargo carrier, manned by as small a crew as possible. Rather cynically, we might say that the death toll that occurred among the (dispensable) common seafarers while they were serving their contracts with the VOC within the East Indies was rather convenient in this respect.¹³⁶ The possibility to operate the ships with a (relatively) small crew was built into the original design, again showing the intricate connection between human and non-human actants.

¹³⁶ Although (as will become apparent in the next chapter) when the death-toll rose too high, the company felt obliged to take action to solve or mitigate the problems caused thereby.

When trying to square the paradox of immutability and mutability residing in the same artefact, a solution was found in interpreting the *retourschip* as a quasi-object, thereby making use of its hybrid character. In fact, the *retourschepen* were in a double sense hybrid, both as artefacts brought forth through the collaboration between human and non-human actants and also in terms of the hybrid activities in which the ships engaged. This leads to a re-considering of the (im)mutability of mobiles, related both to the construction and to the use of the ships. Combining the thing-like qualities of the ships with the VOC's demands for standardized ships required immutability. At the same time, the comings and goings of the *retourschepen* in their connecting the geographical extremities of VOC's empire depended on the artefact's essential mutability. Of course, they had to be sturdy, seaworthy, innovative and standardized, but such qualities were not ends in themselves. To fulfil the roles appointed to them, they needed to change character between outward voyage and homebound voyage; to put it in other words, they showed different aspects of the hybrid character with which they were endowed. The immutable and mobile character that the *retourschip* displayed as a constructed artefact was complemented by the mutable mobile character of its use: mobile in the sense that it sailed back and forth between the Republic and the East Indies (and often – in between voyages - within the East Indies), mutable in the sense that to fulfil its role it was able to change the character and the content of the accumulation that took place below decks between the outward bound journey and the homebound journey. In its mutable mobility, the *retourschip* (seen as a quasi-object) displayed its second level of hybridity, through which it could connect the Republic and the East Indies in different capacities, going and coming.

The *retourschip* mirrored the activities of the VOC in a dynamically interactive way, linking two networks of accumulation. On the one hand, it occupied pride of place in the centre of a constructive network through the immutable mobile of its design that was in turn inextricably linked with the building methods and the accumulation of materials and know-how centred on Oostenburg and the other shipyards; the connection between these shipyards was strengthened by the design itself. On the other hand, the *retourschip* was the powerful centrepiece of an extensive and complicated trading network through the mutable mobility on its journeys, leaving the Republic with people, ballast, coins and goods and returning to its port of departure with an impressive array of Asian produce and goods, to be accumulated again in the huge storehouses that had contained most materials for its inception and equipment before it took to the seas.¹³⁷ These powerful

¹³⁷ That in 1822 the *Zeemagazijn* at Oostenburg collapsed under the weight of grain that had been stored in the building instead of materials for shipbuilding and equipment and instead of products and produce from the East Indies seems like a dramatic coda to the

retoursschepen will continue to sail through the next chapters. In the second chapter it will be shown that the ships had a great impact on the wellbeing of their crews, whereby severe health problems were at first partly solved by using machines, and later by implementing centralized procedures which led to a decrease of the independence of ships and skippers. In the third chapter we consider a negotiated change in the design of the *retoursschip* that not only made the ship more powerful but also helped to reclaim a certain amount of independence for some of the chambers of the VOC as local centres of accumulation. In the fourth chapter we see that the ships were powerless against charts and sailing instructions that were not up-to-date; however, the use of locally produced improved charts and the (albeit reluctant) introduction of foreign charts (again on the instigation of people outside of the central offices of the *Heeren XVII*) re-asserted the importance of small de-central centres of accumulation *vis-à-vis* the efforts of the *Heeren XVII* to emphasize the importance of centralization in the Republic.

demise of the trading and shipbuilding empire of the VOC. According to an archaeological survey carried out in 2002, part of one of the walls of the building had slipped off its foundations and that may in turn have caused the collapse of the whole building.

<https://www.facebook.com/Stadsarchief/photos/pb.325668453157.-2207520000.1404664205./10152498080388158/?type=1>

2

NAVIGATING THROUGH HEALTH

NAVIGATING THROUGH HEALTH: TENSIONS, MACHINES AND PROCEDURES

70

The trade of the Dutch East India Company depended for its shipping operations and the protection of its interests (both intercontinental and intra-Asian) on the permanent availability of a sufficient number of reliable ships and sufficient numbers of sailors and soldiers. To that end, the company introduced an increasingly standardized system of shipbuilding (as we saw in the first chapter and as we will see in the next chapter) and it relied on the continuous shipping of large numbers of personnel to the East Indies. Soldiers and sailors had to be sent across in such numbers that the troops within the East Indies stayed at the level required by the High Government of the East Indies, and that the intra-Asian fleets and the homebound fleets could be manned by an adequate crew despite the high mortality rates associated with sailing for the VOC and the casualties that inevitably occurred in the East Indies. However, the ships of the VOC did not offer a very healthy environment. A poor state of health often plagued sailors and soldiers already before they embarked on their journey; during the journey bad water and corrupt food, cramped accommodation and lack of fresh air below decks, climatic conditions that were either cold and wet or hot and humid, and the outbreak of diseases led to an average mortality rate on the first part of the voyage to the East Indies (between the Republic and the Cape of Good Hope) of about seven percent, almost twice the rate in the Republic. The second part of the outward voyage (between the Cape and Batavia, Ceylon or other destinations in the East Indies and beyond) added almost three-and-a half percent in mortality.¹³⁸ Although it was apparently quite feasible to compensate for this “normal” death rate *en route*, a sudden increase in mortality might cause problems for the company. The cause of such increases was often the onslaught of infectious diseases, which, for instance, happened between 1689 and 1695 when the (average) mortality rate between the Republic and Asia rose to 21% and between 1770 and 1775 when it even went up to 23%.¹³⁹

In this chapter I describe, discuss and analyse the tension-filled situation the VOC found itself in when dealing with such sudden increases in sickness and mortality, and the way the company tried to find solutions, either

¹³⁸ Average overall losses on the outward voyages between the Republic and the Cape amounted to 6.7 % during the seventeenth century and to 7.3 % during the eighteenth (cf. Bruijn e.a. (1979-1987) Part I, p. 162-163 (esp. Table 30) and Bruijn (2009), pp. 74-75 (Table 2.3)). For the whole journey between the Republic and the East Indies the average mortality (between 1660 and 1780) can be calculated as 10.4 % (based on the numbers given in Bruijn e.a.(1979-1987) Part I pp. 162-163, Table 30)

¹³⁹ Bruijn (1976), pp. 222-223

on an *ad hoc* basis or of a more permanent character. Two different, but not mutually exclusive, strategies become visible. The first of these is a mechanical approach whereby machines were introduced on board of the ships primarily as tools to prevent the onslaught of diseases. The second is a procedural approach whereby preventive and curative courses of action were centrally prescribed to skippers, officers and surgeons on their ships. It was already noticed in the first chapter that *retourschepen* were in a double sense hybrid, both as artefacts brought forth through the collaboration between humans and non-humans and also in terms of the hybrid activities in which the ships engaged. When we look at the health situation on board another layer of hybridity becomes visible: the socio-material character of the *retourschepen*.

In the first section I describe this character by considering VOC's *retourschepen* as socio-material ensembles within a tension-filled network. The ships were quite often cut off from the rest of society for months on end with almost no communication with the outside world. Unless sailing in the company of a few other ships, the only connection would have been via journals and reports that had to be written on a daily basis and that had to be delivered at the ship's destination and, from the late seventeenth century onwards, also at the intermediate stop at the Cape of Good Hope. However, it would take several months at best before these reports found their way to the offices of the relevant VOC chamber. This implied that the skipper, officers, crew, soldiers and passengers were for a considerable time locked in the confines of their ship without any possibility for escape. Although everybody belonged to the same socio-material ensemble, there existed a great (metaphorical) distance between officers and sailors, accentuated by the main mast that demarcated "fore" and "aft". "Fore" was the area where the sailors lived and "aft" the domain of the officers, although in material terms this distance was a matter of only a few feet. That this could create tensions on board in normal circumstances seems obvious, but an outbreak of contagious diseases certainly put an extra strain on the relation between officers and crewmembers. Isolated as the ships might be on the ocean, they did belong to the much wider network of the VOC that in itself had its fair share of tensions. As we will notice, attempts to improve the health situation on board interacted with the tensions in the wider network.

The second section is concerned with these diseases as such, specifically the one that was called *rotkoorts* in Dutch (*putrid fever* in English) which caused epidemics on the ships of the VOC on several occasions during the (long) eighteenth century. Using archival data it is still possible to see when these epidemics emerged, how they developed and how they ebbed away. To get an impression of the impact these epidemics had, we will look into contemporary characterizations of the disease. One such was recorded by the naturalist Thunberg when he travelled to the Cape in 1771/1772. He

described the disease, its effects and the measures that were taken. Another account was written by the ships' surgeon Van Moor who looked into possible causes when he had to combat the disease on a voyage to Batavia in 1699/1700. Accounts were also given by a number of writers who published essays on *rotkoorts* in the Transactions of societies in the aftermath of the epidemic of the 1770s. Especially in these essays several suggestions were presented on how to manage health effectively on the ships of the VOC, with a view to preventing and curing diseases. On the one hand this entailed a selective approach to enlisting personnel, if such were at all possible. On the other hand it meant applying technological and/or procedural solutions. In fact, when these essays were published in the late eighteenth century, both approaches had already been used (or were still being used) by the VOC. Indeed, the company tried to prevent or alleviate serious health problems, through a technological approach, an increase in procedures and prescriptions or through a combination of the two. Turning seawater into drinking water through distillation, forcing fresh air into the living quarters of the crew through the use of mechanical ventilators, a significant reduction in the number of crew on board and a reliance on standardized procedures were all attempts to improve the survival rate on the *retourschepen* of the VOC. In the third and fourth section I critically look into these technological and procedural attempts. It seems as if there was a fundamental shift in the character of these solutions. Whereas the VOC first relied to some extent on the use of machines (distillation machines and ventilators) to promote health and to prevent or to combat the outbreak of diseases; in the course of the eighteenth century this technological approach gave way to a predominantly procedural approach intended to control the health situation on board. The directors of the VOC opted for a centralistic procedural approach which could rekindle old tensions or create new tensions, as we will see in this chapter and in the next chapters.

In the third section, we look specifically to the technological solutions that were introduced to prevent health problems from occurring. These technological solutions came in the form of two different types of machines that were (for some time) used on the ships of the VOC. The *waterwerk* (a machine for the distillation of drinking water out of seawater) was the first of these, followed half a century later by the mechanical ventilator. Providing its ships with a sufficient amount of fresh water had been a concern for the directors from the early days of the VOC. In the 1690s, after some experiments by the Amsterdam chamber, the *waterwerk* was introduced on most of the *retourschepen* of the VOC, only to be abolished about fifteen years later. The abolition was the result of tensions that emerged between skippers and the directors of the VOC in the Republic, between the directors in the Republic and between those in Batavia, and between skippers and their crew. It also shows

that whether a machine is successful depends on the verdict of its users, as the philosopher Bruno Latour succinctly formulated it: “*First principle* The fate of facts and machines is in later users’ hands; their qualities are thus a consequence, not a cause, of collective action”,¹⁴⁰ When the *waterwerk* made a surprising short-lived reappearance in the late 1760s, tensions revealed themselves between the stadholder of the Dutch Republic and the other directors of the VOC. Problems with extracting foul air and providing fresh air between decks were technologically tackled from 1746 onwards when the *Heeren XVII* introduced hand-driven *ventilators* to expel noxious airs. On the homebound voyage these machines were abolished in 1772, and in 1791 they were also discarded on the outward bound voyage. When we discuss and interpret the different opinions (spilling over into tensions) on the effectiveness and reliability of *waterwerk* and *ventilator*, and look into the reasons and circumstances that led to their demise, we notice a shift in emphasis away from machines that played a role within an individual ship towards a disciplinary practice that applied to all ships.

This disciplinary approach forms the subject of the fourth section. As we found in Thunberg’s notes, the use of mechanical ventilators did not prevent severe outbreaks of *rotkoorts* (gaol- or hospital-fever, nowadays known as spotted typhus) on the *retourschepen* of the VOC in the early 1770s. In an effort to contain and prevent these outbreaks, extensive discussions ensued within the ranks of the *Heeren XVII* over the way the challenges and tensions posed by this disease could be overcome. Their meetings, considerations, the advice they sought and their proposed solutions will be discussed and interpreted. By then, the VOC’s policy to overcome or solve tensions was predominantly centred on centralized procedures and disciplinary practice, leaving behind the earlier technological approach. The outcome of the measures that were implemented (which until now do not seem to have been investigated in depth) will be analysed and critically reviewed. Again it may be noticed that success or failure, not only of a technological solution but also of a procedural approach, are as much a matter of interpretation as of facts and numbers. The change in policies signalled a move away from the (partial) independence enjoyed by skippers and even from the independence of the six chambers towards a situation in which initiatives would be taken and controlled from one centre in the Republic – the offices in Amsterdam (and Middelburg) where the *Heeren XVII* resided. Whether this centralistic move was completely successful remains to be seen, as new players (such as societies) tried to become involved in the network and older players might still find ways around the prescribed policies.

¹⁴⁰ Latour (1987), p. 259

In the final section, first I consider the contemporary experiences of a number of people who went through the outbreak of contagious diseases on board of a ship. That puts the different approaches into a human perspective. Starting from that perspective, I interpret the way the VOC sought to tackle matters of health through its different strategies. Instead of relying on machines, the VOC displayed an increasing emphasis on prescribed and standardized courses of action to be taken by officers and crew alike without the aid of machines. By the end of the eighteenth century, all types of machines for health that had once been introduced had been discarded and a policy of prescription took their place; the officers and ordinary sailors who operated the ships were subjected to a bureaucratic system of disciplinary practice and were turned into an increasingly controlled workforce. As we will notice, the VOC was turned into a more centralized enterprise through the approaches that were chosen by its directors, and as a consequence the degree of independence of its constituent chambers and of its skippers and officers decreased. This led to tensions between the VOC chambers *vis-à-vis* the *Heeren XVII* (for instance when it proved impossible to follow directives about which people should be accepted as sailors and soldiers) and between skippers and officers *vis-à-vis* the *Heeren XVII* concerning the strict rules for route finding (examples of which are extensively discussed in the fourth chapter). In the third chapter it will be noticed that the disciplinary practice became to a certain degree materialized in a re-design of the ship, a re-design that was produced by the independently-minded Zeeland chamber and was advocated by the Zeeland society. Then, through a combination of formal structure and structural form, the ships of the VOC became increasingly powerful hybrid parts of the VOC network.

2.1 *Retourschepen*: socio-material ensembles within a tension-filled network

In the first chapter the *retourschepen* of the VOC were characterized as having a double hybrid character: hybrid as artefacts brought forth through the collaboration between humans and non-humans and hybrid concerning the activities in which the ships were engaged. We noticed that these ships were on the one hand immutable to comply with the demands of the VOC for sturdy, seaworthy, innovative and standardized ships that could withstand the often hostile environment they had to sail through on their way between the Republic and Asia – and back again – and within Asia. On the other hand, as these ships connected the geographical extremities of VOC's empire, they had to be mutable in the sense that they were able to change character between outward voyage and homebound voyage. Outward bound they were

predominantly carriers of (metaphorical) building blocks for the construction and upkeep of VOC's empire overseas, such as goods, bullions, coins and people; as we will see the ships were also crammed with sailors and soldiers. Homebound, the ships became heavily loaded (if not overloaded) sailing warehouses carrying a huge array of Asian produce and goods and a minimal crew. Even when these ships had on occasions to sail on their own for several weeks on end, they still belonged to an impressive network that was in its original conception de-central in character (built as it was on the six semi-independent chambers that constituted the VOC) but which became subject to ever more centralistic tendencies, as we will see in this chapter. That this network had its share of tensions (such as central versus de-central, between the directors in the Republic and the High Government in the East Indies, and between skippers and directors) will also become manifest. Apart from the twofold hybrid character of the *retourschepen* that was described in the first chapter, these ships displayed yet another layer of hybridity linked to the situation of their crews.

This third, socio-material layer of hybridity became visible on the ships of the VOC when - just as on other ships on long voyages in those days - all those on board (skipper, officers, common crewmembers, soldiers and passengers) were physically cut off from the outside world. The world for those who sailed on a *retourschip* consisted of the ship itself, the people on it and the sea surrounding it. The tensions that existed between different classes of people in the wider society that was seemingly left behind when the ship left port re-emerged in the condensed micro-society that existed on board. When considering these tensions within the organizational structure on board, we should explicitly take into account the materiality of the *retourschepen*. That materiality went beyond the fact that the ship embodied the physical space in which tensions were played out. People were brought together in the artificial environment of a *retourschip*, cut off from the rest of society and lived for a considerable time in the micro-society of the ship where all aspects of their lives were regulated. This environment had its own active social role instead of being just the material boundary that set it apart from the natural environment in which it operated or of just being the means to connect the Republic and the East Indies. It made of course a difference whether the ship was still at anchor near Texel (or other points of departure in the Republic), at anchor at some halfway port to take refreshments on board or at anchor at its destination, compared to the situation when the ship was at sea for months on end where it even might be on its own for a considerable time. The micro-society that was demarcated and materialized in and through each ship while out on the ocean (almost in the literal sense of the word: each ship being for a time a world of its own) was only distantly connected to the far away outside worlds of Amsterdam or Batavia or

wherever the ship was destined to go. Those living and working together for months on end were closely connected physically by the ship on which they sailed, although separated by the main mast into the common crew “before” and the officers “aft”. Crew, officers and ship were dependent on each other for surviving the voyage in the midst of a powerful and often hostile natural environment. As we will notice in this chapter, this interdependency concerned aspects such as discipline, food and drink, sickness and health aggravated by a sometimes hostile environment that was created by forces of nature such as storms and calms, heat and cold, drought and incessant rain.

Fig. 2.1 VOC-officer writing his log, creating part of a "paper shadow". Drawing by Jan Brandes, late eighteenth century (Rijksmuseum Amsterdam NG-1985-7-1-149)

Matters became even more complicated because the ships were increasingly seen as part of the centralized enterprise that the directors of the VOC tried to establish; this led to tensions within the network of the VOC – tensions between this enterprise that concentrated on the profitability, the preservation and the expansion of its trading empire on the one hand and the independence of the chambers of the VOC, of the skippers on their ships out

on the ocean, and of those who were in charge of the company's settlements in Asia on the other hand. The distant connection between each ship and the headquarters of the company was given form through the fact that skippers had to follow the charts and sailing instructions of the VOC, had to obey its procedures and were obliged to write extensive reports about it. By writing these reports skippers and officers created a "*paper shadow*" for the benefit of the directors of the company.¹⁴¹ Through this daily paperwork and the regular meetings on board skipper and officers were remotely but consciously connected to the rules, regulations and demands of the VOC: in their logs skippers had – in increasing measure as the eighteenth century wore on – to report on whether they stuck to the procedures prescribed to them.¹⁴² Acting in concert with fellow officers it was however feasible to report that the rules had been followed, irrespective of the fact whether that had actually been the case.¹⁴³ Whereas the *Heeren XVII* may increasingly have interpreted Amsterdam as the official geographical (and hydrographical) centre of accumulation of the company (although the High Government in Batavia probably had different ideas) ships can still be interpreted as (at least to a certain degree) individual centres of accumulation; that this state of affairs could (and did) create tensions between those on the ships and "Amsterdam" will become clear in what follows in this chapter. We will then also come across tensions between "Batavia" and "Amsterdam" and between the individual chambers of the VOC and "Amsterdam" regarding their role as centres of accumulation.¹⁴⁴

The term "paper shadow" seems also quite appropriate considering the position present-day historians find themselves in. The remains of the large number of paper shadows created on board and transferred to the meticulous administration of the bureaucratic machinery of the VOC grants historians a glimpse into what went on within the shipping enterprise of the VOC and even into the lives of people on board of the ships of the company. Although one might wish to come across a paper "trail" which might lead (although by a sometimes circuitous route) to an unambiguous outcome, one

¹⁴¹ The term "paper shadow" was coined by Goffman (1957) in his essay on total institutions, p. 66

¹⁴² For instance, by order of the *Raad van Indië* (the High Government of the East Indies) dd. 13.04.1779 it became obligatory for ships officers to keep note in their journals of every prayer and/or sermon on board, cf. NA 1.10.59/28 *EXTACT* (sic) *uit de Notulen van het geresolveerde in RAADE van INDIE op dingsdag den 13 April 1779*.

¹⁴³ In chapter 4 we come across some documented cases in which this obviously had been the case.

¹⁴⁴ In what follows in this chapter I will use "Amsterdam" and "Batavia" (between quotation marks) as shorthand for "the *Heeren XVII*, i.e. the main directors in the Republic" (who resided most of the time in Amsterdam) and "the High Government in Batavia". Hydrographical issues will be discussed in chapter 4.

is often confronted by mere shadows of the past – not in the first place because of parts missing or because of illegible handwriting but most importantly because of the fact that what has been written may have served other purposes than just the reporting of straight facts and figures. To complicate matters even more, when one compares the provisional minutes of meetings of the *Heeren XVII* with the definitive version, one can sometimes actually see that sentences have been crossed out and remarks have been inserted, suggesting that the discussions went rather less smooth than the polished definitive minutes suggest.¹⁴⁵ In such a case one can count oneself lucky to have been allowed a glimpse behind the shadows, but it leaves one wondering about those cases in which one can only rely on official reports and definitive minutes. As we will notice in chapter four, this all raises the question whether the centralization envisaged by the *Heeren XVII* could actually be enforced or whether the enterprise of the VOC remained (at least in part) rather decentral in character. On the other hand, as we will notice in chapter three, the independently minded Zeeland chamber can be seen as having contributed to a more centralized operation of the *retourschepen* through an important change in the design of the ships.

As was already noticed, there existed a great distance between the common crew (as a group) on the one hand and the ships' officers, high ranking officials and important passengers on the other hand, materially made visible by the mainmast and the *kuil* or waist in the classic design of VOC's *retourschepen* and many other ships of that time.¹⁴⁶ Another way through which this division became apparent was in the quality, the quantity and the choice of food that was made available to each group.¹⁴⁷ As Emma Spary remarked: "(...) élite practices of social management and discrimination formed a local disciplinary framework, preserving shipboard society as a hierarchy."¹⁴⁸ Apart from the strict and sometimes brutal way in which discipline was maintained on board (as we will see in section 2.2) food was another way in which the distance between officers and common crewmembers was made visible, day upon day. Although one may interpret food, eating habits and (supposed) preferences as markers of distinctive groups, there is little in the way of contemporary remarks by crewmembers about the quantity and quality of their food; Spary conceded that "the crew's own accounts of eating only rarely survive".¹⁴⁹ Over a century ago, in 1913, the historian and archivist J. de Hullu published an essay on the food and drink that was provided on the *retourschepen* of the VOC in which he drew on

¹⁴⁵ We will come across examples of this in chapter 3 and again in chapter 4.

¹⁴⁶ For more details on the design of the ships, see chapter 1 and also chapter 3.

¹⁴⁷ Spary (2009), p. 366 interpreted the ships' surgeon as a go-between the different groups.

¹⁴⁸ Spary (2009), p. 365

¹⁴⁹ Ibid., p. 384

contemporary notes and memoirs, not only by officials and officers, but also by (some) common crewmembers. His research showed that the quantity of the crew's food and drink in general seemed to have been sufficient considering the amount of energy provided, although a prolonged journey might spell trouble. Regarding the quality of food and drink, remarks made by common crewmembers suggest that the diet (which consisted mostly of salted, preserved meat, pork or dried fish, dried beans and pulses and bread, cheese, butter, beer, wine and water) was rather monotonous and that its quality left much to be desired, and which also deteriorated horribly in the course of the voyage.¹⁵⁰ The higher echelons were provided with as much fresh food as was possible, for which purpose a veritable *ménagerie* of living animals was kept on board.¹⁵¹ Adding insult to injury, some skippers used part of the crew's rations to provide a more generous amount of food (and especially) drink for the officer's table; a misuse of provisions that even caused shortages for the sick and infirm.¹⁵² This suggests that in a number of cases, and obviously against the wishes of the *Heeren XVII*, the "élite practices" as mentioned by Spary were actively pursued by some skippers to further their own interests; they can therefore not be seen as contemporary matters of fact, but were to a great extent the product of deliberate actions.¹⁵³

Adding to the complexities and tensions involved in the interaction between crew, officers, ship and nature was the fact that (as we will notice later) the common crew (and to a lesser extent officers) increasingly consisted of foreigners, from such diverse areas as the Southern Netherlands,

¹⁵⁰ Hullu, J. de (1913C); also Diebels (1987/1988)

¹⁵¹ In 1731, the *Heeren XVII* had decided that a 130 ft. vessel was to be supplied with twelve live pigs, a 145 ft. vessel with sixteen and a 160 ft. vessel with eighteen. In 1791 this was changed into ten live pigs and four live sheep for every hundred people on board (Hullu, J. de, 1913C, p. 551). In addition, ships carried some live chickens. In some cases the choice and quality of food presented to officers and high ranking passengers was quite impressive, as becomes clear from the journal kept by the sisters Swellengrebel on their homebound voyage from the Cape in 1751 (cf. Barend-Van Haefen, pp. 119-161); also Pearson (2003), p. 188

¹⁵² Hullu, J. de (1913C), pp. 543-544

¹⁵³ During the eighteenth century, these practices were sometimes extended to such a degree that skippers of the VOC provided extra food and drink – against payment – for the other officers, in addition to the double rations that the company already made available. In a number of cases these payments amounted to several hundreds of guilders, i.e. the complete earnings of these officers. Refusal to cooperate meant that life on board could be made very hard for them. (Hullu, J. de (1913C), pp. 561-562). Against these practices, a resolution had been drawn up by the *Heeren XVII* on 10 Dec 1695, which was attached to every *Lyste van de Victualien en ordre op de Ranstoenen* (List of Provisions and Order on Rations) that was published since then (e.g. the list of 1777 in NA 1.10.59/29)

Scandinavia, the German states, France or Asia.¹⁵⁴ According to Bruijn and Van Eyck van Heslinga:

The Company recruited in 1770, for instance, about 8500 new men. No more than 3100 of them were Dutchmen; amongst the 2900 soldiers not even 500 were Dutchmen! Due to a lack of European hands, in Asia the Company had to recruit Asians. They were first used on voyages in the intra-Asiatic trade. (...) In the last quarter of the century one meets Asians also on board of homeward- and outward-bound fleets.¹⁵⁵

The situation on board became even more charged when serious health problems emerged during the eighteenth century. During the seventeenth and eighteenth century scurvy (sometimes called “the scourge of sailors”) regularly had a devastating effect on the health of the crews; however serious scurvy was, it was not contagious and could not pass from one crewmember to the next. Then from the late seventeenth century onwards, even more serious diseases manifested themselves. These diseases (usually called *rotkoorts* in Dutch, or “putrid fever” in English) were not only more deadly than scurvy but they were – in contrast to scurvy – contagious as well. That must not only have caused a similar strain as in the case of scurvy of seeing your mates suffer but it had the added uncertainty of whether or not your mates might pass on the disease to you. It also had a material aspect in that a physical separation between the sick and the (still) healthy had to be organized on a ship which offered very cramped accommodation to its common crewmembers anyway. Finding solutions for the onslaught of these diseases revealed tensions between skippers and the directors of the company (the *Heeren XVII*) and between a technological and a procedural approach. These tensions existed beyond individual ships within the network of the VOC as a whole, alongside other tensions such as those that existed between “Amsterdam” and “Batavia” concerning the availability of sailors and soldiers, tensions between the chambers of the VOC and the *Heeren XVII* about the wish of local directors to enlist only healthy, preferably young sailors of Dutch descent and the need to enlist a sufficient number of sailors for which – as we will notice in the next sections – it turned out to be necessary to work with the notorious *volkhouders*.¹⁵⁶

¹⁵⁴ Hullu, J. de (1914), Bruijn (1976), Bruijn & Lucassen (1980), pp. 139-140, Bruijn & Eyck van Heslinga (1984), passim, Lucassen in Van Royen e.a. (eds.) (1997), pp. 11-23, Davids in *ibid.*, pp. 41-71, Lucassen (2004), Van Lottum & Lucassen in Gorski (2007), pp. 13-42. Van Rossum has made an extensively study of the employment of Asians in VOC’s intra-Asian traffic (cf. Rossum, Van (2011), passim and Rossum, Van (2014) esp. chapter 3)

¹⁵⁵ Bruijn & Eyck van Heslinga (1984), p. 17

¹⁵⁶ For more on *volkhouders*, see the next section

As time wore on, solutions for these tensions were increasingly sought through a centralized approach. Concerning the way the ships were operated, ships and their officers and crews were in increasing measure “ring-fenced” by prescribed procedures. Partly as a result of the health problems that the VOC encountered in the (long) eighteenth, the directors of the company issued a growing number of decrees about what ought and what ought not to be done and how it ought to be done, thereby trying to get a centralized grip on each individual ship. Instead of a *retourschip* being directed by the skipper and his fellow officers (with some – independently applied - assistance from machines), now each ship was increasingly seen as part of a centralized enterprise for which the course was set (in more sense than one) from “Amsterdam”. There is some irony in the fact that this approach was partly made possible because the skippers themselves, either through their role as outspoken active anti-users of machines (in the case of the *waterwerk*) or as tacit non-users of machines (in the case of ventilators), offered the *Heeren XVII* sufficient arguments to discard these machines and thereby contributed to the decline of their independence. A number of implications of this (albeit contested) centralistic approach by the VOC will be discussed in the final section of this chapter after I first have considered the character of the serious health problems that confronted the VOC from time to time, possible technological solutions, procedural approaches and the personal experiences of powerful and powerless people in the tension-filled network of the VOC.

2.2 The onslaught of *Rotkoorts*: characteristics, causes and consequences

In 1771/1772, the naturalist Carl Thunberg, a former student of Linnaeus, travelled from the Republic to the Cape of Good Hope on the first part of his voyage to Japan.¹⁵⁷ He left in December on the VOC *retourschip Schoonzigt*, as “*surgeon-extraordinary*” which meant that he was not obliged to fulfil any duties during the voyage. In his account of the voyage, Thunberg painted a clear (although rather detached) picture of the serious problems caused by poor health, bad water and infectious diseases on the ship, gave a succinct analysis of what he saw as the causes and informed his readers regarding the measures that were being taken.¹⁵⁸ On boarding, he saw

¹⁵⁷ Thunberg described this voyage in Thunberg (1795), Volume 1

¹⁵⁸ The *Schoonzigt* (a ship of the second charter) left Texel on 30 December 1771 with 343 people on board, so it was very crowded compared to what was usually the case; in section 2.4 the problem of overcrowding will be extensively discussed. By the time the ship reached the Cape on 16 April 1772, 105 people on board had died. Thunberg and thirty-four more persons disembarked at the Cape and presumably some of those were transferred to

As the crew had been but a week on board, I expected on my arrival, to find no patients, but found, to my great surprize, that several men were already ill; I heard also, that the number of sick and dead on board the ships which had been lying in the Texel since September last was so considerable, that (...) several ships (...) were obliged, for want of hands, to wait for fresh supply, notwithstanding they had been sent out at first with more than three hundred men. (...) But what very much, if not solely, conduces to the increase of maladies, is undoubtedly the great number of diseased soldiers sent on board by the kidnappers (*zeelverkoopers*) with bodies partly emaciated, and partly replete with scurvy and corrupted fluids. These men (...) soon contract putrid fevers, and infect the rest of the crew.¹⁵⁹

Thunberg described several measures against the spread of diseases, such as the use of vinegar and the use of ventilators

The physician of the company, indeed, Dr. Famars, had ordered, by way of preventing infection in the ships, that the attendants should hold a sponge filled with vinegar in their mouths, and wash themselves with vinegar; (...) that the sides of the ships should be sprinkled with vinegar &c.;¹⁶⁰

the hospital at the Cape. In fact, Thunberg himself was not at all well. On 25 June 1772, the *Schoonzigt* departed the Cape after an unusually long stay of more than two months, arriving in Batavia on 29 August 1772. On this part of the voyage ten more people died. As far as actual sailing times were concerned, the voyage was a fast one. See

<http://resources.huygens.knaw.nl/das/detailVoyage/95172>

¹⁵⁹ Thunberg (1795), pp. 72-73. Those referred to as “kidnappers (*zeelverkoopers*)” (or crimps) were in the Republic also known as *volkhouders*. They pressed people into enlisting with the VOC (or other companies or admiralties), provided them - between the time of signing up and the actual departure - with lodging and food (the lodging usually consisting of very cramped conditions and the food being of bad quality), and at the time of departure they provided them with equipment which was usually insufficient, both in terms of quantity and of quality, as Thunberg also noticed. As payment, the *volkhouder* took the bounty (two month’s wages) that was paid to the sailor/soldier; in addition, the sailor/soldier had to make out a *transportbrief* (transfer letter) to the *volkhouder*, which entitled her or him to (at least) six-month’s wages. This sum was only payable after the sailor/soldier had earned enough on his voyage. If the sailor/soldier died or deserted before having earned enough, the *volkhouder* was not paid the full amount. Even if the person survived, the *volkhouder* had to wait for his records being transferred from Batavia to the Republic, which meant a delay of at least two years. It occurred quite often that the *volkhouder* sold these *transportbrieven* at a discount to somebody else, which meant that the *volkhouder* was provided with ready money at short notice, transferring any risks to the buyer. This practice of selling *transportbrieven* (or “*ceels*”) gave rise to the pejorative term *zeelverkoopers* or *zielverkoopers* (soul-sellers). Van Alphen has shown that the majority of the *volkhouders* were women, quite often married to a sailor. Until around 1725 most soul-buyers were also female. (Van Alphen (1991), *passim*).

¹⁶⁰ *Ibid.*, p. 78

(...) during the voyage we had constantly about a hundred and fifty patients on the list, till we had passed the line and the most infirm and disabled part of the crew were carried off by death. With a view to prevention of diseases during the voyage, orders were given that the ventilators should be constantly kept in play (...) and, in order to introduce fresh air between the decks, that the air-sail should be kept constantly hanging through the main-hatchway.¹⁶¹

These remarks show that at this time both a machine and procedures were used as preventative measures against the onslaught of diseases. Thunberg added that the quality and quantity of the drinking water on board left much to be desired, as becomes clear from the following

Our water, notwithstanding that quicksilver had been put into it, grew putrid, and began to emit a cadaverous smell, and generated maggots, so that it could not be drank but in tea or coffee; but in the course of a few weeks it purified itself, and after having precipitated to the bottom all its filth and insects, became sweet and palatable. In the meantime, rain-water was collected more than once, notwithstanding it had been prohibited, on the supposition of its generating diseases, besides that it tasted of pitch from the cordage of the ship.¹⁶²

As Thunberg noticed, the VOC had implemented measures, technological and/or procedural in character to get to grips with excessive mortality on its ships. Sometimes the measures that had been introduced were rather short-lived; other measures lasted for several decades, such as the *Ordre en Instructie voor de Chirurgyens* (Order and Instruction for the Surgeons) that was introduced in 1695 and was updated throughout the eighteenth century. Around 1690 and again around 1745 the VOC introduced machines to combat problems with the provision of clean drinking water and clean air. In the second half of the eighteenth century the VOC concentrated predominantly on procedural strategies to discipline humans as the ultimate remedy against problems of poor health and the outbreak of infectious diseases. The shift that took place from an approach that was partly based on the innovative use of machines towards an approach that almost exclusively relied on formalized and standardized procedures may be linked with the quest for centralization and standardization that already became apparent in the change in ship-design and shipbuilding procedures that we encountered in the first chapter.

As mentioned in the introduction, the average mortality outward bound between the Republic and the Cape of Good Hope was about twice as high as what could be expected in the Republic. While the outward voyage could therefore be considered as rather dangerous, it was from the 1690s

¹⁶¹ Ibid., p. 93

¹⁶² Ibid., p. 90

onwards that serious health problems made the situation even more hazardous on a number of occasions.¹⁶³ According to Bruijn e.a. decades with mortality figures well above what could be expected were 1690-1700, 1730-1750 and 1760-1780.¹⁶⁴ In those periods, the *Heeren XVII* had to find a solution because the health problems had a negative impact on the number of personnel available for duty within Asia and (after a number of years) on the ships that returned to the Republic. To complicate matters, it took almost a year before the directors of the VOC could be informed of such problems; the earliest opportunity for outward bound ships to make landfall on VOC territory was at the Cape of Good Hope, which took place on average five months after departure during the seventeenth century, shortened to four months during the eighteenth century. From the Cape, a ship returning to the Republic had to take these messages across which took again about four months, not counting the time messages lay waiting at the Cape. Then, whether health problems were due to incidental unforeseen circumstances or were part of an emerging pattern could only be established after several more messages had been received which added to the already unavoidable delay. It should therefore come as no surprise that it usually took a number of years before any measures could be taken. Meanwhile, the *retourschepen* displayed yet another layer of their hybridity: they were turned into sailing hospitals where dozens of seriously ill crewmembers had to be cared for by the small number of ships' surgeons and surgeon's assistants that were on board.

When a rise in mortality occurred, it was always most acute on the first part of the outward journey, between the Republic and the Cape of Good Hope. Between 1689 and 1695 (within the decade 1690-1700) the average mortality for the voyage to Asia was 21% and for the first part of the journey of 13%.¹⁶⁵ The mortality percentage on the first part of the journey is shown in graph 2.1. There are a number of reasons for restricting this and following graphs to what happened between the Republic and the Cape. First is the fact that (as was already stated) most of the problems emerged on that part of the journey, a second consideration is that information on the second part of the journey is far less complete than on the first part and finally the only contemporary source (as we will notice in the next section) dealt only with that part of the journey. In graph 2.1 (and also in the other graphs), the mortality percentage is calculated as the percentage of the original crew (consisting of sailors, soldiers and craftspeople) dying between the Republic and the Cape.¹⁶⁶ A "Man-to-Ton Ratio" is also shown, because on several occasions contemporary

¹⁶³ Bruijn e.a. (1979-1987) Part 1, pp. 161-167 and Schoute (1929), p. 46 & pp. 78-90

¹⁶⁴ Bruijn e.a. (1979-1987) Part I, pp. 161-163, also Bruijn (1976), p. 223

¹⁶⁵ Bruijn (1976), p. 222 and graph 2.1

¹⁶⁶ Using archival data for which sufficient information was available in the Dutch Asiatic Shipping (DAS) database <http://resources.huygens.knaw.nl/das>

Graph 2.1 Mortality percentage (left-hand axis) and Man-to-Ton Ratio (right-hand axis) between 1687 and 1700, calculated as an average for all ships leaving for the East Indies in the year concerned for which sufficient information was available.

Graph 2.2 Mortality percentage (left-hand axis) and Man-to-Ton Ratio (right-hand axis) between 1730 and 1780, calculated as an average for all ships leaving for the East Indies in the year concerned.

sources pointed to overcrowding as a possible explanation for the rise in mortality. This ratio is calculated by dividing the combined number of crewmembers, soldiers and craftspeople (upon departure) by the carrying capacity of each ship; the higher the ratio, the greater the density of people on board.¹⁶⁷ I will return to the issue of overcrowding in section 2.4 when I discuss the measures that were implemented by the VOC during the 1770s.

Another peak in mortality figures occurred between 1730 and 1750 when the mortality for the whole voyage amounted on average to 13% and for the first part of the journey to 9% - during these years the mortality numbers fluctuated heavily. Then in the early 1770s, a sudden and sharp increase in illness and mortality occurred, in all likelihood (just as in the earlier cases) caused by intermittent outbreaks of a disease that became known as *rotkoorts* (gaol- or hospital-fever). During this epidemic, the absolute and relative number of sailors and soldiers dying on board of the *retourschepen* of the VOC rose to an all-time high. For that period, figures for the whole voyage to Asia show an average mortality of 23% over the years 1770-1775,¹⁶⁸ whereby the mortality rate on the first part of the journey rose to an average of almost 21% over the four years 1770-1773, with a peak of 28,3% for the year 1771. Graph 2.2 shows the fluctuation of the mortality and the Man-to-Ton Ratio between 1730 and 1780.¹⁶⁹ After the epidemic of the 1730s/40s, the number of fatalities had at first fallen drastically (apart from a sudden surge in 1757 and 1758), but the new epidemic of the 1770s caused severe concern to the VOC and it attracted public attention in the Republic, which became visible when it ended up on the agenda of some of the societies that had recently been established there. On the ships that were affected, the large number of crewmembers that fell ill must have added an extra layer of complexity to the way the ship was supposed to be operated, not to mention the tensions that it may have caused between those ill and those still healthy. On Thunberg's ship apparently almost half of the crewmembers were on average incapacitated because of illness, which must have put a heavy strain on those still capable of working.¹⁷⁰

In 1699/1700, Heindrik van Moor, chief surgeon on the *retourschip Unie*, wrote an extensive document on what he called *febris maligna hungarica*

¹⁶⁷ In the DAS database, the tonnage of the ships is calculated on the basis of their length, beam and draught using Decquer's "common calculation" dating back to the late 1680s. Cf. Bruijn e.a. (1979-1987), Part I, pp. 42-44 and Decquer (1688/1690). On Decquer, see also chapter 1.

¹⁶⁸ Bruijn (1976), p. 222

¹⁶⁹ The sustained drop in the Man-to-Ton Ratio will be explained in section 2.4.

¹⁷⁰ The *Schoonzigt* had on this voyage to contend with a mortality of about 30%, only slightly higher than the average mortality for ships leaving in 1771 which was over 28%.

describing (in sometimes graphic detail) its symptoms, causes and cures.¹⁷¹ Looking at the description he gave there can, according to the historian of tropical medicine, D. Schoute, hardly be any doubt that this was the disease which is currently known as *typhus exanthematicus* (i.e. typhus or “spotted fever”).¹⁷² Van Moor, referring to a number of named “other authors”/ “*andere autheuren*”, pointed to “poisoned air” (“*vergiftinge logt*”) as an external cause and to having a wrong way of life as far as food and drink was concerned (“*quaat levensreegel houden van spijs en dranck*”) as an internal cause. In addition, he warned against the habit of sailors to work bare-chested in the blazing sun during the day and then cool down in the evening in a windy spot. He also remarked that his experience was that the larger the crew was (both on naval vessels or on company ships) the more likely it was that the disease would occur. On large ships with many sailors and soldiers these people had to sleep on the same deck close to one another which meant that somebody who had the disease could easily infect his mates.¹⁷³ About sixty years later the physician Salomon de Monchy (in his prize winning essay for the *Hollandsche Maatschappij der Wetenschappen*) also pointed to malodorous vapours in the air (“*stinkende dampen in de lugt*”), food and drink that was off or which was hard to digest, and water that was contaminated.¹⁷⁴ As preventative measures, De Monchy suggested therefore to keep the air pure, which could be done by either carrying pots with smoking

¹⁷¹ NA 1.04.02/ 5110 *Febris Maligna Hungarica*. Heindrik (or Hendrick) van Moor died on 9 August 1700, about a month after the *Unie* had arrived in Batavia on 5 July 1700.

¹⁷² Schoute (1929), pp. 87-90. Typhus or “spotted fever” (Dutch: *vlektyfus*) is caused by the *Rickettsia* micro-organism which is transmitted through infected body lice (Bruijn (2009), p. 80). It should not be confused with typhoid fever (Dutch: *buiktyfus*) which is caused by the bacteria *Salmonella typhia* and is usually transmitted through contaminated water or food. Both diseases thrive in unhygienic conditions, which were rife on board of the ships. See also (Risse (1985), passim and Dubois (2008), pp. 80-81.

¹⁷³ NA 1.04.02/ 5110 *Febris Maligna Hungarica* (paragraph 4)

¹⁷⁴ Salomon de Monchy (1716-1794) was *doctor medicae* from the University at Leyden. In 1760, he was appointed town medical doctor in Rotterdam, where he was for a time professor at a medical school, founded to improve the knowledge and expertise of local ships’ surgeons. He was one of the directors of the *Bataafsch Genootschap*. His prizewinning essay on diseases on ships to the West Indies (*Verhandeling van de Oorzaaken, Genezing en Voorbehoeding der gewoone Ziekten van ons Scheepsvol, ’t geen naar de West-Indiën vaart*) was published in *Verhandelingen van de Hollandsche Maatschappij der Wetenschappen VI Deel (1)* (1761), pp. 1-185; it was also translated into English. The pages on which he described the causes of *rotkoorts* are pp. 76-86. He campaigned for variolation/inoculation to prevent smallpox in children. A biography is in *Nieuw Nederlandsch Biografisch Woordenboek*, http://resources.huygens.knaw.nl/retroboeken/nmbw/#page=679&accessor=accessor_index&source=1&accessor_href=accessor_index%2Findex_html%3FSearchSource%253Auf%253Austring%3Dmonchy&view=imagePane

tar around or else by introducing fresh air between decks to which end a ventilation system as had been suggested by Sutton was quite useful.¹⁷⁵ Next, one had to see to it that the food and drink that was provided for the crew was wholesome and beneficial, and was preferably served spread out over the day in not too big portions instead of one big meal.¹⁷⁶ Finally, for keeping the water palatable after it had been in casks for several months, De Monchy suggested to use casks that had been treated with sulphur, to add some *geest van vitriool* (sulphuric acid as it currently known) or to open these casks some days before the water was to be consumed. In a footnote he seems to point to the distillation of seawater.¹⁷⁷

The conviction that the main (external) cause for *rotkoorts* was malodourous or poisonous air was widespread in Europe at the time. For instance, the British physician John Pringle (who was quoted often by De Monchy) wrote in 1750

Such (i.e. the occurrence of hospital fever) is the danger of breathing in air full of animal steams, which are the excrementitious parts of the humours (...) But where these conveniences (i.e. access to a court for the freedom of air) cannot be had, the only resource is in ventilators; an invention so evidently useful, and so well known, that it is surprising they should not be hitherto applied to jayls; especially since it is evident what good they have done in ships.¹⁷⁸

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Three years later he wrote, based on his experiences as physician-general in the British army

Among the chief causes of sickness and death in an army, the reader will little expect that I should rank, what is intended for its health and preservation, the Hospitals themselves, and that on account of the bad air and other inconveniences attending them.¹⁷⁹

Writing on the emergence of hospital- or jail-fever in Great Britain in general, the historian of medicine Risse concluded

(...) physicians postulated the spontaneous generation of a poison, a contagion, arising with the stale air of confined spaces saturated with the exhalations emitted by too many dirty bodies crowded into single rooms.¹⁸⁰

¹⁷⁵ De Monchy (1761), pp. 157-161. For more on mechanical ventilators, see section 2.3

¹⁷⁶ Ibid., pp. 164-168

¹⁷⁷ Ibid., pp. 168-173 (the footnote concerned is at page 171)

¹⁷⁸ Pringle (1750), pp. 47-48

¹⁷⁹ Pringle (1753), pp. viii

¹⁸⁰ Risse (1985), p. 179

Forced extraction of noxious air was therefore an obvious remedy to expel a major cause of diseases, and according to Pringle it produced good results. In section 2.3 we will consider attempts by the VOC to technologically combat problems caused by impure water and air.

Analytical reflections by societies

In the summer of 1774, two recently established societies in the Republic (the *Bataafsch Genootschap* in Rotterdam and the *Zeeuwsch Genootschap* in Vlissingen) invited essays on the causes of the increase in fatalities on board of the VOC-ships between the Republic and the Cape of Good Hope and on how to cure and prevent diseases such as *rotkoorts*. In 1777, three answers were published in the third volume of the Transactions of the *Bataafsch Genootschap* at Rotterdam; the society had received answers only after it had repeated the question in 1775. In 1776, the *Zeeuwsch Genootschap* announced that it had received several answers on its question about the subject of *rotkoorts*, *although* publication of the prize-winning essays did not take place until 1778.¹⁸¹ Despite the fact that the essays appeared too late to have an impact on the decisions taken by the VOC, a summary of their analyses will be given here, as some of the arguments that were put forward in the essays relied on testimonies by persons who had actually experienced what it meant to sail on a disease-ridden ship. All authors suggested a policy of strategically disciplining prospective crewmembers and the *volkhouders* who provided a

¹⁸¹ The *Bataafsch Genootschap* awarded two first prizes, one to Gijsbertus ten Haaff (*medicinae doctor* at Rotterdam), and the other to Dirk Schuurman, *chirurgijn, operateur en vroedmeester* (general and operating surgeon and supervising male midwife) at Rotterdam, who had first-hand experience as a ships' surgeon employed by the VOC. The silver medal for the second prize was awarded to Joachim Muller, a citizen from Amsterdam. Gijsbertus ten Haaff later became one of the directors of the *Bataafsch Genootschap* and acted as its secretary. Joachim Frederik Muller was a prolific author on various subjects. In 1778, he won a gold medal for an essay on how to use wood and peat ash in the improvement of agricultural lands. That essay was published in the *Verhandelingen* of the *Maatschappij ter bevordering van de landbouw, Achtste Deel* (Amsterdam, 1778). He also won a gold medal for an essay on the problems of the exchange rate and another gold medal for an essay on how immovable property (such as warehouses) could be used as a security to obtain loans (*Beredeneerd Register Zeeuwsch Genootschap* (Middelburg, 1789), pp. 63-64 & 68-69). In 1788, he published an essay on how to effectively train farmer's children in the agricultural profession, in response to a question by the *Maatschappij ter bevordering van de landbouw*. In 1794, he was mentioned as a member of the *Provinciaal Utrechtsch Genootschap van kunsten en wetenschappen* (*Verhandelingen van het Utrechts Genootschap*, Vol. 8-9, p. 25 (Utrecht, 1794)). The *Zeeuwsch Genootschap* awarded two prizes; Johannes Veirac, *medicinae doctor* at Rotterdam, was presented with a gold medal and Bernardus Hussem, surgeon at the Amsterdam admiralty and an experienced ships' surgeon, won a silver medal.

great number of these crews (especially those of foreign origin), of prescribing certain types of medicines or of dominating the spread of disease through better systems of ventilation. In addition, a vivid picture was painted of the conditions in the lodgings of the *volkhouders* and the conditions on board of the ships. These conditions continued to play a role in the arguments surrounding the contested introduction of an adapted design of the *retourschip*, the so-called three-decker, as we will see in the next chapter.

The *communis opinio* emerging from the essays was that the main cause –directly or indirectly - for the rise in the occurrence of *rotkoorts* was the fact that the VOC had to rely for its crew on inexperienced and predominantly foreign people, supplied by *volkhouders*, who offered cramped, overcrowded and unhealthy lodgings and bad, insufficient food. The authors identified those who were the most at risk to fall victim to the disease as those foreigners that were supplied by *volkhouders*. Steps should therefore be taken to eradicate that group and by doing so, the underlying cause of diseases could be removed; it was explicitly suggested not to employ this specific high risk group, consisting of (German) foreigners provided by *volkhouders*. Whereas the interaction on land between prospective crewmembers (especially foreign soldiers) and *volkhouders* was seen as the main cause of the health problems, these problems were made worse by the interaction at sea between new and experienced crewmembers; the last group usually robbed the first group of their possessions. The two (former) ships' surgeons among the authors specifically mentioned that new crewmembers got into problems because of insufficient clothing; they usually had only one set of clothes left, because the rest had been stolen by more experienced crewmembers.¹⁸² This problem of just having one set of clothes available had already been noticed by Van Moor more than seventy years earlier, who had attributed it to the poor equipment that was provided by *zielverkopers* (i.e. *volkhouders*). Tensions between new and experienced crewmembers were apparently nothing new. The effect of being robbed of one's possessions meant that once these sailors got wet they had to sleep in their wet clothes, and the prevalence of moist laden southerly winds while the ships were waiting in the roadsteads added to an overall atmosphere of dampness, which in turn triggered an outbreak of the disease. The sudden change from the poor diet provided by the *volkhouders* to the rich and fatty diet on board was also seen as contributing to the outbreak of diseases.

The *Bataafsch Genootschap* had added a question as to why the number of fatalities was smaller on ships from other nations (such as England, France, Denmark and Sweden) than on the ships of the VOC. Schuurman, a former ships' surgeon employed by the VOC, attributed this to the fact that

¹⁸² *Verhandelingen Bataafsch Genootschap, Derde Deel* (1777), pp. 26, 55 and 108-110

these countries could rely on a sufficient number of well-qualified, local sailors.¹⁸³ In addition, the way discipline was maintained on board of the ships of the VOC came in for harsh criticism by him. Admitting that on ships of other nations discipline was kept in a rude and strict way, he argued that – according to his experience – on almost every ship of the VOC the situation was far worse. Usually officers and petty officers of the VOC tried to run their ship through “horrible swearing, the foulest and most despicable terms of abuse and sometimes undeserved beatings”.¹⁸⁴ Also a blind eye was turned to the fact that inexperienced crewmembers were robbed of their possessions. Here, Schuurman pointed to another cause for concern, although not directly connected to the outbreak of diseases. He suggested that the way discipline was maintained might be a reason for the unpopularity of signing on with the VOC. He urged a more humane approach to discipline on board. His remarks seem to have had little effect, because as late as the 1790s, directors and *supercargos* (merchants) from the VOC factory at Canton preferred to travel back to Europe using ships of the English East India Company because of the “disagreeable and lengthy voyages in our ships” and “in order to arrive in Europe in four months’ time in decent company”.¹⁸⁵

As far as prevention was concerned, the idea was that it might be possible to restrict the occurrence of *rotkoorts* to its former level. Two suggestions were made, the first of which was that the *Heeren XVII* should refrain from employing crewmembers supplied by *volkhouders* and that they only should enlist healthy persons that were suitable for the job; a second – less far reaching – suggestion was that the accommodation offered by the *volkhouders* should be improved to prevent the occurrence of the disease. To combat the problem of finding a sufficient number of (Dutch) people to enlist with the VOC, the idea of a pay rise was considered. Two authors suggested that in order to make the VOC more attractive for Dutch sailors, ordinary crewmembers should be allowed to engage in some trade for personal profit (which in fact already was the case). As an alternative (or in addition), competent and experienced sailors should be paid a higher wage than was currently the case.¹⁸⁶ Therefore, a better crew should ideally consist of experienced Dutch sailors and soldiers, who signed on out of their free will,

¹⁸³ Of whom he classified the English, Danes and Swedes as belonging to the best seafarers in Europe.

¹⁸⁴ *Verhandeligen Bataafsch Genootschap, Derde Deel* (1777), pp. 65-67: “gruwelijke vloeken, de laagste en verachtelijkste scheldwoorden, en somtijds onverdiende slagen” See also Pearson (2003), pp. 187; for a number of individual cases, see Bruijn & Eijk van Heslinga (1980)

¹⁸⁵ Quoted by Jörg (1982), p. 42 in footnote 144

¹⁸⁶ *Verhandeligen Bataafsch Genootschap, Derde Deel* (1777), pp. 32-37 (Ten Haaff) & pp. 70-71 (Schuurman)

and who were better paid. In 1991, the historian of nautical medicine Leuftink wrote that “the apparently most obvious solution to the problem of recruitment consisting in a substantial pay rise was so unheard of that none of the authors came up with that solution.”¹⁸⁷ However, as we noticed above, the opposite was the case; one of the explicit suggestions was in fact a pay rise for crewmembers. In addition to better pay, all authors suggested that crewmembers should be equipped with sufficient personal equipment, that they should be given sufficient rations of good quality food and drink, that they should be allowed to engage in some trade for their own profit and that they should be eligible for promotion on the basis of merit.¹⁸⁸

Supposing that it might be possible to prevent unhealthy crewmembers from boarding the ships, there still remained the problem of conditions on board. The former ships’ surgeon Hussem remarked on the very cramped and oppressive accommodation available on board of ships. He suggested that it might be preferable to sail with a smaller but healthy crew than to insist on a full complement that was not completely healthy. He wrote that it would be a good policy – if compatible with the requirements of the VOC – to dispatch more ships, each with smaller crews, to the Indies as this would solve the problem that the number of crewmembers was disproportional to the space available. A similar suggestion was made by the “citizen” Muller when he proposed to conduct an experiment that should be carried out over several years, to see whether *retourschepen* with a smaller crew fared better than ships with a large crew.¹⁸⁹ The interesting point is that at the time when these essays were published, such an experiment was actually carried out as we will see in section 2.4. It also turned out that Muller was quite aware of a recently introduced policy of the VOC to send ships with surplus crew (soldiers and sailors) to the Cape.¹⁹⁰ He commented that this (admittedly sensible) policy was to no avail, because as soon as these people finally arrived in Batavia they succumbed (like almost everybody else) to the diseases that were rife there. To combat the health problems in Batavia, Muller suggested establishing a *Genees- en Heelkundig Collegie* (a medical and surgical college) in Batavia, where local and ships’ surgeons who passed through could be (re)schooled. He also made some suggestions to improve conditions in the town of Batavia.¹⁹¹ Apart from the critical remarks by

¹⁸⁷ Leuftink (1991/2008), p. 169 (“*De ogenschijnlijk meest voor de hand liggende oplossing van het wervings-probleem in de vorm van een flinke verhoging van de gages was blijkbaar zo ondenkbaar, dat de gedachte daaraan bij geen van deze auteurs opkwam*”)

¹⁸⁸ However, in contrast to what was implied by some of the authors, crewmembers were in fact still allowed to carry out some personal trade.

¹⁸⁹ *Verhandelingen Bataafsch Genootschap, Derde Deel* (1777), p. 143

¹⁹⁰ *Ibid.*, p. 159. On this policy, see also section 2.4

¹⁹¹ On the college, *ibid.*, p. 158; on the improvements, *ibid.*, pp. 160-164

Hussem and Muller, on the whole the opinion was that it was possible to keep a large crew in good health, provided that only healthy crewmembers were employed and that sufficient care was taken of proper ventilation.¹⁹²

Ventilation was considered very important both to prevent outbreaks of diseases at sea and to prevent these diseases from spreading: contaminated air should be forced out of the crew's accommodation by using ventilators and clean air should be let in by opening the hatches.¹⁹³ Healthy crewmembers should as soon as possible be separated from the sick, and those that had been in close contact with sick people should be given preventive medicine, of which the *koortsbast* (or *kina*, the bark of the Peruvian cinchona-tree) was explicitly mentioned.¹⁹⁴ Suggestions for its use were either based on personal experience or by referral to the opinions of authors such as De Monchy and Pringle.¹⁹⁵ When considering the measures suggested by the authors, it appears that they were quite similar to observations made by contemporary British medical practitioners who (as we saw) also suggested enhanced ventilation to remove contaminated air as a preventative and curative measure. By the end of the seventeenth century, *koortsbast* had already earned an international reputation as a remedy against "intermittent fevers". In his book on experimental pharmacology and therapeutic innovation in the eighteenth century, the historian of medicine Maehle suggested that surgeons played an important role in the extension of the therapeutic use of Peruvian bark, such as in the treatment of gangrene and scurvy.¹⁹⁶ However, the use of Peruvian bark was still contentious, with opposition mostly being situated in German academic circles. In the Republic, the medical faculty at Leiden played a part in the acceptance of the drug.¹⁹⁷ In the early 1750s, John Pringle, physician-general in the British army, published a number of papers in which he reported on trials he had undertaken with the use of Peruvian bark against "putrid fevers". Experimentally he demonstrated that the bark had strong antiseptic properties.¹⁹⁸ Through this extension of medical knowledge, Peruvian bark changed "from specific febrifuge to universal remedy".¹⁹⁹ From a number of the essays it becomes clear that the reputation of Peruvian bark

¹⁹² *Verhandelingen Zeeuwsch Genootschap, Zesde Deel* (1778), pp. 195-197

¹⁹³ *Ibid.*, pp. 101-102 where mention is made of (Trieuwald's) bellows as used on Swedish ships, of the commonly used ventilators and of the possibility to install Sutton's machine.

¹⁹⁴ *Ibid.*, pp. 104

¹⁹⁵ *Ibid.*, pp. 167-168

¹⁹⁶ Maehle (1999), pp. 247-258. Maehle remarked that the term gangrene was used in a wider variety of cases than is currently the case. "Complicated forms of leg ulcers (...) possibly due to widespread ascorbic acid deficiency" were also classified as gangrene (pp. 247-248).

¹⁹⁷ *Ibid.*, pp. 245-247

¹⁹⁸ *Ibid.*, pp. 260-262

¹⁹⁹ *Ibid.*, p. 287

as a remedy against putrid fevers such as *rotkoorts* had become well known among physicians and (ships') surgeons in the Republic, in fact so much so that already in 1739 *Cortex Peruvianus* had been added to the collection of medicines that was available on board of the ships of the VOC.²⁰⁰

Sickness problematized

In the essays, the outbreak of *rotkoorts* was seen as a problem brought about by specific groups within the crew, predominantly foreign soldiers and foreign sailors, and by those who provided these crews, the *volkhouders*. Sickness was not only seen as a severe problem that had to be cured when it occurred on the ships, but it was also seen as something that could (to some extent) be prevented, assuming that those (be it prospective crewmembers or *volkhouders*) with the problematic characteristics were identified in time and an appropriate system of disciplining was effectuated. Independently from one another, four professionals (two physicians and two surgeons) and one "amateur" produced a finely tuned grid which offered an insight into these characteristics. As they saw it, the root cause of the health problems was the fact that – to procure sufficient numbers of crew – the VOC had to rely on inexperienced foreigners, supplied by *volkhouders*, who provided these persons with poor lodging and bad food. Soldiers (probably weakened by previous military service) presented an even larger risk than sailors. We see a solution being sought through a system of strategically disciplining (prospective) crewmembers and those who provided these crews. By suggesting methods to regulate and to control the way the *volkhouders* operated, the essayists hoped that the supply of crewmembers could be better supervised. By dividing the crew as a whole into functional groups and considering the relations between these groups the authors tried to get a better grip on the issue of sickness and health on board. *Volkhouders* and the people they provided had to be thoroughly controlled and checked, and any prospective crewmember should only be admitted when he was considered to be in a sufficient healthy state. In addition, the topic of ventilation came under scrutiny, whereby some essays advocated an up-to-date technological approach and some calling for the (re)introduction of (improved) existing methods (such as the cooling sail). It is interesting to note that three authors (including the two persons who had hands-on experience as ships' surgeons) advocated an extensive use of machines to assist in the ventilation of ships. In cases when, despite precautions having been taken, the disease nevertheless manifested itself on board, sick crewmembers had to be immediately separated from those that were still healthy, and medicine such as *koortsbast*

²⁰⁰ The *Lyste van de Medicamenten* as it was introduced in 1739 is at NA 1.10.69/91 (see also section 2.4)

(Peruvian bark) should be readily available and immediately dispensed. What most of the essays seemed to overlook, was that finding solutions to cope with the health problems of the outward bound crews might never be fully realized without some solution to the health problems in Batavia. As we saw, only Muller (neither a physician nor a surgeon) made a number of suggestions in his essay concerned with the situation in Batavia.

When we interpret the analyses and suggestions contained in the essays, it appears that they all engaged in a system of quantification, not only by numbers but more importantly by scrutinizing characteristics of diverse groups of people, and using the outcome of this scrutiny to offer possible solutions. The analyses pointed to a rather administrative approach which contained not only a meticulous description of those parts of society from where crewmembers were recruited, but also the micro-society (i.e. the *retourschip*) to which they would belong and (quite importantly) the situation (their stay with the *volkhouders*) in which they found themselves in between their original position in society and the position they would enter once they boarded their ship. In addition, the authors tried to get a more policy oriented grip on the relevant population, by signaling their existing problems and shortcomings, prescribing alternatives for the situation on board (which concerned topics like accommodation, food and drink, clothing and the way discipline was maintained) and offering suggestions to improve the *volkhouter*-system. At that point we see in the essays of the societies an attempt to engage with and influence the health policies of the VOC; what had happened (and might happen again) was seen as a matter that went beyond the interests of the largest commercial company in the Republic at the time and which was not restricted to commercial or economic aspects alone. Improvement might be realized through a thorough analysis of causes, both in the fields of prevention and of cure. In the next sections we will notice that –as far as the role of machines was concerned - opinions seemed to differ between the VOC and the essayists. Whereas the essays promoted the use of machines (especially ventilators), the VOC meanwhile was in the process of discarding existing machines or had already done so. Instead the company introduced procedural policies through which it hoped to improve and preserve the health of the crew on its ships and if possible to cure them from their diseases. Whereas there seems at first not to be an obvious reason why technological and procedural approaches should be mutually exclusive, the directors of the VOC clearly favoured centralized procedures over machines. In the next section I turn my attention to the fate of two “machines for health” that played a role on the ships of the VOC, and the reasons for their introduction, their effectiveness and their subsequent demise. Then, in the section thereafter, I will look in depth to the procedural approaches that the VOC pursued instead of machines, into the possible reasons for doing so and into the effectiveness

of these approaches. In both cases it will become clear that tensions within the organization of the VOC, between “Amsterdam” and “Batavia” and between directors and skippers often played an important role.

2.3 Machines for health: tension between success and failure

When contemporary experts pointed to noxious air and impure water as external causes for the outbreak of contagious diseases they sometimes mentioned technological means to overcome these causes. This was quite explicit in the case of air, when – about the middle of the eighteenth century – mechanical ventilators were suggested; such suggestions were less frequent in the case of water. Maybe this had to do with the predominant emphasis on “the air (which) was at once a source of disease and of cure” as the historian of science Simon Schaffer wrote, although (as we will see later in this section) proposals for distilling machines seem to predate those for ventilation machines by several decades.²⁰¹ At the end of the seventeenth century the VOC introduced its first “machine for health” which was the *waterwerk*, a distillation machine that was intended to improve the poor quality and insufficient quantity of the drinking water on board by distilling drinking water from seawater. Around the middle of the eighteenth century, the VOC introduced its second “machine for health”, the *ventilator*, which was meant to improve the quality of the air between decks. This section will be concerned with the fate of these machines, and whether their “success” or “failure” was determined by technological issues or was the outcome of negotiations regarding the tensions between machines, environment, users and directors. According to the protagonists of the *waterwerk*, the use of the distilling machines contributed to a decrease in the incidence of diseases and it led to a reduced mortality on the *retourschepen* of the VOC, although a number of skippers considered these machines instead as a cause of diseases. Similarly, after the introduction of mechanical ventilators in the late 1740s, the mortality rates on the ships decreased for a while. Nevertheless, the introduction of both *waterwerk* and *ventilator* met with some resistance, either open and vociferous or silent and stubborn. Although these machines were apparently rather successfully used for a number of years, they were – apparently to an important degree as a result of opposition by skippers – discarded after a number of years. By considering tensions that emerged between the protagonists of these machines and their users and between the directors in the Republic and in the East Indies in the wake of the introduction of these machines, an explanation will be sought for the apparent

²⁰¹ Schaffer (1990), p. 293

contradiction between the VOC acting as a forerunner in the introduction and actual use of machines to improve living conditions on board versus its subsequent decisions to discard these machines and to emphasize non-technological practices. At the end of this section and more explicitly in the next and in the final section I will also consider how these substitute practices contributed to a change in the way the VOC was operated and how they became integral elements of a changing socio-material system.

For the voyage from the Republic to the East Indies, the amount of supplies and water that had to be taken along was impressive – even after the settlement at the Cape of Good Hope had been established where fresh water and fresh supplies were provided. First of all, the voyage took a long time. At the turn of the seventeenth and eighteenth century, the average time to reach the Cape was 155 days, and thereafter, having stayed at the Cape for about a month, the journey to Batavia took another 80 days, which led to a total journey-time of 266 days, i.e. almost nine months. By the end of the eighteenth century, the time to reach the Cape had fallen to 128 days, the stay at the Cape was still about a month and the voyage to Batavia took 84 days (slightly longer than before) which led to a total of 242 days, i.e. about eight months.²⁰² In addition, the large number of people on board had to be taken into account: a crew consisting of two- to three-hundred people was quite common on the standard ships of the VOC.²⁰³ The amount of water available per person increased during the eighteenth century. Whereas the *victualielijst* (list of provisions) of 1684 mentions 30 *toelasten* (of 614 litres each) per 100 crewmembers, by 1695 this amount had risen to 30 in winter and 45 in summer. The apparent shortfall in winter can be explained by the fact that in winter more beer was carried than in summer. The list of 1724/1731 mentions 47 *toelasten* water in winter and 53 in summer, the one of 1786 has 69 *toelasten* all year round. However, the increase is less impressive than it appears because the amount of beer (per 100 crewmembers) dropped from 100 tons of beer (of 155 litres each) all year round in 1684 to 12½ tons in winter (and none in summer) by 1786. In every *victualielijst* it says that the amount carried was sufficient for nine months. Apparently, a ration of a *flapkan* (1.5 litres) of drinking water per person per day (after the beer had been consumed) was assumed to be sufficient for a voyage from the Republic

²⁰² These figures are derived from Bruijn e.a. (1979- 1987) Part I, p. 67 (table 6), 69 (table 8) and 72 (table 11a). Travel times to Ceylon, Bengal or China were of course different.

²⁰³ That number depended on the class of ship, the crew on the smaller class (or *charter*) was at the lower end of the scale, that on the largest *charter* at the higher end of the scale. These numbers remained fairly constant during the last decades of the seventeenth century and the whole of the eighteenth century – apart from a rather significant drop in numbers during the 1770s as we will see later in this chapter.

to Batavia without re-virtualizing on the way.²⁰⁴ To give an example, this ration meant that on Thunberg's ship (with its crew of 343) the total amount of water and beer would have been almost 133,000 litres (i.e. 133 metric tons). One doesn't need a large dose of imagination (or one could just read Thunberg) to realize how the quality of the water would have deteriorated after a number of months' storage in wooden casks on a hot ship. The possibility to distil seawater into drinking water might therefore have seen an

²⁰⁴ The *virtualielijsten* of 1684, 1695 and 1786 are in NA 1.04.02/4967A, the list of 1724/1731 is in NA 1.10.69/89. The lists of 1684, 1695 and 1724/1731 mention a separate amount of water for cooking purposes, by 1786 this amount had been incorporated into the total amount. The amount of cooking water consisted of 6 *pijpen* (of 400 litres each) per 100 crewmembers, equalling 4 *toelasten*. As mentioned, ships also carried a supply of beer; those leaving in summer had a smaller amount than those leaving in winter, hence the extra amount of water in summer. Taking everything together, one sees that the combined amount of water, cooking water and beer equalled 59 *toelasten* per 100 crewmembers in 1684, 59 - 61½ in 1695, 63 - 63½ in 1724/1731 and 69 - 72 in 1786. The conversion of old measures into current-day measures is somewhat complicated. According to the VOC Glossarium (<http://resources.huygens.knaw.nl/das/VocGlossarium>), the *kan* (or *flapkan*) as used by the VOC equalled 1.5 litres in modern terms. In comparison, the voyages made by the ships of the WIC (the West India Company, counterpart of the VOC) took less time and their ships were manned by a much smaller crew. The types of ship that the WIC predominantly used for its African trade were yachts and small frigates of between 70 and 100 feet in length (Heijer (1997) p. 99) – smaller therefore than the smallest charter of the VOC. Calculating the tonnage of these ships (using Decquers's formula – see chapter 1) gives an estimated tonnage of 100 to 300 tons. The ships were manned by a crew of about thirty-five whereas on outward bound VOC-ships of a similar size the crew was on average eighty-four (calculated on the basis of similar-sized VOC-ships that left the Republic between 1674 and 1740). The average outward voyage between the Republic and West Africa took just under three months. Assuming the same allowance of water per person, and assuming enough water was carried for a maximum voyage-time of five months, the amount of water needed would be at least four times smaller relative to the amount required by the VOC. The WIC was also involved in the triangular trade between the Republic, Africa, the West Indies and the Republic. Already in the Republic, the slaveships (measuring 100 to 120 feet in length, with therefore an estimated tonnage of 300 to 500 tons) were provided with most of the provisions needed for the so-called "Middle Passage" to the West Indies. A voyage between the Republic and Elmina (the main port where slaves were traded) took about three months with a crew numbering about forty. Water for the voyage across the Atlantic was taken on board in Africa. The voyage between Africa and the West Indies (Surinam or the Caribbean) with a human cargo of two-hundred to six-hundred slaves, took on average three months. Assuming that on this voyage enough water was carried to last five months, the amount of water required would have been between 50,000 litres and 150,000 litres – depending on the numbers of slaves. This means that presumably the largest slaveships (though in size comparable to the smallest charter of the VOC) had to carry more water on the Middle Passage than the largest charter of the VOC between the Republic and the Cape.

obvious solution to the quantitative and qualitative problems of providing the huge water supply that was needed.

Not only was providing the crew with a sufficient quantity of water of reasonable quality a logistical *tour-de-force*, providing fresh air was a problem of similar proportions. Because of the large number of sailors and soldiers on board and the restricted space available, the common crew had to stay in cramped conditions with low ceilings between decks with marginal or non-existent natural ventilation. Providing the common crewmembers with sufficient fresh air was the more important as there was (as we already noticed) a widespread conviction in the seventeenth and eighteenth century that noxious air was an important cause of sickness. Instructions on providing fresh air, which usually relied on the opening of gunports and ventilation grilles and the use of contraptions such as cooling sails, were issued as a matter of routine. Nevertheless, as these guidelines were apparently insufficient to ensure a steady flow of fresh air and to prevent the occasional outbreak of diseases, the introduction of a recently invented *ventilator* could be thought of as a practical solution that was less at the mercy of weather conditions than the opening of gunports or the appliance of cooling sails. I will look into what happened to the *waterwerk* first and then into what occurred regarding *ventilators*. I will conclude with an interpretation and explanation of the contradiction that was mentioned at the beginning of this section.

2.3.1 *Waterwerk*

The idea that it might be possible to turn seawater into drinking water through a process of distillation – thereby creating a reliable system of water supply that was not exclusively dependent on water carried in casks or on re-supplying *en route* - emerged in the early years of the VOC's existence. However, questions about which aspects had to be taken into account regarding reliability and who should have a say in these matters, turned out to be at least as complicated as the system itself. Pieter van Dam, the *advocaat* of the VOC, wrote in the *Beschryvinge* that in 1619, Dr Aegidius Snoeck approached the VOC with the promise that he could produce two *tons* (220 litres) of drinking water within twenty-four hours.²⁰⁵ Although the Amsterdam chamber pursued the matter until 1624, nothing came of it. In the course of the seventeenth century, similar suggestions were made by other inventors but again – according to Van Dam – none of these got beyond the stage of experiments ashore. However, in a journal kept by Robertus Padtbrugge during his voyage on the *Sparendam* from Texel to Ceylon (in 1670/1671) he mentioned that the distillation machine on board produced

²⁰⁵ For more on Van Dam, see the introduction of this dissertation. The distillation process is mentioned in Van Dam (1701/1927), DI. 1.2 Chapter 49, pp. 672-687

2½ to 3 *kannen* (i.e. approx. 4 litres) of drinking water from seawater per day. The water (although small in quantity) was “beautiful and sweet like the best springwater” (*schoon en lieflijk als 't beste bronwater*). The *fluit Sparendam* was built at VOC’s Amsterdam shipyard in 1662 so it is possible that a machine – either the one demonstrated in 1660 by Dr. David Rosine Roseus at the premises of the Amsterdam chamber or the one proposed in 1661 by the merchant Govert van Outvorst - was actually installed at this vessel that was being built at the same time.²⁰⁶ The ability to distil drinking water during the long voyages to the East Indies promised several advantages over the carrying of drinking water. Assuming that it was possible to design a non-complicated system for distillation that could more or less continually be operated on moving ships in various types of weather conditions, then (first) the problem of the deterioration of the quality of drinking water could be avoided as it was possible to produce fresh water whenever it was needed, (next) it might reduce the number of crewmembers falling ill or dying *en route*, (third) it could be possible to carry a smaller amount of water than used to be the case, and (finally) when a voyage took longer than usual - which was incidentally also the case on Padtbrugge’s journey - there was no need for the severe rationing of drinking water that otherwise would have to been implemented. In short, a more reliable system of providing ships with drinking water of a better quality might then be at hand. Although, what exactly constituted such reliability and whether it could be reduced to the technological, health- and financial aspects that were important to the *Heeren XVII* at the time, was something that was going to cause controversy within a few years.

First appearance and disappearance of the waterwerk

In November and December 1690, the Amsterdam chamber of the VOC embarked on an experiment whereby two ships of this chamber (the *Spierdijk* and the *Brandenburg*) were equipped with a *waterwerk*, invented by Christiaan Nentwigh of Amsterdam.²⁰⁷ The start of this experiment coincided with the sharp rise of mortality figures that occurred in 1690. However, as the ships that were most severely affected did not arrive before September 1690

²⁰⁶ The experiments on board the *Sparendam* are mentioned by Padtbrugge in his journal (NA 1.04.02/505, unpaginated, page 10 and 11), by Schoute (1953), p. 1137 and Roessingh (1970), p. 636, but not by Van Dam. Roseus and Van Outvorst are mentioned by Van Dam (1701/1927) Dl. 1.2 p. 673.

²⁰⁷ NA 1.10.48/24 *Lyste van 's Compagnies Schepen etc.* (unpaginated, bottom of third page); also Van Dam (1701/1927) Dl. 1.1 pp. 409-410 & Dl. 1.2 pp. 673-674. Details on the voyage of the *Spierdijk* are at <http://resources.huygens.knaw.nl/das/detailVoyage/92666> and on the voyage of the *Brandenburg* at <http://resources.huygens.knaw.nl/das/detailVoyage/92667>

at the Cape and the only ships that left the Cape for the Republic after September 1690 did not arrive before November 1691, it is impossible that knowledge about what was happening *en route* could have had any bearing on the decision to equip these two ships with distillation machines.²⁰⁸ This *waterwerk* was a distillation machine that used the fire in the caboose, thereby avoiding the need for a separate stove and thus promising an efficient use of fuel. As no drawings exist anymore of these machines, we have to rely on the surviving extensive manual for the *waterwerkers* (the operators of the machine) to reconstruct (to some degree) the working and the layout of the machine.²⁰⁹ A large copper vessel (tinned on the inside) was situated at the back of the fire-range in the caboose, and was (at the beginning of the day) partially filled with seawater by the *waterwerker* or his assistant. The evening before, the remaining brine of the distillation of that day would have been removed through a tap. First thing in the morning, the *waterwerker* pre-heated the vessel by a fire that - if possible - was made from scraps of wood that had been left over by the ship's carpenter. Once the cook's fires were burning, these fires would take over the process of heating; the pre-heating was meant to reduce the time before the distillation could commence. Once the seawater was boiling, the rising vapour emerging from the seawater entered through a pipe into the actual distilling unit, which was probably situated in a room next to the caboose. This unit was called the *kloot* and, considering its Dutch name, it had probably a spherical form. In the distilling unit, the vapour was cooled with seawater, pumped into the system by two sailors on duty. The sweet water resulting from the condensed vapour was collected into a designated vessel, also outside the caboose. Part of the cooling water was used to replenish the seawater in the boiler, which meant that it was preheated during the condensation process, thus leading to a saving in the amount of fuel that had to be used. Excess cooling water was syphoned off over board.

In June 1691, two more ships of the Amsterdam chamber (the *Nederland* and the *Purmer*) left on their outward voyage, also provided with a *waterwerk*.²¹⁰ Again, looking at the dates mentioned above, by that time the

²⁰⁸ In 1690, almost all ships returning from or via the Cape left in April or June of that year, and only one ship left by the end of July. The next ship leaving the Cape did so in March 1691 and thereafter a group of ships in July 1691 (retrieved through <http://resources.huygens.knaw.nl/das>)

²⁰⁹ This paragraph is based on NA 1.04.02/4969 *Instructie en Informatie voor de Waterwerkers* (1695) which gave details about the role and tasks of the *water-werkers* on board of ships & *Informatie, ofte Onderrechtinge voor de Water-werkers* (1695) which was an extensive manual on how to operate the machine. See also Roessingh (1970), p. 639.

²¹⁰ NA 1.10.48/24 *Lyste van 's Compagnies Schepen etc.* (unpaginated, bottom of third page)

Amsterdam chamber still cannot have had any knowledge about the health situation on the ships that had left in 1690. On 16 November 1691, the VOC was in possession of a message from the Cape on the process of watermaking on the *Brandenburg*. Every day they had produced between 80 and 90 *mingelen* (i.e. between 100 and 110 litres) water, the quality of which was deemed to be very good and better than the water that had been taken along in casks.²¹¹ When a further discussion took place in the spring of 1692, the experiment was considered to have been a success. On 25 and 26 March 1692, the Amsterdam chamber was asked to see to it that this invention was effectively introduced (*werkstellig gemaakt*) at the other chambers. Christiaan Nentwigh was appointed as supervisor for the installation of the *waterwerken* on the ships (for the Amsterdam chamber and for the other chambers as well) and as instructor for the *waterwerkers*.²¹² The size of the distillation machine apparently was geared to the size of the ships, the machines installed on a 160 ft. *retourschip* (the largest charter at the turn of the eighteenth century) could produce 28 *mingelen* per hour, and those on a 130 ft. ship (the smallest charter at the time) were capable of an hourly output of 18 *mingelen*.²¹³ A daily production of 280 *mingelen* was therefore feasible on a 160 ft. ship, which – given that the number of crewmembers was about 300 – just about equalled the daily allowance for water for the whole crew.

Three years later, on 13 July 1695, the *Heeren XVII* drew up an extensive resolution regarding the use of *waterwerken*, partly based on statistical material prepared by Casper Van Collen, a director of the Amsterdam chamber who had been probably assisted by his cousin Johannes Hudde, also a director of the Amsterdam chamber.²¹⁴ While reaching their decision, the *Heeren XVII* also discussed the reasons why diseases had affected the outward bound fleet within the last few years and which still caused problems, according to recent messages from the Governor and Council at the Cape of Good Hope. Discussing preventative measures, the introduction of seawater distillation was seen as an at least partial solution.²¹⁵ Although the original idea had been that the amount of water that had to be carried could

²¹¹ NA 1.04.02/155 dd. 16.11.1691. A *mingel* equals approx. 1.2 litres. The *Brandenburg* had arrived at the Cape on 4 June 1691, several returning ships left the Cape in early July, and two of those (the *Langewijk* and the *Nierop*) arrived at Goeree on 6 & 7 November 1691, the other ships arrived a month later. Therefore either the *Langewijk* or the *Nierop* must have delivered the report of the *Brandenburg*.

²¹² NA 1.04.02/155 dd. 25.03.1692 & 26.03.1692; also Van Dam (1701/1927), Dl. 1.1 pp. 409-410 & Dl. 1.2 pp. 673-674

²¹³ NA 1.01.48/24 *Extract uit de Resolutiën* dd. 13.07.1695 (unpaginated – marked in pencil as folio 16)

²¹⁴ NA 1.01.48/24 *Bijeenbrenginge van de manschap*

²¹⁵ NA 1.01.48/24 *Extract uit de Resolutiën* dd. 13.07.1695 (unpaginated – marked in pencil as folio 5)

be reduced by a third or a quarter, it was decided that for the time being the ships should be provided with the same amount of water in casks as usual; the reason for this was that one should not antagonize the crew. Apparently, other arguments than those that could directly be translated into numbers entered the discussion. Even though the *Heeren XVII* had decided not to go ahead with a reduction of the water supply, the Amsterdam chamber discussed a potential reduction of the amount of water shipped in casks on 22 April 1697. After some deliberation and referring to the resolution of 1695, a (local) decision was taken to reduce this amount henceforth with one-sixth; we may assume that ships provided with a *waterwerk* that were dispatched by the Amsterdam chamber sailed from then on with this reduced water supply on their outward journey.²¹⁶

In the 1695 resolution, objections raised by unnamed complainants against the distillation process were refuted, by invoking Van Collen's analysis; he had based his numbers on the comparison of the sickness and mortality rates on all ships with and without *waterwerk* that had travelled between the Republic and the East Indies from 1690 until 1694.²¹⁷ Probably to counteract a possible suggestion that the underlying figures were prejudiced, it was pointed out that the mortality figures were produced by "others" although who these others were was not specified. The results showed a significant difference in mortality for the voyage from the Republic to the Cape between ships without a *waterwerk* (average mortality 13¼ per cent) and ships with a *waterwerk* (9¹/₇ per cent), a reduction therefore of about a third, resulting in the saving of hundreds of lives. The objection was dismissed that excessive space was needed for the extra wood that was used to heat the distillation kettle. As far as the extra space for firewood was concerned, calculations were given from which emerged that the average amount of extra firewood needed (about five *vadem*) took up a volume that equalled eight *leggers* (one *legger* equalled between 400 – 563 litres). The average production resulting from these five *vadem* was more than 40 *leggers* of water.²¹⁸ The implication was that the extra amount of space needed for the storage of firewood could easily be offset by the production of drinking water. Moreover, the bundles of firewood were not as heavy as the same volume of water and they could be more easily stowed. The objection that the distilled

²¹⁶ NA 1.04.02/246 dd. 22.04.1697

²¹⁷ The fact that the resolution was prepared by Van Collen can also be deduced from a letter by Hudde to the government in Batavia in which he mentions "my cousin Van Collen" as having done so (NA 1.01.48/24 *Mijn Heer*). The handwriting of the letter is identical to (Hudde's?) handwriting of the statistical analysis (NA 1.01.48/24 *Lyste van 's Compagnies Schepen etc.* in which the underlying numbers can be found.

²¹⁸ That suggests that one *vadem* of firewood was equal to about 800 litres or 0.8 cubic metres in modern terms.

Fig. 2.2 Statistics regarding mortality by VOC director Van Collen, based on data that are (partly) not available anymore (NA 1.10.48/24). Picture by the author at the National Archives on 20 Feb. 2013

*Schepen dese vier jaaren Sonder waeterwerk
 gewaexen hebben belopen een getal van 2902 man,
 Soo Sijn gevolgelyk van deselve de Dooden door den
 anderen geuekent tusschen hier en de Caap over
 leiden 1125 loppens mackende $13\frac{1}{4}$ Procent Daer de
 Schepen met waeterwercken in deselve vier
 jaaren verbrocken, hebben opgetaelt 7131 man,
 van welke tusschen hier en de Caap overleiden
 Sijn alleen 653 uytmackende $9\frac{1}{4}$ Procent*

Fig. 2.3 Summarized comparison of mortality figures for ships with and without a waterwerk by Van Collen (NA 1.10.48/24). Picture taken by the author at the National Archives on 20 Feb. 2013

water was unhealthy was also dismissed, and the suggestion that the water produced had a “coppery” taste was counteracted with the arguments that the food was also cooked in copper kettles and that nobody had ever objected against that, that the gin and brandy that was carried on board had been distilled in copper kettles, and - even more importantly - because the distillation kettles and the condensation machine on board were provided with a tin lining, no copper could come into contact with the water anyway.

Finally, there was a calculation given of the financial advantages that the VOC could gain by the distillation process. As far as costs were concerned, the *waterwerk* itself – which would last several years - cost 300 guilders.²¹⁹ Running costs were the wages for the *waterwerker* and his assistant, which amounted on average to 96 guilders for the voyage between the Republic and Batavia; these extra costs would be easily offset by the increase in health of the crewmembers and the lower mortality figures. The resulting actual net financial gains brought about by using a *waterwerk* were also given: the thirty-one ships that had been supplied with a *waterwerk* over the four year period under consideration had produced an overall profit of 62,330 guilders for the voyage between the Republic and the Cape alone; this figure arose from a calculation of the expenditure that was wasted when an ordinary crewmember died during the voyage combined with the fact that (on average) more than nine lives on each ship were saved thanks to the distillation process

²¹⁹ And – it was added – it kept its scrap value as old copper.

– this was set against the extra costs for the running of the *waterwerk*, consisting of the wages of the operators and the cost of shipping the extra firewood.²²⁰ Potential financial gains were calculated by suggesting that if on all ships across the fleet these waterworks would have been installed and the amount of drinking water carried in casks would have been reduced by a third, an extra cargo – calculated for the outward and return voyage combined – to the value of almost half a million guilders could be shipped.²²¹ The fact that the *Heeren XVII* decided to continue with the policy of distilling seawater, gives the impression that they trusted the numbers that were provided. The fact that this policy promised financial gains may not have been unwelcome to the VOC, the more so given the fact that the company had been in rather severe financial problems for a number of years since 1672.²²²

The resolution led to new instructions for the officers on board of the ships of the VOC, regarding the use of the *waterwerk*. Skippers had to attend an instruction meeting at the Amsterdam yard where they would be presented with a printed copy of the instructions, and a journal had to be kept of the working of the *waterwerk* on pre-printed forms which had to be handed over at the Cape –when the skipper failed to do so, he would forfeit a month’s worth of his wage.²²³ The Governor and Council at the Cape, in Batavia and on Ceylon were advised that they had to cooperate in these matters; additionally, as far as the High Government in Batavia was concerned, the *Heeren XVII* decided to send a “substantial” explanation as to why this policy was considered to be a serious matter.²²⁴ This suggests that there existed some tensions between “Amsterdam” and “Batavia” regarding the *waterwerk*. Whereas the *Heeren XVII* seemed – at least for the time being –convinced that they had introduced a reliable system (based on the numerical evidence that had been provided) for the supply of drinking water, one gets the impression that the question what actually constituted a reliable system had still only been answered from their point of view. Writing about the early modern period, the historian of science Theodore Porter pointed out: “Political and business information alike was spread mainly through networks of personal acquaintances. Indeed, political and business connections were often inseparable, and neither could be readily distinguished from friendship.”²²⁵

²²⁰ NA 1.01.48/24 *Extract uit de Resolutiën* dd. 13.07.1695 (unpaginated – marked in pencil as page 15)

²²¹ NA 1.01.48/24 *Extract uit de Resolutiën* dd. 13.07.1695 (unpaginated – marked in pencil as page 19)

²²² Gaastra (1989), chapter V and Stapel (1927), *passim*

²²³ Schoute (1929), pp. 90-95 gave a summary of the surviving 24 reports by *watermakers*.

²²⁴ NA 1.01.48/24 *Extract uit de Resolutiën* dd. 13.07.1695 (unpaginated – marked in pencil as page 21)

²²⁵ Porter (1995), p. 46

We might call this “technology of trust”: “gentlemanly trust”.²²⁶ Porter’s observations echo those made by the historian of science Steve Shapin when he analysed who (in seventeenth century England) could be considered as a credible and trustworthy witness to scientific experiments

The credibility of witnesses followed the taken-for-granted conventions of that setting for assessing individuals’ reliability and trustworthiness: Oxford professors were accounted more reliable witnesses than Oxfordshire peasants.

and

They (i.e. credible witnesses) belonged to a culture that pointed to gentlemen as among their society’s most reliable truth-tellers, a culture that associated gentility, integrity, and credibility.²²⁷

In the Dutch republic which lacked the extensive class of nobility that existed in England, that role was taken over by the class of regents and wealthy merchants, and Van Collen, Hudde and their fellow directors can all be considered as belonging to this class.²²⁸ The reliability of the machine (for the time restricted to aspects of technology, health and commerce) was translated into statistical and prognostic numbers by persons belonging to the same class as those who took the decisions.

A continuing controversy about reliability (and what it consisted of or should consist of) became clear from a number of letters from Batavia. The first letter dated from 8 February 1696, when the Governor-general and Council of the East Indies wrote that – according to unnamed skippers - the process of water making was detrimental to the health of the crews involved as it had contributed to an increase in disease and mortality, that the permanent heating of the still next to the galley was very inconvenient and that the hassle of the process (they presumably meant the storage of firewood) blocked part of the *orlop* deck which was needed for the provisions and accommodation of the crew.²²⁹ Whereas this implied that the general wellbeing of the crew was considered to be at stake, the argument wears a bit thin when we realize that in July 1694 the same Governor-general had dispatched an expedition to Makassar to quell local unrest. That expedition was equipped with two stills and two “*vers-watermakers*” (possibly *waterwerkers*) to produce water for the local castle.²³⁰ This makes the assumption about the presumed unhealthiness

²²⁶ The term “technology of trust” was introduced by Porter in Porter (1995), p. 15. See also Shapin (1994), ch. 3

²²⁷ Shapin (1984), p. 489 and Shapin (1994), pp. 241-242

²²⁸ Gaastra (1989) Bijlage I

²²⁹ The letter from Batavia is mentioned and partly quoted in *Generale Missiven* Dl. V (p. 776)

²³⁰ *Generale Missiven* Dl. V, p. 678

Fig. 2.4 Title page of the information for the *waterwerkers* (NA 1.04.02/4969) and the first page from the journal on the operation of the *waterwerk* as it was kept on board of the (Zeeland) *retourschip* Cartago (NA 1.04.02/11360); pictures taken by the author at the National Archives on 13 August 2013, resp. 22 March 2013

of distilled sea-water somewhat questionable. In the letter, no mention is made of any interference with the organization of the shipping and with the actual shipping of merchandise back to the Republic. However, looking at the way the discussion would evolve, the remark about the “hassle of the process” seems to hint towards the way the ships were operated in general. A concept of a reply by Hudde survives in which he argues that similar objections had already been answered by the resolution of 1695.²³¹ For the time being, things remained as they were and ships continued to be equipped with distillation machines.²³²

The second (and final) set of critical remarks arrived by letter from Batavia dated 21 February 1698. In the *Generale Missive* of that date, mention was made of the unwillingness of skippers to sail for the Republic with a reduced amount of water. The Governor-general and the Council based this on

²³¹ This concept is in NA 1.01.48/24 *Mijn Heer...*

²³² A number of reports on the operation of the *waterwerken* (also after 1696) can still be found at the National Archives (NA 1.04.02/ 5077 - 78, 5084, 5091 - 92, 5096 - 97, 5099 - 5101, 5104, 5106, 5108 - 11, 5114, 5116 - 17, 5120, 5122, 5124 -25, 11360)

two letters they had received that same day, both signed by their secretary Christoffel van Swol.²³³ In their *missive* to the *Heeren XVII*, the Governor-general and Council wrote that the use of a *waterwerk* on the returning ships could not be implemented as none of the returning skippers had been willing to leave half, a third or even a quarter of the usual water-supply behind because they wanted to avoid a potential conflict with the crew. This was a plausible line of reasoning from the point of view of skippers, as sailing with a disgruntled crew could lead to problems on board or even mutiny.²³⁴ However, remarks by Hudde in the margin of an extract of the *missive* suggest that there was no need for the skippers to be concerned: in the resolution of 1695 it was explicitly mentioned that a reduction of the amount of water carried in casks would only be feasible if and when the process of water distillation was completely understood.²³⁵ This suggests two possibilities, either the policy of reducing the amount of water was more strictly implemented by those in authority in Batavia than had been suggested by the directors in *patria*, or this policy was used as leverage to strengthen the complaints of skippers and *waterwerkers*. However that may be, the *missive* showed that tensions had arisen between skippers (based on their experience) and those in the Republic who favoured the use of the *waterwerk*. The fact that “Batavia” mentioned the opinions of skippers in their official *missive* suggests that the skippers had at least found a listening ear within the High Government.

According to the *missive*, the comments of skippers and of a number of *waterwerkers* had been conveyed to the *constabel majoor* Otto van Thiel (who had had been skipper on the outward voyage of the *Nederland*, one of the first experimenting vessels in June 1691 and who was now employed in Batavia)

²³³ Christoffel van Swol had travelled to Batavia in 1683 as assistant to the chief merchant on board of the *Juffrouw Anna*. He rose through the ranks of government; at the time he wrote these letters, he was secretary of the High Government of Indië. In 1700, he became a member of the Council of the East Indies, and in 1713 he was appointed Governor-general, a post that he held until his death in 1718.

²³⁴ Mutiny on board ships of the VOC was not unheard of, see Bruijn & Eijk van Heslinga (1980)

²³⁵ *Generale Missiven* Dl. VI, p. 16. The extract of the *missive* with Hudde’s comments in the margin is in NA 1.01.48/24 *Extract uit de missive...* The relevant passage of the 1695 resolution is in NA 1.01.48/24 *Extract uit de Resolutiën* dd. 13.07.1695 (unpaginated – marked in pencil as folio 17). Of the skippers involved with the Batavia letter, only one person could have possibly been affected by the Amsterdam decision to reduce the amount of water carried on the outward journey. However, considering the amount of time it took for the ships to be fully equipped, it seems rather unlikely that this skipper (Anthonie Pronk) who left Texel on 01.05.1697 already had to deal with this reduction.

Fig. 2.5 Fragment of the letter by the Governor General and High Government, stating concerns of skippers (NA 1.10.48/24), picture taken by the author at the National Archives on 20 Feb. 2013

and to the *equipagemeester* Maurus Jacobsz Eijk.²³⁶ The letters containing these comments were written in response to a request by the Governor-general Van Oudshoorn, directed at the skippers staying in Batavia and waiting to depart for the Republic. He had enquired whether they were prepared to leave with a reduced amount of water in casks. The first of the two letters to the Governor-general and the Council (drawn up on 17 January 1698) records the opinions of seven skippers, four *waterwerkers* and – possibly – the *constabel majoor* as well, as he is mentioned in the list of those who gave their opinions. The second letter (also compiled on 17 January 1698 and signed by the same people as the first letter) contained answers given by a number of *waterwerkers* to a set of questions.²³⁷ Whether these answers were collected from the same *waterwerkers* as those who signed the first letter is unclear, as the names of those who answered the questions are not explicitly mentioned.²³⁸ In the first letter, it was made clear that the skippers were not prepared to sail with a reduced water supply, they argued repeatedly that the distillation process asked for more wood than was calculated, that they had great difficulty in stowing that wood, and that – consequently – there was no room for any extra return cargo.

²³⁶ The role of *equipagemeester* and that of *constabel majoor* (or *constabel-mayor*) is described in Van Dam (1702/1927) Dl. 3, pp. 172-180. The *constabel majoor* was responsible for the artillery and munition in and around Batavia, commanding over 860 persons at the castle, in the town and at the outlying fortresses. On 12 May 1699 (at the death of Eijk), Otto van Thiel was promoted to *equipagemeester*, which was the official who was responsible for all materials and supplies concerning the ships of the VOC arriving at and departing from Batavia.

²³⁷ The skippers involved were – apart from Otto van T(h)iel – Willem de Vlaming, Jan Vlasblom, Anthonie Pronk, Servaas Goudswaard, Kornelis Dekker, Jan de Wersijn and Gerrit Kolaart. De Vlamingh and Kolaart had explored the coast of Western Australia during 1696 and 1697. The *watermakers/waterwerkers* that signed the letter were Abraham (van) Lier, Jan Lagerman, Jan Schilt and Martinus Mijdens.

²³⁸ NA 1.01.48/24 (first letter) *Aan de Edele Heer Mr Willem van Outhoorn...* & (second letter) *Ter Ordre van de Edele Heer Mr Willem Van Outhoorn...*

The experiential numbers presented in these letters differed from the numbers produced in Amsterdam. Although in fact, little in the way of actual numbers were given, other than that 150 “*brandhouten*” were needed to produce one *legger* of water.²³⁹ That number was however a serious challenge to the official numbers, because it was three times as high as the number that Hudde wrote in the margin of the letter.²⁴⁰ When we look at the numbers produced by Joan Nentwigh in his defence of the *waterwerk* (see below), Hudde’s number of about 53 *houten* seems to have been very low – in fact it is the lowest number in the survey of 32 ships presented by Nentwigh. When we construct an average of out of Nentwigh’s numbers, the production of one *legger* of water would require 126 *houten*, which is much closer to the skippers’ number than to Hudde’s number. If the experiential number, acquired as it was by users, was reliable and trustworthy, that would imply that the basic official numbers were too optimistic. In that case, the assumptions built on these numbers could not be realized and the whole edifice that had been built on the supposed advantages brought about by the *waterwerk* threatened to come down. The questioning by *watermakers* and skippers of the official numbers therefore posed a serious threat.²⁴¹ It is therefore not surprising that Hudde’s comments seem to show that he was not best pleased by what was said in the letter from Batavia; he accused the *watermakers* of not paying sufficient attention to the distillation process and instead spending their time smoking and chatting, and neglecting their duty. In addition to their comments on the efficiency of the machines, the users stated that one had to keep some space available near the cabin of the ship’s *constabel* where ammunition and a number of cannons could safely be stowed, to prevent the risk of fire. The users also invoked a religious argument which implied that water-making should be seen as a “token of God’s grace” (as coming to the rescue of people on long voyages) but that it was not meant to deprive those people of better and to provide them – without good reason – with worse.²⁴² The consequence of this argument could have been that one should have a distillation machine (and sufficient firewood) on board, in case a voyage took longer than expected, but no mention was made of that possible consequence. On this particular point Hudde remarked that a time would

²³⁹ According to Nentwigh (NA 1.11.01.01/621) one *vadem* of wood equalled 500 *houten*

²⁴⁰ NA 1.01.48/24 (remarks by Hudde in the margin of the second – i.e. *watermakers*’ - letter).

²⁴¹ On the effects of questioning of assumptions underlying (scientific) controversies, see Pinch (1985). Following Pinch, the numbers provided by the skippers would have questioned official reports at a low level of *externality*.

²⁴² NA 1.01.48/24 first letter

come when people would also on short and on homebound voyages, see the process of water-making as a token of God's grace.²⁴³

In the 1698 letters, an earlier argument that distilled water was the cause of extra mortality had disappeared; in fact, in the letter that contained the summarized answers of the *watermakers*, the answer was a straightforward "Yes" on the question whether the distilled water was just as good and wholesome as the water that was carried in casks. The *watermakers* said that in windy conditions no water could be distilled, although officially it was suggested otherwise. Relying on their "hands-on" experience, the *watermakers* (just like the skippers) expressed doubts over the official interpretation of reliability in different conditions, although – they said – it made no difference in the amount of fuel needed whether distillation took place when lying at anchor or when actually sailing. According to them, there might be an increased risk of fire due to the constant burning of the distilling fire. They also said that the possibility to distil water was very necessary in times of need, but that one should not be totally reliant on this technique and should therefore carry the usual amount of water in casks. Hudde, however, suggested that the skippers exaggerated the amount of extra wood that was needed, that the distillation machine did not cause any extra risk of fire and he assumed that the *waterwerkers* had more or less been put under pressure to give the answers that were expected from them. Commenting on the assumed lack of space on board, Hudde mentioned that he had noticed that a separate space had been constructed on the *orlopdeck* which was filled with private trade. At least the greatest part of that space could – according to Hudde – be set aside for the stowage of firewood. The thinly veiled underlying message was that returning crews engaged in too large an extent of (possibly illegal?) private trade. Hudde's suspicions may have been well-founded, because when the *retourschip Veicht* had arrived back in the Republic on 4 October 1700, the Delft chamber intercepted a number of letters from on board that ship. From those letters it emerged that a number of people in the East Indies were engaged in excessive private trade. On 15 March 1701, the *Heeren XVII* instructed the High Government in Batavia to take immediate and severe action against fifteen people being suspected of this trade.²⁴⁴ The first person

²⁴³ We might say that invoking God's grace lifted the discussion to a very high level of externality.

²⁴⁴ *Generale Missiven*, Dl. VI, pp. 175-176. Also among the fifteen people accused of illegal trade was Jurriaen Beeck, citizen and merchant in Batavia (although not employed by the VOC). The *missive* by the *Heeren XVII* had been written on 15 March 1701, according to Van Beeck (1702) p. 3. Van Beeck and a number of others entered into legal proceedings against the VOC to have their expulsion from Batavia revoked http://books.google.nl/books?id=6tRXAAAACAAJ&printsec=frontcover&dq=Requeste+en+documenten&hl=nl&sa=X&ei=Zv2UUq_mKIOBywP8oYJw&ved=0CDcQ6AEwAA#v=

who appeared on the list was the *equipagemeester* at the time in Batavia, Otto van Thiel. His successor was elected on 6 December 1701 and on 20 December 1701 it was announced that he was appointed “as of tomorrow”.²⁴⁵ Van Thiel’s dismissal will almost certainly have been linked to the accusations that he was involved in excessive private trade, and it will have been the outcome of the investigations that were carried out in Batavia from 20 November 1701 onwards, following the request of the *Heeren XVII*. His (illegal) activities may point to another reason for the complaints about the large space that was taken up by the extra firewood: perhaps this space was indeed meant to be available for his (and other persons’) private trade.

In any case, the skippers and the *watermakers* had an interpretation of reliability that was different from that of the *Heeren XVII*. For the skippers it was important that ships were operated in the time-honoured fashion with a stable water supply that was readily at hand in sufficient measure. They were

[onepage&q=Requeste%20en%20documenten&f=false](#) (accessed 26 Nov 2013). In 1705, Beeck c.s. published another pamphlet, which contained a request to the *Staten Generaal der Vereenigde Nederlanden* against the VOC. They complained that the VOC protracted proceedings and refused to send over certain papers and they asked for financial compensation
<http://books.google.nl/books?id=FwtZAAAAcAAJ&printsec=frontcover&dq=beeck&hl=nl&sa=X&ei=wqPGU97YJOe50QXEHYCACQ&ved=0CGUQ6AEwCg#v=onepage&q=beeck&f=false> (accessed 16 July 2014)

The *missive* was apparently discussed in Batavia on 20 Nov 1701, see http://www.sejarah-nusantara.anri.go.id/pagebrowser/icaatom-dasa-anri-go-id_339-ead-xml-1-2521/#source=1&page=660&accessor=thumbnails&view=imagePane and http://www.sejarah-nusantara.anri.go.id/pagebrowser/icaatom-dasa-anri-go-id_339-ead-xml-1-2521/#source=1&page=659&accessor=thumbnails&view=imagePane&accessor_href=thumbnails%2Findex_html%3Fsource%3D1%26batch_start%3D655 (all accessed 15 Sep 2014)

On the career of Otto van Thiel, see <http://resources.huygens.knaw.nl/das/detailVoyage/92678>, <http://vocopvarenden.nationaalarchief.nl/detail.aspx?ID=1613967>, <http://www.sejarah-nusantara.anri.go.id/search/?q=Otto+van+Thiel&models=all> and http://www.gahetna.nl/collectie/index/nt00344/4998d07d-8ef5-4170-901b-f7161298e3bb/view/NT00344_opvarenden/q/zoekterm/ottho/q/comments/1 (all accessed 26 Nov 2013).

²⁴⁵ On the election and appointment of Van Thiel’s successor, see http://www.sejarah-nusantara.anri.go.id/marginalia_browse/?order_by=-date&page=3378 and http://www.sejarah-nusantara.anri.go.id/pagebrowser/icaatom-dasa-anri-go-id_339-ead-xml-1-2521/#source=1&page=691&accessor=thumbnails&view=imagePane resp. http://www.sejarah-nusantara.anri.go.id/marginalia_browse/?order_by=-date&page=3376 and http://www.sejarah-nusantara.anri.go.id/pagebrowser/icaatom-dasa-anri-go-id_339-ead-xml-1-2521/#source=1&page=706&accessor=thumbnails&view=imagePane (all accessed 15 Sep 2014)

willing to accept the introduction of distillation on long voyages (which in their opinion meant the first part of the outward voyage), but under no circumstance were they prepared to sail with a smaller supply of water than usual. That linked the process of watermaking and its (dis)advantages to the need of avoiding conflicts with the crew. The fact that maintaining the health of the crew was not only a matter of improving their physical wellbeing but that it was also connected to the social aspect of avoiding unnecessary tensions within the socio-material ensemble of the ship (i.e. keeping the crew “on board” in the metaphorical sense of the word) seems to have been missing in the original considerations of the *Heeren XVII*. In practice, the skippers showed that it was impossible to isolate the social aspect from the material aspect, if only because there was no way that a smaller number of casks could be kept hidden from a crew that had become quite experienced during its stay in the East Indies; a fact which might cause disciplinary problems. In addition, the experiential numbers provided by skippers and *waterwerkers* showed an outcome that was less optimistic than the calculations produced in the Republic.

The High Government in Batavia had its own interpretation whether distillation of seawater might be considered reliable. Regarding the homebound fleet, its main concern was to organize its departure in time. This meant collecting and dividing the cargo that had been required by the different chambers in the Republic, to have a sufficient number of seaworthy ships ready (through the *Generale Missiven*, the High Government often complained that there was no sufficient number of ships at hand), to provide these ships with an appropriate crew in the numbers needed, and to see to it that the ships were also supplied with provisions, water, firewood, guns and ammunition. If the introduction of distillation on the homebound voyage might lead to a shortage of crewmembers because of their refusal to sail on ships equipped with a *waterwerk*, this might lead to increased unreliability instead of increased reliability in the complicated logistic procedures Batavia had to perform. In the letter, written by the Governor General and the High Government in 1698, no mention is made of any decrease in the amount of cargo that could be shipped as a consequence of the need to carry extra firewood. The only and very explicit concern of the High Government seemed to be for the problems skippers were facing when forced to sail with a smaller supply of water than usual. The letter stated that skippers were not prepared to sail with a reduced water-supply to prevent “the dissatisfaction of the common crew and other inconveniences that by chance thereby could be caused; of which they didn’t want to be guilty”. This remark showed that tensions between skippers and “Amsterdam” (spilling over into tensions between skippers and crew) were acknowledged by “Batavia”: avoiding

tensions within the socio-material ensemble of the *retourschepen* meant that tensions between skippers and “Amsterdam” needed to be resolved.

By the time the letter from Batavia was written, the Hoorn, Delft and Zeeland chambers already had given up on distillation, for reasons that are nowhere mentioned. Although the Rotterdam, Enkhuizen and Amsterdam chamber continued to use the *waterwerk*, it becomes clear from a memorandum by Joan Nentwigh, that things were not running smoothly.²⁴⁶ In his memorandum, he argued that the advantages of the *waterwerk* had not been sufficiently brought to public attention. However, as he was sworn to secrecy – as all employees of the VOC were – he could not appeal to the court of public opinion.²⁴⁷ The best he could hope for was that the VOC would bring matters out into the open. Nentwigh gave several examples of long voyages that would have run into severe trouble, had it not been for the possibility to turn seawater into drinking water, among which was his personal experience from the years 1696/1697 when he had served as assistant water-maker (*onder-waterwerker*) on the *Ijsselmonde*. It had taken the ship (after a stay of three months in Portsmouth) another five and a half months to arrive at the Cape. He had produced 36 *leggers* of water on route and when the ship arrived at the Cape it had only one and a half *legger* of water to spare which meant that the situation would have been disastrous without the *waterwerk* on board.²⁴⁸ He argued that the volume of wood needed to operate the machine was far less than the volume of water that was produced. In addition, being able to produce drinking water made it possible that ships bypassed harbours which were reputedly unhealthy (such as St Iago on the Cape Verde islands) or where crewmembers might desert. He added that it would be quite possible to reduce the number of water-casks on the return-voyage with a third, provided the *waterwerk* was properly operated. This would offer the possibility to take several *lasts* extra of valuable commodities instead, thus increasing the profits of the company. The extra wood needed could be easily stowed in different nooks and crannies on board. Nentwigh added that a successful operation of

²⁴⁶ NA 1.11.01.01/621 *Klaare aanwijzing etc.* On 8 November 1703, Joan Nentwigh had – upon the death of his father – been appointed as supervisor of the *waterwerken*. This memorandum is probably written not long after 1703, as it refers to a voyage that took place in 1703 but not to any later voyages (of which there were quite a number). Possibly, Nentwigh wrote his memorandum following the death of Hudde and Van Collen in early 1704.

²⁴⁷ Van Dam (1702/1927) Dl. 1.1, p. 369

²⁴⁸ NA 1.11.01.01/621 621 *Klaare aanwijzing etc.* (second page). Nentwigh returned with the same skipper, Adriaan Palestein, on the *Lek* via Ceylon. On the VOC-opvarenden website (<http://vocopvarenden.nationaalarchief.nl/default.aspx>) Nentwig(h)’s name is misspelled as Ventwig. Although he was in the East Indies during the time the Batavia letters about the use of the *waterwerk* on the homebound voyage were written, his opinion was not included nor that of his skipper. Presumably they were already in Ceylon.

the *waterwerk* was also dependent on the good relations between the *waterwerker* and the *bottelier* (the person responsible for providing water and other drinks) and between the officers and the *waterwerker*. He made some scathing remarks regarding the quality of the rainwater that was put into the casks upon departure, pointing out that such water could well have been fetched from stinking stagnant pools or dirty canals in towns and cities, whereas the distilled water came from the clean seas with just the salt taken out through the distillation process. He finished by saying that his hope was that this essay might help to dispel the disdain about the honest craft of watermaking. Nentwigh's perception of reliability centred on personal experiences (by him and others) that the distillation of seawater could save the life of dozens of crewmembers on voyages that took much longer than was expected. He was of the opinion that these successes should have been brought to the attention of a wider public, so that people could have judged for themselves. It is interesting to see that Nentwigh stressed the importance of good relations between the *waterwerker*, officers and lower ranking crewmembers. He must have been experientially convinced of the importance of this social aspect, just like the skippers, although his was a different perspective. We might say that for Nentwigh, although he (contrary to the skippers) was in favour of the distillation process, he agreed with the skippers that the system couldn't work without trust on the work floor. The fact that Nentwigh saw the need to write this memorandum suggests that he noticed that the opposition against the *waterwerk* was gathering momentum. Interestingly though, as we saw, Nentwigh's numbers seemed to confirm the skippers' numbers which may have strengthened their case.

When the high-ranking protagonists Hudde and Van Collen both died in 1704, the opinions of Nentwigh, even in his position as supervisor of the *waterwerken*, were no match against earlier oppositional voices coming from Batavia.²⁴⁹ In fact, some of Nentwigh's own numbers highlight problems that were emerging. In his memorandum he wrote that, depending on the charter of the ships, six to eight *vadems* of wood were needed for distillation purposes between the Republic and the Cape, which – again according to Nentwigh – equalled a volume of ten to thirteen *leggers* of water. This gives us the possibility to make an estimate of the space that was needed for the (extra) firewood on the homebound journey, using calculations based on the ships of the Amsterdam chamber, which was the chamber most engaged in the process

²⁴⁹ The remark by Haarhoff that Van Collen died in 1707 is not correct. Both Hudde and Van Collen died in 1704. The manuscript source at NA 1.11.01.01/938 gives that Hudde died in Jan 1704, and that Van Collen died in March 1704. Valentyn (1724) gives as Hudde's date of death May 1704 and as Van Collen's 19 March 1704. Gaastra (1989) Bijlage I mentions (based on a number of sources) that Hudde died on 15 April 1704 and Van Collen on 21 March 1704.

of distilling seawater. Between 1690 and 1707, the third (i.e. the smallest) charter had an average crew of 171 on the outward voyage and these ships carried six *vadems* of extra firewood, which was – according to Nentwigh – sufficient for the journey to the Cape which lasted five months on average. In that same period, on the homebound voyage (which had a total average sailing time of about seven months) the average crew (calculated across all charters) turned out to be 128. This means that just over six *vadems* of extra firewood would have been needed to support the distillation process for the whole of the return voyage.²⁵⁰ As all the firewood for the whole of that sailing was provided in the East Indies, this means that the space taken up by that amount of extra firewood was not available for cargo. To be able to carry the usual amount of cargo, the number of *leggers* with drinking would to have been reduced by at least ten – compared to the 78 *leggers* that were needed on the basis of the average size of the crew.²⁵¹ That would entail a reduction of at least thirteen percent, coincidentally rather similar to the reduction of one/sixth as implemented by the Amsterdam chamber.

After having been used for about fifteen years, the *waterwerk* was abolished by a decree of the *Heeren XVII* on 15 July 1707. They considered that the distillation of seawater did not give sufficient benefits and that – apart from Amsterdam – the other chambers had never introduced the system or had meanwhile given up on it.²⁵² Despite what this consideration suggested, the Enkhuizen chamber was at the time of the decision still involved in the distillation of seawater. Piecing together available evidence, we can be fairly certain about the way the system of distilling seawater had been taken up across all chambers by looking at the (minimum) number of ships that sailed outward bound with a *waterwerk* between 1691 and 1707. The Amsterdam chamber dispatched at least 153 ships with a *waterwerk* over the whole period; this meant that about three-quarters of its ships had the machine and the specialized personnel on board. Of the other chambers Enkhuizen sent out

²⁵⁰ Using data available at <http://resources.huygens.knaw.nl/das> the average crew on the outward voyage has been calculated for all 112 ships of the third charter that sailed out for the Amsterdam chamber between 1690 and 1707; the average crew on the homebound voyage has been calculated for all 97 ships of the first, second and third charter that sailed home for that chamber in the same period. Sailing times are given in Bruijn e.a. (1979-1987), Part I, [outward] p. 67 (Table 6) , p. 69 (Table 8) & p. 72 (Table 11a), [homebound] p. 82 (Table 15a) & p. 89 (Table 20). The calculation is then made as follows: Outward bound 6 *vadems* are sufficient for 171 people during 5 months (i.e. 855 people.months). Home bound there are 128 people during 7 months (i.e. 896 people.months). This outcome is 1.05 times larger than the outward number, so 6.3 *vadems* would be needed on the homebound voyage.

²⁵¹ Calculated using the standard amount of about 60 *leggers* per 100 crewmembers (cf. note 12)

²⁵² NA 1.04.02/159 dd. 15.07.1707

thirteen ships with a *waterwerk* (which means that about half of its ships sailed with such a machine), Zeeland ten, Rotterdam four, Hoorn two and Delft one.²⁵³ Looking in more detail it becomes clear that until the very end the Amsterdam and Enkhuizen chamber equipped a number of their ships with a *waterwerk*. The Amsterdam chamber still had the machine installed on ships built in 1706, and it dispatched at least seven vessels with a *waterwerk* in 1707 (the last two left on 19 May of that year) and the last ship of the Enkhuizen chamber with a *waterwerk* also sailed in 1707. By contrast, the last Rotterdam vessel with a *waterwerk* sailed in 1703, the last Zeeland vessel in 1697, the last Hoorn vessel in 1694 and the only Delft vessel in 1693. As we already saw, the Hoorn, Delft and Zeeland chambers had ended their use of distillation machines before the 1698 letters from Batavia arrived in the Republic. The implementation of the *waterwerk* at these chambers – the practicalities of which had been explicitly left to the Amsterdam chamber by the decision of 1692 – apparently had no lasting effect.²⁵⁴ Therefore the decision of the *Heeren XVII* in fact only affected the water-distilling policies of the Amsterdam and Enkhuizen chambers. In their considerations, the *Heeren XVII* referred to the Batavia letters from 1698, mentioning that - as both extra wood had to be shipped as well as the standard amount of water - no extra

²⁵³ These numbers are minimum numbers, as only ships have been included for which archival confirmation could be found that they had a *waterwerk* or at least one *waterwerker/watermaker* on board. The statistics regarding the *waterwerk* over the years 1691-1694 as prepared by Van Collen contain twenty-two Amsterdam vessels, five Zeeland vessels, two Hoorn vessels, and one vessel each from the Rotterdam, Enkhuizen and Delft chamber. Of the surviving twenty-four *waterwerk*-journals (mostly spanning the period between 1698 and 1701), eighteen are from ships operated by the Amsterdam chamber (although of those two had been built by the Delft chamber and one by the Enkhuizen chamber), four are from ships operated by the Enkhuizen chamber (one of those ships had been built by the Hoorn chamber), one is from a ship operated by the Rotterdam chamber and one from a ship operated by the Zeeland chamber (in 1695). In addition, incidental evidence points to a *waterwerk* in use in 1693 on a ship of the Enkhuizen chamber (the “*Gouden Buis*”) which is not contained in any overview, possibly because it was wrecked before it reached the Cape of Good Hope (cf. Gessel, van & Kieskamp (1995)). In addition those ships are added that had one or more *watermakers* in its crew (which were not included in those above) as could be derived from

<http://vocopvarenden.nationaalarchief.nl/list.aspx> – searching for “*watermaker*” / “*onder-watermaker*” / “*opper-watermaker*” / “*anders*” with subsequent checking for appropriate descriptions (accessed between 18 - 22 July 2014). However, this database (somewhat incomplete as it unavoidably is) is only based on the occupation of crewmembers on their outward journey. Whether they were actively involved in *watermaking* on the homebound voyage is unclear. Van Collen’s numbers and the journals are also only concerned with the first part of the outward journey, i.e. between the Republic and the Cape of Good Hope.

²⁵⁴ It may be the case that these other chambers were less than enthusiastic because they didn’t like to being subjugated to policies implemented by the Amsterdam chamber.

space had been created for shipping a greater amount of commercial goods. It is rather ironic that a policy that was originally designed to ease the introduction of the machine (i.e. that for the time being ships should carry the same amount of water as usual to alleviate fears of the crew) was now used as an argument for the abolition of these machines. As far as the Amsterdam decision to reduce the amount of water carried in casks by one-sixth is concerned, it is likely that it was only applied on the outward voyage, considering the opposition of skippers to sail home with a reduced amount of water. Maybe the *Heeren XVII* had by now come to realize that the trust they had put in numbers provided by gentlemen residing in their own circles (and therefore seen by them as trustworthy) had not been matched with a similar trust by the skippers who had to operate the ships and by the officials in Batavia who had to prepare the ships for the homebound voyage.

Reflecting on the abolition of the distillation process, tensions emerged between the *Heeren XVII* in Amsterdam and the Government in Batavia, as became clear from the Batavia letters. However, whether a general antagonism was the main argument behind those letters seems somewhat doubtful given the fact that no mention was made of problems connected with preparations for the homebound voyage which were specifically issues for the High Government in Batavia.²⁵⁵ Concerning the homebound voyage, the VOC organisation in Batavia played a very important role, as we noted earlier. On the homebound voyage (as we saw in the first chapter), the crew numbered about a third of the outward crew. This meant that the total amount of supplies (food, water and firewood) that was needed was considerably smaller than on the way out. The casks were filled at the point of departure in the East Indies (in most cases this was Batavia), and these casks were probably refilled at the Cape. The firewood, supplied in Batavia, was calculated to be sufficient for the whole journey to the Republic.²⁵⁶ The presumably only extra effort would have been a relative small amount of extra firewood – the stowage of which might however interfere with the space available for (private) cargo. Considering this, it is difficult to see how the process of distilling water on the outward-bound voyage could have been related to official matters in Batavia in particular or to the shipping activities in the intra-Asian trade. In the resolutions regarding the introduction of the *waterwerk* only mention is made of the outward and homebound journeys of

²⁵⁵ This link to a general antagonism between “Amsterdam” and “Batavia” has been suggested by the historian Roessingh when he wrote that the position of “Batavia” regarding the *waterwerk* could have been related to a general antagonism between the High Government in Batavia and the *Heeren XVII* - the feeling in the East being that the *Heeren XVII* were interfering in local matters of which they had no experience. Cf. Roessingh (1967), p. 24 and Roessingh (1970), p. 637

²⁵⁶ Van Dam (1701/1927), Dl. 1.1 pp. 523-530 & Dl. 3 pp. 494-515

the *retourschepen* and none whatsoever regarding journeys within the East Indies. It is therefore doubtful whether the actual preparations for distilling water on the homebound voyage had much of an impact on the way the Government and departments in Batavia had to organize the returning fleet.

There has been a suggestion that the demise of the *waterwerk* was connected to a shortage of firewood, especially at the Cape.²⁵⁷ However, considering the way the supply of firewood was organized (not only for the distillation process but also for cooking purposes) this seems not quite convincing. Ships leaving the Republic were equipped with water in casks (as we have seen above, still in the standard amount as originally had been prescribed – probably apart from the Amsterdam ships), and in addition they were equipped with a *waterwerk* and the extra firewood needed for its operation. As we also noted, the quantity of water in casks was calculated to be sufficient for nine months. When the ships arrived at the Cape, all casks (even those that still contained water) were refilled with fresh water. Firewood supplies were also replenished. Looking at the voyage from the Cape to the East Indies (be it Batavia, Ceylon, Bengal or the Malabar coast) which as we saw took just over half the time needed for the first part of the journey, there must have been less need for the distillation of water as still all casks had been refilled. The extra amount of firewood needed for the operation of the *waterwerk* for the second part of the outward journey (between the Cape and the East Indies) cannot have been very large in absolute numbers, certainly not compared to the amount that would have been needed for cooking anyway. Moreover, the complaints made by skippers regarding firewood did not concern any lack of firewood as such but the space that the extra amount for the distillation process took up; but then they only seemed to be worried about these problems when it concerned the homebound voyage. That “Batavia” might have had problems in supplying sufficient firewood for ships returning to the Republic cannot be substantiated by any remark in the *Generale Missiven*. The High Government was aware of the somewhat precarious situation regarding firewood at the Cape, because in December

²⁵⁷ The historian Haarhoff wrote: “Ships leaving the Netherlands were only provisioned with firewood to reach the Cape, where the balance had to be provided for the remainder of the voyage. Ships leaving Batavia were provisioned for the entire return journey. (...) Wood was therefore a scarce commodity from the start. (...) In 1708, the crisis deepened when Batavia, for some unknown reason, could not supply all the firewood for the return journey, which put more pressure on the meagre firewood resources at the Cape. (...) The shortage of firewood was therefore a serious problem throughout the period (1690 to 1707) when the DEIC practiced seawater distillation. The success of seawater distillation therefore did not only hinge on the stowage volume saved, but also on the difficulty to procure extra firewood. These reasons explain why the other chambers and some of the ship captains were less enthusiastic about distillation than the Chamber of Amsterdam.” Cf. Haarhoff (2009), pp. 241-242

1700 there is a remark to that effect; the authorities in Batavia apparently used to ship firewood to the Cape on supply ships, although they complained (but not before 1710) of not having been informed earlier about the dire situation at the Cape.²⁵⁸ Between 1686 and 1713, there is only one mention on scarcity of firewood in the East Indies itself; in the *Generale Missiven*, it says on 15 January 1710 that it was impossible to provide the returning fleet leaving Batavia with firewood for the whole journey.²⁵⁹ That means that these problems can only have occurred when the homebound fleet left at the turn of 1709/1710 by which time the *waterwerk* had already been discarded, word of which must have reached “Batavia” by the end of 1708 at the very latest. It is hard to understand how problems regarding firewood that occurred in the East Indies some years after 1707 can have had any bearing on a decision that the *Heeren XVII* took in 1707.

In all likelihood, the main argument must have been the tensions between skippers, crewmembers and machines as they were experienced or expected by a number of skippers, backed up by numbers that questioned the efficiency of the system. This dissatisfaction, distrust and disquiet speaks from the letters that had been written in 1698 and which (in more general terms) had also been apparent in the 1696 letter, to which the 1698 letters had added experiential numbers. Both letters conveyed the message that the skippers saw the machine that they were obliged to use as a radical, disruptive and even dangerous change to the way they had to run their ships, as it increased the risk of fire and quite possibly antagonized the crew. If a distillation machine was to be used at all, it had to be on a long voyage, which meant the first part of the outward voyage. The sociologist of technology Madeleine Akrich noted “The evaluation of the disadvantages and advantages of an innovation is entirely in the hands of the users: it depends on their expectations, their interests, on the problems they raise”.²⁶⁰ However, looking at the innovation of the *waterwerk*, it seems that the position and power of the users was more complicated than suggested by Akrich. To confront the tensions they were faced with, the reluctant or unwilling users had to use a rather circuitous route to get their voices heard. A combination of a number of skippers, some *watermakers* and a high ranking employee in the hierarchy in Batavia were apparently needed to make their critique heard in the Republic, aided by letters of the High Government in Batavia. The High Government in Batavia was willing to listen to the comments of the skippers and to act accordingly by not putting them under a (real or perceived) obligation to sail with a smaller amount of water than usual. This suggests that it was not so much the High Government in Batavia that was using skippers to get its point

²⁵⁸ *Generale Missiven*, Dl. VI, p. 137 (1.12.1700) and pp. 706-707 (29.11.1710)

²⁵⁹ *Generale Missiven*, Dl. VI, pp. 654 (15.01.1710)

²⁶⁰ Akrich e.a. (2002A), p. 202

across - the High Government in Batavia was usually quite capable of arguing its case - but that it was a group of skippers that ultimately made use of the influence of the High Government to strengthen their case. Negotiating the continued use of the distillation machine (or rather its discontinuation) necessitated the skippers to go through "Batavia" to reach "Amsterdam". Knowing that the powerful protagonists of the machines resided in Amsterdam and probably assuming that a direct approach might therefore not yield results, the skippers made use of the next highest institution (i.e. the High Government in Batavia) to bolster the trustworthiness of their experiences, their observations and their opinions. A "progressive disinterest of the users"²⁶¹ in itself was not powerful enough to obstruct the use of the machines, let alone discard the machines altogether. Finding and using spokespersons in high places in Batavia enabled these users to get a (eventually decisive) grip on the evaluation of the official concept of reliability and on the advantages and disadvantages related to the innovation of distilling drinking water on board of VOC's *retourschepen*. To present their experiences convincingly as "matters of fact" and not as mere opinions, meant that the skippers had to connect with people belonging to social categories on a par with the *Heeren XVII*. As Peter Dear noted "(...) in order to persuade people to accept one's knowledge-claim as unproblematic, one needed to expend work in attaching it to the label "matter of fact". A "matter of fact" (...) was all about social categories."²⁶²

None of those involved in the discussions, be it Van Collen, Hudde and the *Heeren XVII* in Amsterdam, or Nentwigh, or the skippers, or the High Government in Batavia could pretend that their claims were unproblematic or that they didn't have a personal interest in the success or failure of the *waterwerk*. In Amsterdam we find a group of directors interested in promoting a new technology that promised financial gains and in which they had invested some personal credibility whereas at the opposite end of the world (in Batavia) we find a group of skippers who had to command their ships on a journey of several months with a crew that should not be antagonized without a very good reason, who wanted to avoid any unnecessary risk of fire and who were possibly not opposed to engage in some profitable trade of their own. The position of the High Government in Batavia can be succinctly characterized as successfully performing the complex logistical operations that were required to ship the precious cargo from the East Indies to the Republic in time, a task that was complicated as it was even

²⁶¹ Akrich e.a. (2002A), p. 203. The decision to introduce the machines had been taken without consulting the skippers which may not have increased their willingness to accept the machines. As mentioned in Jong, Johan de (2010), chapter 3, it was not until the 1740s that skippers were given a certain amount of formal say in matters of ship-design.

²⁶² Dear (1992), p. 627

without tensions with skippers. The trust in calculated numbers as displayed in the early documents of the *Heeren XVII* seemed increasingly to be confined to the Amsterdam and the Enkhuizen chambers and more specifically to the Amsterdam directors Hudde and Van Collen and the inventor Christiaan Nentwigh and his son and successor Joan Nentwigh. Across the Indian Ocean we come across a group of rather outspoken skippers and their *watermakers*, who – through high-ranking connections – conveyed their own experiential numbers to those in authority in the Republic via the High Government in Batavia. The High Government in turn, had its own numbers to adhere to, such as its responsibility for the lucrative trade in the East Indies and the organization of the shipping of precious cargo reliably and safely back to the Republic. Whereas the *Heeren XVII* can be considered as VOC's Dutch "centre of calculation" (to borrow a term coined by the philosopher Bruno Latour²⁶³) this centre was challenged by the centre of calculation that was the High Government in Batavia. Both centres collected and accumulated people, materials, artifacts, goods, facts and figures and processed these into the merchandise and numbers for the trading empire of the VOC and also into an impressive paper shadow, parts of which are visible to this day. Although there were often tensions between "Amsterdam" and "Batavia", in the surviving letters related to the *waterwerk* we do not come across remarks specifically related to the responsibilities that "Batavia" had for its part of the business. Instead, the letters are concerned with the responsibilities of the skippers and the tensions they experienced or feared. By sailing expertly between the two centres of calculation, the skippers brought existing tensions out in the open (thereby linking tensions on individual ships to tensions in the wider network) and disseminated their experiential numbers to the centres. The circuitous re-routing of their comments gave their considerations eventually a stronger position than those from "Amsterdam" and – after almost a decade – they were ultimately and decisively invoked as underlying reasons for the discarding of distillation machines on the VOC *retourschepen*, added to which was the apparent disinterest of most chambers outside Amsterdam. A few years after the main protagonists of the *waterwerk*, Van Collen and Hudde, had died, the practical and experiential distrust of skippers in this new technology and their numbers (actually confirmed by Nentwigh, the other advocate of the *waterwerk*) won the argument. The need to avoid ongoing tensions on board of the ships, and the realization that the financial gains were not as impressive as originally had been suggested became stronger than the trust in the original numbers and the calculations based on them. In the end, the skippers' numbers were acknowledged as the most trustworthy on the topic of the *waterwerk* - which means that in the end

²⁶³ On "centres of calculation", see Latour (1987), ch.6 (specifically pp. 232-233)

numbers produced by those who distrusted the technology turned out to be more reliable than those who had put their trust in the technology. As we will see later in this chapter and more extensively in the next chapter, it would take until well into the second half of the eighteenth century before institutions emerged that claimed that they produced unbiased (“disinterested”) and therefore trustworthy facts, figures and numbers and were even able to resolve tensions within the VOC network as a whole.²⁶⁴

Second appearance and disappearance of the waterwerk

Fig. 2.6 Poissonnier's *cucurbite* for distilling drinking water from seawater, as used on De Bougainville's expedition between 1766 and 1769. Picture derived from <http://www.academiedemarine.com/anciens/Poissonnier.php>

A final twist to the story of the *waterwerk* occurred sixty years after the early demise of the original machine. In 1768, the French explorer De Bougainville sailed into Batavia with his ships *La Boudeuse* and *l'Étoile*. On board of *La Boudeuse* was a so-called *cucurbite*, a distillation machine devised by Pierre-Isaac Poissonnier, inspector-general of medicine, surgery and pharmacy for the navy and the colonies of France; this machine had successfully been used

²⁶⁴ On the subject of “disinterestedness”, see Dear (1992), pp. 625-628

while the ships crossed the Pacific Ocean.²⁶⁵ Contrary to what had happened seventy years before, this time Batavia took the lead. Governor-general Van der Parra was so impressed by the machine that he had immediately three copies made, one of which was tested in Batavia. From the tests (carried out by the apothecary in Batavia) it emerged that in the first test 46 pounds of coal were needed to produce 46 *kannen* of drinking water out of half a *legger* of seawater.²⁶⁶ The water tasted quite good although it had a slightly “tin-like” taste but that was (according to the apothecary) to be expected when using a distilling machine for the first time. In this first test, an additional powder prescribed by Poissonnier for use with his machine had not been used. In the second test, 161 *kannen* of seawater were put into the machine, plus two spoonfuls of the powder. However, due to the seawater boiling too forcefully, it entered into the head (or *helm*) of the machine, causing the distilled water to become brackish, and so no useful results were obtained. For the third test the boiler was filled in the morning with 168 *kannen* of seawater (again with powder added) and by the afternoon 92 *kannen* of drinking water had been produced, for which 54 pounds of coal had been used. Once the process was underway and the system had been heated up, three pounds of coal were sufficient to produce 21 pounds (or seven *kan*, i.e. about ten litres in modern terms) of drinking water. The apothecary added a few remarks, consisting of an explanation for the inefficiency of the first experiment, a warning not to overfill the boiler, a remark on the uselessness of a certain tap that was presumably meant to check on the water level and finally he wrote that the powder (as prescribed by Poissonnier) was useless and superfluous; when in the first experiment no additive had been added, the water tasted much better than when the additive was used, it was “*zo zoet als regenwater*” (as sweet as rainwater).²⁶⁷

Two of these machines were shipped to the Republic, each on a different ship, the first bound for Enkhuizen, the other – which departed much later – for Amsterdam, together with the earlier mentioned results of the test and a printed instruction on how to use the machine.²⁶⁸

²⁶⁵ Carr (1968), pp. 74-75 gives the surname of the inventor of the *cucurbite* as Poissonnier-Desperrières, but the website of *L'Académie de Marine* names Pierre-Isaac Poissonnier (1720-1798) as its inventor, adding “*Une confusion persiste entre les biographies de Pierre-Isaac POISSONNIER et de son frère Antoine POISSONNIER-DESPERRIERES (1722 ou 23 -1792 ou 93), Inspecteur général des hôpitaux de la marine, auteur de plusieurs ouvrages sur la médecine navale.*”

<http://www.academiedemarine.com/anciens/Poissonnier.php>, accessed 7.10.2015

²⁶⁶ Poissonnier’s machine used coal for heating, in contrast to the wood that was used in VOC’s previous distillators.

²⁶⁷ NA 1.04.02/3222 N° 26

²⁶⁸ NA 1.04.02/3222 N° 25. According to this instruction “good quality English or French coal” should be used and care should be taken not to use “coal dust”

Coincidentally, the Amsterdam and Enkhuizen chambers were the two chambers that had been involved the longest with the original *waterwerk*. The yearly reports (and the information concerning the machines) by the Governor-general and the Council of the East Indies arrived before the machines; as the receipt of these papers is mentioned in the minutes of the meeting of the *Heeren XVII* on 17 October 1769. They referred the machines for testing to the respective chambers and asked to have the results available by April 1770.²⁶⁹ The *Nijenborg*, the vessel bound for Enkhuizen, did not arrive in time, but the *Rijnsburg* (a so-called three-decker, owned by the Zeeland chamber but at that time carrying a cargo for the Amsterdam chamber²⁷⁰) arrived at Texel in February 1770, without having made a stop at the Cape *en route* from Batavia.²⁷¹ Therefore, only the Amsterdam chamber could carry out the required tests in time. The chamber lost little time because within two months a report was ready for the April meeting. It is somewhat remarkable that by 15 March 1770, when the directors of the Amsterdam chamber discussed these matters, they only referred to the opinions of the skipper of the *Rijnsburg*.²⁷² At that time tests still needed to be carried out, but no mention of these is made in later minutes of the Amsterdam chamber although they are mentioned in the minutes of the meeting of the *Heeren XVII* on 2 April 1770. There it says that, based on the report of the skipper of the *Rijnsburg*, on experiments undertaken by Cornelis Lugthart, supervisor of the pharmacy of the Amsterdam chamber and on some remarks from Batavia regarding the construction of the machine and the way it should be operated, the Amsterdam chamber concluded that the profit to be had from the machine did not outweigh “the risk of fire and other inconveniences” and therefore it advised against the introduction of this distillation machine - and so it was decided that for the time being these machines would not be introduced, pending the outcome of the tests in Enkhuizen.²⁷³ These tests never took place because the *Nijenborg* failed to arrive in the Republic; the ship had disappeared between Batavia and the Cape.²⁷⁴

There is no mention of any definitive decision, but on 10 October 1772, all chambers were requested to return to Batavia – at their earliest possible convenience - all distilling boilers (“meant to produce drinking water from

²⁶⁹ NA 1.04.02/62 and 179 dd. 17.10.1769

²⁷⁰ Chapter 3 will be concerned with the controversies, discussions and negotiations concerning the introduction of these three-deckers in which societies played an important part.

²⁷¹ One might be tempted to think that there was no need for a stop because of the possibility to distil drinking water.

²⁷² NA 1.04.02/278 dd. 15.03.1770

²⁷³ NA 1.04.02/180 dd. 02.04.1770

²⁷⁴ See <http://resources.huygens.knaw.nl/das/detailVoyage/98629>

seawater”) that they had received or that they might receive in future.²⁷⁵ Whereas this request at first may seem a bit strange, there is contemporary evidence that distilling machines were being shipped from Batavia to the Republic after 1770; this becomes clear from a memorandum written by commander Van Woensel of the Amsterdam Admiralty.²⁷⁶ Van Woensel mentioned that some homebound ships of the VOC had been equipped (in Batavia) with a copy of the distillator designed by Poissonnier, and he specifically quoted skipper Cornelis Bos who used such a machine when he returned with the *Bleyenburgh*. Van Woensel wrote that the distillators were produced in different sizes; this particular one could contain twelve buckets of seawater.²⁷⁷ A disadvantage of the design was that the flue became very hot, so great care had to be taken when operating it at sea, which seems to confirm the earlier judgment by the Amsterdam chamber.²⁷⁸ According to Bos, the machine produced 130 *kannen* of drinking water per twenty-four hours while laying at anchor in Batavia, and 80-90 *kannen* while sailing, which almost covered the daily ration of water as the crew consisted of 90 persons.²⁷⁹ The water produced was of better quality than the water that was carried in casks. Because it was used only intermittently, the crew was provided with water from the casks; the distilled water was bottled and used exclusively in the officers’ cabin and for the sick. The efficiency of the machine boiled down to the use of one bucket of coal per twenty-four hours.²⁸⁰ One gets the impression that the opinion among skippers on distilling seawater had

²⁷⁵ NA 1.04.02/181 dd. 10.10.1772

²⁷⁶ In his memorandum (NA 1.01.46/1088) commander J. van Woensel advocated the use of distillation machines on ships of the admiralty. It is remarkable that by the time the second experiment of the VOC came to an end, the (Amsterdam) admiralty was apparently considering to introduce the technology. The *Bleyenburgh* had left Batavia on 10 April 1772 and arrived at Texel on 14 October 1772, having made no stop at the Cape.

²⁷⁷ One bucket equalled ten *kan* (i.e. fifteen litres in modern measures). Based on a description of the machine, Van Woensel calculated that it must have been 2½ feet wide and 2½ feet long, with a height of 1½ feet (this would have equalled 70 by 70 by 42 centimetres). However, in that case the machine would have been filled almost to the brim which seems not quite likely, so it must have been somewhat larger.

²⁷⁸ The English design, advocated by Van Woensel, had the distilling vessel placed next to the cooking pot for meat, and the flue of the (combined) fire was led through to the distilling vessel, thereby utilising any excess heat and at the same time cooling the flue. Incidentally, that arrangement is rather similar to the one used on the ships of the VOC between 1691 and 1707.

²⁷⁹ Cf. <http://resources.huygens.knaw.nl/das/detailVoyage/98709> and then following the link to <http://vocopvarenden.nationaalarchief.nl/default.aspx>

²⁸⁰ There is no mention of the total amount of coal that Batavia provided. For a voyage of six months, a total volume of at least 2700 litres of coal would have been needed (i.e. about three cubic metres in modern measures). Nowhere is mentioned how Batavia managed to procure coal in these quantities (and especially the “English or French coal” as prescribed).

changed compared to the turn of the century. Whereas in the late 1690s, skippers complained about the unhealthiness of distilled water, a skipper of the early 1770s kept this water for his (and his fellow officers') personal use and for that of sick crewmembers, which – if anything – shows that it was not seen as unhealthy. Ironically, whereas the original *waterwerk*, introduced by the Amsterdam chamber was discarded by invoking arguments from skippers arriving through Batavia, now a possible re-emergence initiated by Batavia was scuppered by the *Heeren XVII*, acting on an advice of the Amsterdam chamber.

The request to return distilling boilers to Batavia might have been the final end to the affair had it not been for the curious coincidence that a few hours later in that same meeting, a letter was discussed that had been written on 7 October 1772 by Willem V, stadholder of the Republic and chief director of the VOC. Among some other topics, he mentioned a *mémoire* about a distillation machine devised by Poissonnier, suggesting that such a machine might be useful for the VOC. Two days later, the *Heeren XVII* answered that the Amsterdam chamber would investigate whether the machine was different from the one used on *La Boudeuse* and that they would report back.²⁸¹ On 29 March 1773 (based on comments by the Amsterdam chamber), they replied to the stadholder that the new machine was exactly the same as the one that had already been investigated and that the VOC therefore stood by its decision not to introduce distillation by means of these machines on board of its ships.²⁸² Help from high places came too late to secure a second introduction of seawater distillation, but it may have added at least a bit of ceremony to the ending and for the present-day historian it offers a glimpse into some tensions that may have existed between the stadholder as the supreme director of the VOC (at least in name) and the other seventeen directors.²⁸³

2.3.2 Ventilators

On 3 November 1746, the *Heeren XVII* inspected “a certain machine, known as a ventilator, meant to clean the noxious air on ships.” The machine must have made so much of an impression that they asked the Amsterdam chamber to provide each of the other chambers with a specimen of this machine so that it

²⁸¹ NA 1.04.02/181 dd. 10.10.1772 & 12.10.1772

²⁸² NA 1.04.02/181 dd. 29.03.1773. The comments by the Amsterdam chamber are in NA 1.04.02/281 dd. 22.03.1773

²⁸³ Apparently, Willem V was not that easily deterred from giving (technological) advice: a few years later (in 1775) he suggested introducing lightning-rods on the ships of the VOC. However, as lightning-rods have no direct bearing on the health of seafarers, the discussion and experiments that ensued as a result of his suggestions are not included in this dissertation.

could be copied and installed on all ships of the company.²⁸⁴ As we have seen in the previous section, during the 1730s/1740s a sharp rise in mortality on board of the VOC ships had occurred and at the time noxious air was seen as an important if not the main cause of sickness. This becomes clear from an essay written in 1755 for the Philosophical Transactions of the Royal Society by Stephen Hales, one of the inventors of such a ventilator.²⁸⁵ In his essay, Hales said

(...) the principal cause of the sickness in ships is the noxious putrid air; the obvious remedy is the exchanging that foul air for fresh, by effectual means²⁸⁶ (...) it is the high degree of putrefaction (that most subtile dissolvent in nature), which a foul air acquires in long stagnating, which gives it that pestilential quality, which causes what is called the gaol-distemper.²⁸⁷

Apart from promoting the virtues of (his own) ventilators, this text also gives us an impression of eighteenth century opinions on the character and effects of different types of air, seen as a source of health or as a cause of sickness.

The ventilator that was introduced by the VOC was (according to Bicker, writing in 1801) based on Hales's invention of 1741.²⁸⁸ Hales's ventilator consisted of a large, manually operated set of bellows that could force "contaminated" air out or – alternatively – could force fresh air in. Hales was not the first person to invent a mechanical ventilator; in 1727/1728 John Desaguliers had presented to the Royal Society "An Attempt (...) to Shew How Damps (...) may be drawn out of any Sort of Mines, &c by an Engine (...)"²⁸⁹ and in 1735/1736 he gave an "Account of an Instrument or Machine for Changing the Air of the Room of Sick People in a little Time (...)"²⁹⁰. Just before Hales published his invention, the British admiralty had approached

²⁸⁴ NA 1.04.02/49, dd. 3.11.1746 ("*zekere Machine bekenet onder de naam van Ventilators, dienende tot zuivering van de kwaade lugt op de schepen*")

²⁸⁵ Stephen Hales D.D.F.R.S. "An Account of the Great Benefit of Ventilators in many Instances, in preserving the Health and Lives of People, in Slave and other Transport Ships" read on 18 December 1755 in Phil. Trans. (1755), pp. 332-339. The theologian Stephen Hales (1677-1761) had a large interest in natural historic subjects such as botany and chemistry on which he published extensively. One of his practical inventions was the ventilator, which was not only used on ships but also in prisons. He was also interested in the distillation of drinking water from seawater. In 1718 he became a fellow of the Royal Society.

²⁸⁶ Hales (1755), p. 333

²⁸⁷ Ibid., p. 339

²⁸⁸ Bicker (1801), p. 55. The introduction of the ventilator was much more recently mentioned by Kist (1985), p. 17 and Kist (1992A), p. 68.

²⁸⁹ Desaguliers (1727/1728)

²⁹⁰ Desaguliers (1735/1736). On p. 48, Desaguliers suggested that his machine might be used on ships.

Desaguliers to inquire whether his centrifugal “instrument or machine for changing the air (etc.)” that was meanwhile being used to ventilate the House of Commons could be used on ships as well.²⁹¹

However, an experiment on a naval vessel did not lead to an introduction in the British navy. Then, in 1741, three alternative mechanical ventilators emerged almost simultaneously on the European technological scene, invented by Stephen Hales, Mårten Triewald and Samuel Sutton.²⁹² Triewald’s machine was quite similar to the one by Hales; it also consisted of a large, manually operated set of bellows that could force “contaminated” air out or could force fresh air in. The most significant difference between the two machines was the construction of the bellows. Sutton’s system was based on a quite different principle; it consisted of pipes connected to a stove whereby the draught generated by the heat would draw the “foul” air out, to be replaced by fresh air entering through portholes, gunports, hatches and grilles. As early as 1721, Triewald had used a similar heat-principle for the ventilation of mineshafts in England, as an alternative for a manual operated system suggested by Desaguliers a number of years earlier. Between 1739 and 1741, Triewald advocated such a system for the ventilation of mines in Sweden. Apparently, he did not consider his heat-driven system suitable for use on board of ships and he promoted his hand-driven bellows instead.²⁹³ An experiment with Sutton’s machine in 1741 did not immediately result in an introduction across the British navy, although it seems that a few more ships were equipped with this machine; according to Bicker the British admiralty ordered in 1748 that all its ships should be equipped with Sutton’s system.²⁹⁴ But apparently Sutton’s invention lost support and in 1756 a decision was taken to equip all naval ships with Hales’s ventilators, after a first experiment

²⁹¹ On the request of the admiralty, see Bicker (1801), p. 12-14 and Ellis (1948), p. 188.

²⁹² Mårten Triewald (1691-1747) was a Swedish merchant and engineer with a strong interest in natural history. He was for a time employed in the mining industry in England before returning to Sweden where he is supposed to have constructed the first operational steam engine. He was a member of the Royal Society of Sciences in Uppsala, was a founder of the Royal Swedish Academy of Sciences and was a member of the (English) Royal Society. Samuel Sutton (not to be confused with his namesake who was a high ranking officer in the Royal Navy) was the owner of a London coffeehouse who came up with a non-mechanical way of ventilating ships. Apparently he had also turned his hand at the problems of smoking chimneys, which may well have been connected with his invention of the ventilator.

²⁹³ For Hales: Phil. Trans. (1742/1743), pp. 42-45 & 62-70, Hales (1743); for Triewald: *Kongl. Swenska Wetenskaps Academiens Handlingar* (1739-1740), pp. 450-457 and *Kongl. Swenska Wetenskaps Academiens Handlingar* (1741), pp. 96-10; for Sutton: Sutton (1745). Also Bicker (1801), pp. 31-33 and Zuckermann (1976/1977).

²⁹⁴ Bicker (1801), pp. 27-29 and Ellis (1948), p. 188

Fig. 2.7 Ventilation machines: Triewald's machine is depicted as 2^{de} afb., Duhamel's machine as 3^{de} - 4^{de} afb., Hales's invention as 5^{de} - 8^{ste} afb., and three versions of Sutton's principle are depicted as 8^{ste} (sic)- 10^{de} afb. Illustration from *Baak der Gezondheid voor de Zeevarenden* (1760), picture taken by the author at the Library of Leiden University on 19 July 2012.

on a navy vessel in 1749.²⁹⁵ Meanwhile, in 1743 Triewald's machine had been implemented on all ships of the Swedish navy, as mentioned by Hales in his *Description of Ventilators*, published in 1743.²⁹⁶ In the same volume, Hales quoted Triewald in saying that after he had shipped one of his ventilators for testing to France, his system had been adopted by the French navy.²⁹⁷ This means that – as far as commercial ship-owners are concerned – the VOC was the first company to install mechanical ventilators on board of (all of) its ships. The first commercial British ships equipped with ventilators (of Hales's design) were – in 1749 - five Nova Scotia ships (owned by the Earl of Halifax) used for ferrying people to this colony; in 1751 ventilators were installed on four more of these ships.²⁹⁸

Before the invention of the mechanical means of ventilation, one had to rely on cooling sails or alternatively a *windmouw* or *manche à vent* (a contraption made of sailcloth that scooped up fresh air and funnelled it below decks); the principle behind all these contraptions consisted in forcing fresh air in and having the bad air expelled by the incoming air. When we remember the discontinuation of the earlier heat-driven distillation, it is perhaps not surprising that the VOC opted for a manually operated machine. However, Sutton's system could very well have been operated by using the stove in the caboose, thereby avoiding the need for a separate fire and its associated risk. As we have seen, the physician Salomon de Monchy – in his advice to the Zeeland chamber on how to avoid and combat *rotkoorts* – explicitly suggested the use of Sutton's invention to clean the air below decks and so did one of the writers of an essay for the *Bataafsch Genootschap*.²⁹⁹ The VOC not only had mechanical ventilators installed, the company also instructed their skippers to use these machines on a daily basis and to keep a record in the ship's journal of having done so. For example, in 1749 the Zeeland chamber had an instruction printed to that effect (called "*Scheeps-blaasbalken*") in which it said that these *blaasbalken* (i.e. bellows) should be used daily and as often as possible to extract noxious air and to force clean air in, thereby preventing disease and mortality among the crew. In 1760, a similar instruction was repeated across the whole of the VOC with an explicit remark that ship's officers had been found neglectful in following these (and

²⁹⁵ Zuckerman (1976/1977), pp. 233-234 and Hales (1758), Part 2.1 pp. 96-97

²⁹⁶ Hales (1743), pp. xi-xv

²⁹⁷ *Ibid.*, p. xiv

²⁹⁸ Hales (1758B), pp. 83-84. It is interesting to note that these last four ships were fitted out in Rotterdam and that the person responsible (Mr Yeoman) "left a model of a double Pair of Ventilators at Rotterdam and instructed a Person there how to make them".

²⁹⁹ NA 1.04.02/11445 dd. 25.8.1772, pp. 21-22 (§ XXIV), De Monchy repeated here suggestions he made in his essay of 1761 (De Monchy (1761) pp. 157-161); *Verhandelingen Bataafsch Genootschap, Derde Deel* (1777), pp. 79-84

other) orders.³⁰⁰ This may suggest that at that time not all skippers were convinced of the usefulness of ventilators.

The resolutions of the *Heeren XVII* of 1 October 1761 mentioned a memorandum by the master shipwright of the Rotterdam chamber, Pieter van Zwijndregt, in which he proposed a machine that was more effective in expelling the noxious air between decks than the machine currently in use.³⁰¹ Whether they also considered a proposal by the Zeeland master shipwright Willem Udemans Sr for an alternative type of ventilator cannot be deduced from the minutes of their meeting. Udemans had presented his proposal to the Zeeland chamber in a letter, dated 15 December 1760. He had based his proposal on a machine devised by Duhamel de Monceau, which used a centrifugal principle; a description of this machine had been published in "*Baak der gezondheid voor de zeevarenden*" (Beacon of Health for Seafarers).³⁰² Udemans wrote that he had tested this ventilator on the *retourschip Visvliet*, by creating a huge amount of smoke below-decks ("the smoke was so thick that the candles went out") which was cleared within two hours by the machine. This led him to conclude that his ventilator was better than the current ones. Moreover, this new machine did away with the need to route tubes across the space below-decks which were needed for the current ventilators to expel the foul air. He wrote that he was quite willing to repeat the demonstration in the presence of the directors of the chamber, but it seems that this proposal of Udemans floundered (despite his calculation of the cost of the machine), unlike his proposal for the overhaul of the current design of *retourschip* as we will see in the next chapter. The Rotterdam chamber was asked to conduct further experiments on Zwijndregt's ventilator and these must have yielded positive results because a few years later

³⁰⁰ NA 1.04.02/4952 "*Scheeps-blaasbalken*" dd. 17.11.1749 (one gets the impression that the Zeeland chamber was ahead of events, as the *Heeren XVII* issued their recommendation to use these ventilators on 16.03.1750 (NA 1.04.02/ 222 see "Machine") resp. NA 1.04.02/4952 "*Rakende de officieren...*" (*Extract uyt de Resolutiën...*, dd. 2.10.1760)

³⁰¹ NA 1.04.02/57, dd. 01.10.1761.

³⁰² NA 1.10.69/290. Although on an accompanying slip of paper the year 1769 is mentioned, there can be no doubt about the date 1760 in Udemans's letter. Duhamel's machine showed quite some resemblance to the machine described by Desaguliers in 1735/1736. Henri Louis Duhamel de Monceau was inspector general of the French navy between 1739 and 1782. He was member of the (French) *Académie Royale* and of the (English) Royal Society. In 1752 he published a textbook called *Elémens de l'Architecture Navale ou Traité pratique de la Construction des Vaisseaux* which was translated in English and in Dutch. In 1759 he published a treatise *Moyens de Conserver la Santé aux Equipages des Vaisseaux (etc.)* which was translated into Dutch in 1760. The Dutch translation of Duhamel's text of 1759 was made by the physician N.M.D., annotated by professor Johan Lulofs of Leiden and published in 1760. This means that Udemans must have read this translation very shortly after its publication.

Fig. 2.8 Model of (presumably) Van Zwijndregt's ventilator (Rijksmuseum Amsterdam NG-MC-1369)

(on 9 April 1764), the *Heeren XVII* advised the chambers to install the new ventilator on their ships.³⁰³ Apparently some chambers took their time in doing so, because on 6 October

1766, it was decided that those chambers that already used the improved ventilators should continue to do so and that the other chambers should put these ventilators to the test and (when they found them to be satisfactory) should install them on their ships.³⁰⁴

In the early 1770s, reports were received from skippers suggesting that using the ventilator on the return journey brought no advantages, the reason being that the way the cargo had to be stowed made it practically impossible to use the machines. At first, on 10 October 1771, the *Heeren XVII* decided to fine these skippers for not complying with the orders to use the ventilators. However, having received advice from the chambers, it seemed that the skippers had made a convincing case and the use of ventilators on homebound voyages was formally abolished on 9 April 1772 and the fines were revoked. The suggestions by the skippers are consistent with the remarks made by Udemans about cumbersome tubes leading to and from the ventilators. Apparently tensions emerged between stowing as much cargo as possible and the routing of tubes to clean the air; possibly, also the fact that the crew on the homebound voyage was much smaller than on the outward journey may have made the use of ventilators somewhat less urgent. The fact that the *Heeren XVII* abolished the use of ventilators on homebound ships may suggest that they saw cargo as more important than the health of the crew.

Writing in 1801 in the *Transactions of the Hollandsche Maatschappij van Wetenschappen*, Bicker mentioned that the ventilators designed by Pieter van Zwijndregt had also been installed on the ships of the Rotterdam

³⁰³ NA 1.04.02/177, dd. 09.04.1764

³⁰⁴ NA 1.04.02/178, dd. 06.10.1766

admiralty.³⁰⁵ He doubted the efficiency of these ventilators and mentioned that they were hardly used, adding that by 1791 the *Heeren XVII* decided to abolish them on the ships of the VOC altogether. Indeed, in their meeting of 25 March 1791, the directors had argued that there were other effective means of ventilation, such as cooling sails, that ventilators were rather expensive and moreover that they were not used very often. One gets the impression that the *Heeren XVII* realized that their policy of setting fines in the case of non-compliance with the rules had not been successful. In fact, they had already given in to the non-users when they abolished the obligation to use these ventilators on the homebound voyage. They now decided that ventilators should be discontinued completely but that ships' officers should see to it that "proper use was made of other means of ventilation" but how that could be more effectively enforced than the use of ventilators remained unclear.³⁰⁶ This meant a return to the practices that existed before the introduction of ventilators. The argument that ventilators were expensive wears a bit thin if one realizes that the number of ships that the VOC built had dropped considerably. The company built only four ships in 1790, five in 1791, four in 1792 and four in 1793, in addition to which it also bought one ship in that year. In 1794 there were probably four ships on the stocks.³⁰⁷ It seems more likely that the VOC realized that the ventilators were not or hardly being used and that the company had little or no means to force the skippers to use the machines. In fact they had admitted this almost twenty years earlier when they abolished the obligation to use the ventilators on the homebound voyage. Apparently the quiet but effective refusal to use the machine sealed the fate of this technology: non-users mattered enough to discard the machines. Whereas in the late seventeenth century, unconvinced users argued to have machines abolished, by the end of the century a silent, stubborn and continuous refusal to use machines was apparently just as effective a method to have them discarded. Although it seems at first sight that skippers had resolved tensions between them and "Amsterdam" on the use of ventilators to their advantage, it is rather doubtful whether the consequences of the abolition of ventilators were positive as far as the independence of the skippers was concerned.

2.3.3 Puzzling consequences

Not only was the VOC the first commercial ship-owner and -builder that used measured drawings in the design and building of its ships (as we saw in the

³⁰⁵ Bicker (1801), pp. 55-58

³⁰⁶ NA 1.04.02/88 dd. 25.03.1791; Bicker (1801), pp. 59-60. By then – according to Bicker – the use of ventilators had become common practice in Sweden, France and England.

³⁰⁷ See also chapter 1, note 7

first chapter) and the first commercial company to install mechanical ventilators on the ships of its fleet, the company had also been a frontrunner concerning the large-scale use of distillation machines for producing drinking water out of seawater. On that topic the company was at least more than half a century ahead of any other commercial company or any navy. In the case of England, the earliest confirmed mention of distilling machines dates from the late seventeenth century, when two inventors (Walcott versus Fitzgerald) each sought to obtain a patent for their machine. In 1675, Walcott was granted a patent by King Charles II which was revoked when Fitzgerald got his patent in 1683. The following year Walcott's invention was patented by the States General of the Republic.³⁰⁸ Although both inventors argued that their invention was used on a number of occasions, there is no evidence that any of their machines was used with any lasting success on ships, least of all on any large scale, either with the British navy or with the East India Company.³⁰⁹ In 1739, Hales wrote

Mr. Walcot asserted before the House of Commons, that Mr. Fitzgerald's Water was rough, harsh, fiery, corroding and tormenting the Body when constantly drank of. This I suspect was the true reason why both their Methods of preparing fresh Sea-Water was disused, viz. because when they had been used for a considerable time, they were found to be disagree with those who drank them.³¹⁰

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Despite Hales and others suggesting improved distillators, it was not until James Lind published his ideas on sea-water distillation in 1762 that the process was finally introduced in the British navy, although still not as matter of routine. On Wallis's and Carteret's circumnavigation of 1766-1768/9 Wallis had a Lind machine installed on his ship the *Dolphin* and Cook had a similar machine with him on the *Endeavour* between 1768 and 1770. Despite the apparent success on these and other long voyages, the navy seems to have taken its time (until the mid-19th century in fact) before introducing distillation as a standard procedure.³¹¹ In the same year that Wallis and Carteret left for their circumnavigation, the French explorer De Bougainville set sail for his circumnavigation of the globe. As mentioned, on one of his

³⁰⁸ Hales (1739), pp. ix-xxxviii

³⁰⁹ Haarhoff (2009), p. 239 mentions here that eleven sea-captains claimed that the Fitzgerald system (between January 1684 and December 1685) performed well on their ships. Of the Walcott machine (of which the patent had been re-instated in England in 1695) the younger brother of Walcott (who had succeeded him) claimed that "several ships made use of it, of late, particularly the *Lucretia* in several voyages to and from Jamaica. Upon this experience and proof, other voyages carried a much less quantity of water"

³¹⁰ Hales (1739), pp. xiii-xiv

³¹¹ Diamond & Farrer (2005), pp. 548-552

ships, *La Boudeuse*, a distillation machine was installed after a design by Poissonnier. When De Bougainville arrived in Batavia in 1768, it was this machine that caught the attention of the governor-general and which – as we saw – led to the short-lived re-introduction of distillators within the VOC. Similar machines were installed on a number of ships of the French *Compagnie des Indes* and the French navy between 1764 and 1770.³¹² However, it has been suggested that Poissonnier had in fact based his machine on an invention made by Jean Gautier, chief medical officer of the *Compagnie des Indes* almost sixty years earlier. A test with Gautier's machine was undertaken on a vessel bound for Senegal in 1717, but – according to reports delivered upon return – excellent as the system might be, it could not cope with the movements of the ship, because water spilled into the vaporisation unit and out onto the fire, extinguishing it.³¹³ The system made a short comeback (on land) in 1751 where it caught the attention of the *Académie des Sciences*. Then in 1764, Poissonnier presented his distillation machine to the *Académie des Sciences*.³¹⁴ It seems therefore safe to conclude that in the intervening years such machines were not used by either the French navy or by the *Compagnie des Indes*. Just as in the case of the English, it would take until well into the 19th century before sea-water distillation became a standard technology on board of French oceangoing vessels.³¹⁵

The VOC therefore enjoyed for a time a technological lead on the topic of using machines to improve living conditions on its ships. In the early eighteenth century, Nentwigh had argued (referring to his personal experience) that when a ship ran out of water due to unfavourable weather conditions, the presence of a *waterwerk* with which it was possible to distil seawater, could make the difference between life and death. Similarly, when a ship became becalmed in the doldrums, there was no way that a cooling sail could assist in ventilating whereas in those circumstances a mechanical ventilator could still keep the air moving below decks. Nevertheless, in 1707 the decision was taken to discard sea water distillation and in 1772 it was decided to block the re-emergence of the *waterwerk*. Almost simultaneously, the decision was taken that the ventilator had only to be worked on the outward journey. The abolition of distillators in the early eighteenth century

³¹² Kerneis (1967), page thirteen (unpaginated). It concerned the *Duc de Praslin* (1764), *Marquis de Castries* (1768), the *Mars* and the *Triton* (1769) of the *Compagnie des Indes*; the *Pondichery* and the *Berryer* (1770) of the navy; the *Duc de Duras* (1770) owned by the French king (and bound for China) and the *Brisson* (1770) also owned by the French king.

³¹³ Kerneis (1967), page twelve. Kerneis suggests that Poissonnier plagiarized Gautier's invention and profited from it.

³¹⁴ Kerneis (1967), page twelve and thirteen, where Kerneis suggests that Poissonnier plagiarized Gautier's invention and profited from it. Also Rochon (1814), pp. 299-300.

³¹⁵ Kerneis (1967), page nineteen to twentytwo

was in all likelihood a response to the distrust of skippers regarding the new technology, whereby the VOC tried to avoid tensions with skippers and between skippers and crew. An added consideration may have been that the system turned out to be less efficient and thus financially less attractive than originally had been envisaged. The decision of 1772 to abolish the re-introduced distillator may partly have been influenced by the opinions of the skipper of the *Rijnsburg* who brought the machine back from Batavia, coupled with again concerns about the profitability of the process.³¹⁶ In the same year 1772 the use of ventilators was abolished on the homebound voyage because of the fact that skippers had turned effective non-users. This meant that on homebound ships were no longer technological means had to be used with which problems could be tackled “on the spot” (if and when they occurred) based on the experience, judgment and discretion of skippers and officers on board.

The fact that in 1772 decisions were taken to do away with technological means to improve the health situation on board is puzzling: as we already saw, in that year a serious outbreak of deadly *rotkoorts* was just beyond its peak but still far from over and preventive and curative measures were urgently considered, among which were quite prominent the provision of clean water and clean air. Instead, as we will see in the next section, existing procedures were re-introduced, re-formulated and strengthened, and new procedures added which left less room for improvisation by those who had to translate the procedures into practice. No longer were skippers allowed some latitude in the way they could run their ships by offering the possibility to use machines which could technologically assist them in overcoming problems. Instead of machines for health being accepted as a part of a lasting solution to the serious health problems that confronted the VOC, its ships and its crews, the directors of the company opted for a solution that implied a reinforcement of the procedural way of organizing activities on board by prescribing from a distance in great detail how skippers and officers should go about their tasks and by meticulously organizing the whole of the outward voyage from the company’s centre in the Republic. The irony is that skippers through their own actions as anti-users or non-users contributed to an increased disciplining of not only common crewmembers but also of skippers and officers. An acceptance of one or both of these machines could have offered a larger (materially assisted) degree of self-containment for *retourschepen* as far as the topic of health was concerned. Instead, *retourschepen* became even more strictly organized than they already had been. As will be shown in the next section, the VOC as an organization became also more centralized, because the chosen procedural approach had a disciplinary aspect that not only affected

³¹⁶ Things might have turned out differently when another skipper (the one of the *Bleyenburg* for instance) had returned with the machine.

ships, skippers, officers and crew but to some extent also the chambers of the VOC. That these centralizing tendencies contributed to existing and new tensions between “Amsterdam” on the one hand and chambers, skippers and officers on the other hand will also become clear.

2.4 Procedural responses: tensions, experiments and centralization

Not surprisingly, the outbreak of serious contagious diseases led to extensive discussions in the meetings of the *Heeren XVII*, if only for the practical reason that high mortality numbers led to an insufficient number of soldiers and sailors being available in Asia and on homebound voyages. This caused problems for the protection of VOC’s settlements in Asia and it could be quite disruptive for the operation of ships within the intra-Asian traffic and for manning ships returning to the Republic. As we saw in the preceding section, sometimes these discussions led (directly or indirectly) to the introduction of machines for health, but as time wore on measures of a procedural and centralistic character were more often taken, the extent of which usually depended on the reported seriousness of what had happened and what was possibly still happening. As we saw in section 2.2, the unavoidable delay in being informed from the Cape made swift reactions from the Republic impossible and for the same reason it took quite some time before the outcome of any implemented measure could be assessed.

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Discussions, decisions and experiments

The way in which information became available about the fate of *retourschepen* was one of the first procedural matters that was explicitly reorganized as a result of the health issues that emerged in the long eighteenth century. The intention of this reorganization was to arrange that information regarding health issues would become earlier available in the Republic; in this process the Cape played an important role as a centre of accumulation. As a result of the resolution of 13 July 1695 in which also the advantages of the *waterwerk* had been highlighted, skippers of ships that were about to depart were given written orders that they should keep their crew constantly in action, that they should see to it that their ship was cleaned three times per week, that they should report at the Cape on how these orders had been followed, and that a similar report should be handed in at the final destination Batavia or Ceylon. In addition, the ship’s surgeon was instructed that he should keep notes and a journal of the types of diseases of the crew and of the time and place when and where somebody died. Two copies of

these notes and journal should be made, which were to be handed over to the governor of the Cape and which should then be sent back to the Republic as soon as possible. Similar notes should be kept during the second part of the journey, to be handed in at Batavia or Ceylon.³¹⁷ This instruction was later that year formalized in the new instruction for the surgeons (*Ordre en Instructie voor de Chirurgyens*) that was agreed upon on 10 December 1695.³¹⁸ This instruction was even more extensive and explicit; it also stated that surgeons had to report on how long those suffering had been treated, which medication had been used, and what the results of the medication had been (either positive or negative); this was meant to establish what caused the diseases and the high mortality on the company's ships of late and which medication was effective. Surgeons should visit their patients three to four times per day; they should request from skippers and officers food, drink, convenient beds and anything else that might help in curing or preventing diseases. Added to this was the remark that there had been many complaints by surgeons and common crew about skippers who did not provide the healthy crewmembers with their usual rations and who even refused to do so with the sick in their time of need. What is missing in the printed edition of the *Ordre* (as compared to the written minutes of the *Heeren XVII*) is that in the case of contagious diseases, surgeons could ask to have a part of the ship partitioned off to have a separate space available for the sick.³¹⁹ A new list of medication was drawn up as well, a copy of which was added to the *Ordre* whereby the required amounts of medicines (dependent on the size of the crew) were filled in upon departure.³²⁰ A new list of victuals and order on the dispensing of rations (*Lyste van de Victualien en Ordre op de Rantsoenen*) was also published.³²¹ To emphasize the point that skippers and officers should dispense food and drink as was prescribed, they were in an addendum reminded - in rather strong words - of their obligation to provide the crew and especially the sick with the

³¹⁷ NA 1.10.48/24 *Extract uit de Resolutiën* dd. 13.07.1695 (unpaginated – marked in pencil as folio 4). This written orders probably applied to three ships, the *Zandloper* and the *Hennetje* that left from the Meuse on 27 July and on 26 September and the *Faam* that left from Texel on 3 October.

³¹⁸ NA 1.04.02/32 or 111 or 156, dd. 10.12.1695; NA 1.04.02/5148 contains the *Ordre en Instructie voor de Chirurgyens* that was printed in 1696 in Amsterdam.

³¹⁹ NA 1.04.02/5148, pp. 4-5; minutes are in NA 1.04.02/32 (provisional minutes) and in NA 1.04.02/111 or 156 (definitive minutes), dd. 10.12.1695

³²⁰ NA 1.04.02/32 or 111 or 156, dd. 10.12.1695; NA 1.04.02/5148, pp. 6-10. According to Schoute (1929), p. 95 this new list was formalized in 1705 which may explain why the first printed form containing all medication that is still to be found in the archives dates from 1705.

³²¹ NA 1.10.59/29 The *Lyste van de Victualien etc.* of 1695 was several times reprinted; every time the orders as such remained just as they had been formulated in 1695, what did change were the types and the amounts of victuals.

rations they were entitled to, instead of using these for their own convenience. Surgeons were in a subordinate position *vis-à-vis* skippers, which it made it difficult for them to resolve such tensions when they arose. As the same problems were mentioned in later editions of the *Ordre* it seems questionable whether the new regulations were always adhered to.

The advantage of having reports about the health situation sent back from the Cape was that the directors of the VOC could react to unforeseen health risks as soon as possible, although even then there might still be a delay of almost a year. The hope of the directors was that, if the reports had been compiled as they should, it might be possible to establish an underlying reason for the occurrence of contagious diseases. In view of what we will come across almost eighty years later, it is worth noting that already in 1695 one of the many reasons that were suggested as a possible cause for the outbreak of diseases was the fact that soldiers (whose mortality was usually the highest) were carriers of an army disease (*een legerziekte*).³²² What we see in these procedural measures is a predominantly curative aspect, geared to combating diseases after they had manifested themselves. At the time, the preventive aspect was left to the *waterwerk* that had been introduced in the early 1690s.

A similar picture arose during the next period that diseases were rife on the ships of the VOC. In 1733, at the beginning of what would turn out to be a series of intermittent outbreaks in the 1730s and 1740s, a new *Ordre en Instructie* for the surgeons appeared, of which the text and the list of medication was identical to the one of 1695. But on 19 March 1736 the *Heeren XVII* proposed to overhaul the list of medication, considering that a number of medicines that were effective against malicious and other fevers or against scurvy were missing and that on the other hand medicines that were dangerous or superfluous were still on the list. The proposed new list (which was to be identical for all chambers) was sent to the chambers for comments. It is in this proposal that *Cortex Peruvianus* appeared for the first time.³²³ As has been extensively discussed elsewhere, the list that was agreed upon was then sent to the famous medical faculty at the Leyden University (headed by Boerhaave at the time) for a final appraisal. Whether Boerhaave's comments were helpful (or appropriate) seems at least debatable. The historian D. Schoute has given an extensive assessment of Boerhaave's comments, thereby referring to contemporary reports by ships' surgeons. His verdict was scathing: "*er is geen belangrijker onbelangrijk stuk dan dit* (there exists no more important unimportant paper than this one)" explaining that it was

³²² An added advantage for present-day historians is that several dozens of these surgeon's reports still exist which enables them to look at first hand reports on the situation on board, cf. Schoute (1929), pp. 78-90.

³²³ NA 1.10.69/91 *Extract uyt de Notulen (...) binnen Middelburg 19 Maart 1736*. Schoute (1929), p. 95 mentions as date 22 March 1736.

superficial, pompous and showed ignorance of the subject. However, the reputation of the faculty meant that this paper hampered the progress of nautical medicine for a considerable time.³²⁴

In hindsight, surgeons, crews and officers may have counted themselves lucky that at least the use of *Cortex Peruvianus/ koortsbast* was not frowned upon by Boerhaave and his colleagues. The outcome of this all was the publication in 1739 of an extended edition of the *Ordre en Instructie* for the surgeons and an updated list of medication which for the first time contained *Cortex Peruvianus*. This *Ordre* was on a number of points more specific than the earlier 1695/1733 order. Apart from some rather minor details, two things stand out: first, chief surgeons were to be given a hut (when the condition of the ship permitted to do so) which meant that they were effectively now seen as belonging to the group of officers and (secondly) when the ship's council had to take a decision on the curtailing of rations they had to make their views heard and take proper notes of what had been decided, to which end they were supplied with a list of all that was specifically set aside for the sick.³²⁵ The emphasis in the surgeons' order of 1739 was (just as it had been in 1695) on the curing of diseases.

When the third (and probably the worst ever) health crisis broke out in the early 1770s, the *Heeren XVII* had coincidentally already spent a day in the spring of 1770 discussing an update of the list of medicines on board, a suggestion that sick crewmembers should be separated from those that were still healthy and be placed under the *halfdek*, a proposal that water should be distributed in a sufficiently generous amount, and that – when the ships were waiting in the roadsteads – the chambers should strictly follow the rules regarding the quantity and quality of the food and drink that was to be provided.³²⁶ This suggests that existing tensions concerning the distribution of food and drink had still not been resolved. When the outbreaks of *rotkoorts* became known in early 1772, the *Heeren XVII* discussed matters on several occasions. The first of these discussions took place on 22 April 1772 and the final (at least for the time being) on 2 April 1774.³²⁷ On 22 April 1772, first the recent situation at the roadstead near Texel was extensively discussed where a great number of soldiers and sailors had been taken off the waiting ships because of illness and to prevent infection; these people had at first been transferred to lighters and a hulk that had been stationed there for that

³²⁴ Schoute (1929), pp. 95-102; the quote is on p. 99.

³²⁵ Details were concerned with cleaning the air by evaporating vinegar or burning gunpowder, looking for external causes such as cold or hot weather, food and drink or excesses in case of the outbreak of diseases, and taking notes the geographical longitude and latitude and the weather conditions when a disease emerged.

³²⁶ NA 1.04.02/180 dd. 26.03.1770

³²⁷ NA 1.04.02/181dd. 22.04.1772 & NA 1.04.02/182 dd. 02.04.1774

purpose and later to the fort at Texel.³²⁸ These problems were not confined to Texel as similar problems had apparently also arisen at the roadstead near Goeree. The meeting then considered whether the great number of diseases and deaths that occurred from time to time on the outward bound ships and of which most recently distressing instances (“*allersmertelijkste voorbeelden*”) had been received from the Cape were linked to overcrowding of the ships. The decision was taken that on the ships that were destined to leave in the autumn the crew (sailors and soldiers combined) should be reduced by fifty persons on ships of the first charter and by thirty on the second charter, compared to the current regulations. The chambers were asked to reconsider the only recently (on 2 October 1771) established standard size of the crew. That consisted of 300 on ships of the first charter and of 225 on ships of the second charter, whereby ships leaving before the first of January 1772 were allowed to sail with a crew of up to 350, respectively 260.³²⁹ It even said in the minutes of 2 October 1771 that “the chambers are allowed to equip their ships with so many extra crew members as space allows”.³³⁰ The provisional reduction meant that the crew on a vessel of the first charter decreased from 300 to 250 and on a vessel of the second charter from 225 to 195.³³¹ Furthermore, the chambers should consider how nevertheless a sufficient number of people could be made available for the Indies when ships sailed with a reduced crew, which points to still existing tensions between “Batavia” and “Amsterdam” about the number of people that became available in Asia.

When the *Heeren XVII* considered this reduction in numbers again on 30 September 1772, they decided that - in order to see whether it was effective in preventing diseases - chambers should dispatch a number of ships with a crew according to the originally prescribed size, and some ships with the reduced crew as per the April resolution; these ships should set sail at the same time. It was realized that a reduction in the size of the crew meant that

³²⁸ As we saw in section 2.2, this situation was described by Thunberg.

³²⁹ NA 1.04.02/180 dd. 02.10.1771. In a crew of 350, there were 200 sailors and 150 soldiers, and in a crew of 260 two-thirds were sailors and one-third soldiers. After 1 January 1772, the rules as already formulated on 18 November 1750 (NA 1.04.02/170 dd. 18.11.1750) would be applied again. This meant that a vessel of the first charter (150 ft.) had a crew of 300, of the second charter (140 or 136 ft.) a crew of 225, and a vessel of the third charter (130 ft.) one of 180; in all cases consisting for two-thirds of sailors and for one-third of soldiers. A vessel of 120 ft. had a crew of 120 and a (specifically mentioned) *fluyt* a crew of 80. In these last two cases, the crew only consisted of sailors.

³³⁰ NA 1.04.02/180 dd. 02.10.1771 “*de Cameren by dezen te qualificeeren om boven het bepaalde getal zo veel meerdere Manschappen op iederen Bodem te plaatsen als deszelfs ruymte sal kunnen toelaten*”

³³¹ Because the chambers were possibly still allowed to equip their ships with a crew larger than the official number, the numbers of 250 and 195 must be seen as minimum numbers.

the number of sailors and soldiers arriving in the East Indies would not be sufficient to satisfy the demand for personnel in Batavia and beyond. In fact, the problem of insufficient personnel to operate the ships in the East Indies and on the return voyage had predated the outbreak of *rotkoorts*. In the 1771 meeting in which the standard size of the crew was established, mention was already made of a shortage of healthy personnel available at the Cape to compensate for those that arrived sick (or had died *en route*). This shortage was so severe that ships had to wait for a considerable time until a sufficient number of patients had been discharged from the local hospital. Therefore a decision had already been taken that the Amsterdam chamber should dispatch the *hoeker Zon* to the Cape, carrying building materials for a new hospital and ferrying extra crew to be left at the Cape that was to be picked up by ships bound for the East Indies. In addition, the Amsterdam chamber and the Zeeland chamber got permission to purchase a *fluyt* specifically for that purpose.³³²

An overview of the points that had to be discussed in the final meeting of 1774 was compiled by Dr. Cornelis De Famars, the official physician of the VOC.³³³ His compilation was based on the advice that had been sought from several sources, and which consisted of considerations of the Zeeland, Delft and Hoorn chambers and three memoranda, one by De Famars himself, one by Adriaan Titsingh, the *equipagemeester* of the Amsterdam chamber and one by the skippers Jan Och and Wopke Popta.³³⁴ Also available was a paper written in August 1772 by Dr Salomon de Monchy in response to a request by the Zeeland chamber; in this paper De Monchy offered a large number of suggestions on how to prevent or combat diseases in general and more specifically the current disease. For theoretical considerations De Monchy referred to his prizewinning essay that had been published in the 1761 edition of the *Verhandelingen van de Hollandsche Maatschappij der Wetenschappen* (Transactions of the Holland Society of Sciences). Among other things, he suggested to engage in an experiment with Sutton's ventilation system on a

³³² NA 1.04.02/180 dd. 02.10.1771 and NA 1.04.02/ 280 dd. 28.10.1771. The *Zon* had been stationed at the Cape for a few years, from where it had sailed to the Republic (arriving at Texel on 29 September 1771) with a cargo destined for the Amsterdam chamber. That cargo had originally been transported by the *Damzicht*, which ship had been declared unseaworthy at the Cape.

³³³ NA 1.04.02/182. Leuftink (1991/2008), pp.165-166 suggested that De Famars's paper was the result of a committee of which he was a member. However, from the paper it transpires that De Famars himself – asked to do so by the *Heeren XVII* – made this compilation based on several independently written considerations and suggestions.

³³⁴ Jan Och and Wopke Popta each made four return voyages as skipper to and from China between September 1767 and July 1778. As we will notice in chapter 4, they almost always sailed in convoy with each other. For more on Jan Och and Wopke Popta, see Bruijn (2008), pp. 219 & 227 resp. 93, 153, 219 & 227

number of ships. This system, according to De Monchy, required no manual effort, worked independently of weather conditions and had been used with good results on several English naval ships and on a Dutch slave ship. De Monchy also suggested the distillation of seawater to avoid problems caused by foul water.³³⁵ It is interesting to see that an expert, who was not directly involved with the VOC and so may be considered as “disinterested” – not in the sense that he was not interested in the problems at hand but in the sense that there were no personal gains at stake - suggested an alternative for the current mechanical system of ventilation and that he advocated the (re)introduction of the distillation machine that had twice been dismissed by the company.

In his compilation, De Famars distinguished two main points, first the causes of diseases, and then possible solutions to prevent the diseases or to reduce their impact. He divided each of these main points into four sub-sections: crew, vessel, provisions and skippers cum surgeons. Regarding causes, there was the problem of too many crewmembers on the outward bound ships who were accommodated in cramped conditions, the large number of inexperienced and ill equipped foreigners in a poor state of health (of these foreigners, the soldiers were the first to succumb to diseases), the fact that patients were not separated from those still healthy and the long time spent waiting for favourable winds at the roadsteads in autumn and winter. As far as the vessels were concerned, there was the problem of cramped conditions, of impure air between decks, the dirtiness of the decks and the insufficient protection against incessant rain and blistering sun. Provisions left much to be desired: water was foul and stinking, beer was thick, turbid and sour, food became fermented and decayed and it was not prepared properly, and there was too little in the way of fortifying foodstuffs. Finally, skippers and surgeons came in for criticism because they paid little attention to the crew (whether they were healthy or sick), they were not alert on ventilation below decks or on the general cleanliness of the ship and they were not concerned about a proper distribution of food among the crew and the way it was prepared. Again this suggests that tensions regarding the distribution of food and drink had still not been resolved.

³³⁵ NA 1.04.02/11445 dd. 25.8.1772. De Monchy mentioned Sutton’s machine in § XXIV (Point 1). According to De Monchy, the experiment on the slave-ship had been carried out on the suggestion of professor Allamand of Leyden University and its results had exceeded expectations. De Monchy mentioned the distillation of seawater in § XXXI (Point 9), where he explicitly referred to his earlier essay for the *Hollandsche Maatschappij van Wetenschappen*. In contrast to what Leuftink (1991/2008) says (p. 165), De Monchy’s prizewinning essay (in *Verhandelingen van de Hollandsche Maatschappij der Wetenschappen VI Deel (1)* (1761), pp. 1-185) predated his Zeeland paper by several years

Following most of De Famars's suggestions for improvement, the *Heeren XVII* took a number of decisions that had to be implemented by every chamber. These measures implied that the chambers should see to it that only young and healthy people ("*jong en gesond volk*") were employed and sent onto the ships; that on boarding the ships, the health of the crew should be checked by the ship's surgeons (or other qualified people) and that people suffering from diseases should be rejected. In order to increase the number of Dutch sailors, the *Heeren XVII* suggested to start an experiment with employing young people (of fifteen years and over) earning between five and seven guilders a month; how many of these boys should be employed had to be decided by the local chambers.³³⁶ As far as overcrowding was concerned, the decision was taken to wait for the outcome of the experiment with smaller crews that was meanwhile carried out. All chambers were asked to investigate whether the space allocated to the crew and their belongings might be too cramped and whether it was possible to enlarge that space. In addition, the *Heeren XVII* agreed on some technical adaptations to provide more ventilation below decks, which involved the construction of extra grids. As was noticed by Thunberg, De Famars was obviously in favour of the use of ventilators. In his document he suggested to use these continuously (*aanhoudend*) which was translated by the *Heeren XVII* into repeatedly (*geduurig*). This of course could only have applied to the outward voyage as the use of ventilators on the homebound voyage had been abolished in April 1772, two weeks before the directors discussed for the first time the most recent outbreak of *rotkoorts*. On the subject of provisions, the directors decided that ample fresh water should be carried and that – apart from other measures to keep the water drinkable – lemon juice should be added to make it taste better. Unlike De Monchy in his advice to the Zeeland chamber, De Famars did not mention sea-water distillation as a way to solve the problem of foul drinking water although a re-introduction of the *waterwerk* had been discussed a number of times between 1770 and 1773 with (as we have seen) a negative outcome. The chambers were asked to consider whether their ships should be provided with larger quantities of vinegar, lemon or lime juice, wine and adequate quantities of dried sorrel and pickled cucumber.³³⁷

³³⁶ The representative of the Delft chamber argued that offering a wage of no more than five guilders might cause problems as the bounty paid to these boys might not be sufficient to pay for their equipment. Besides, the Delft chamber had apparently fewer problems in procuring its crews than the other chambers partly thanks to its connections with a local orphanage and partly because it had reputedly a better survival rate for crewmembers than other chambers. On procuring crew, see *Verhandelingen Bataafsch Genootschap, Derde Deel* (1777), pp. 60-61; on the Delft orphans, see Bruijn (1976) pp. 241-242; on the Delft survival rate, see Schouwenburg (1988), *passim* and Schouwenburg (1989), *passim*.

³³⁷ NA 1.04.02/182 dd. 02.04.1774

All these measures (and several more) found their way into a printed document which detailed eighteen points of action for the staff on board.³³⁸ This “*Extract uyt de Resolutien*” (dated 2 April 1774) displayed to a large extent a reliance on procedures; it contained a great number of (sometimes very detailed) prescriptions concerning the health situation (both preventative and curative), the dispensing of food and drink and it stated that at least once a week a meeting had to be convened about the health situation on board (of which minutes had to be taken in a separate book that had to be handed over to the authorities at the Cape of Good Hope and at the final destination).³³⁹ In case of an extraordinary number of sick or dead on board, skippers and surgeons would be kept responsible for the diseases and the mortality of the crew when they had not followed the rules. Proceedings would then be started leading to an “exemplary” punishment; this points to an ongoing attempt to centralize control by the VOC over its shipping operations and the staff on board of its ships. The procedures and prescriptions contained in the *Extract* can be seen as moving powers from the individual chambers to the headquarters of the company, leading to a centralized and standardized system of discipline, as a means to combat the actual health crisis. There was an organizational aspect in the sense that not only personnel such as officers and crew were extensively prescribed how they should go about their business but the semi-independent six chambers of the VOC as well. There was also a corporal aspect where it involved the administering of materials as additives to food and water, of medicinal substances to the crew in order to prevent or combat disease and the physical separation of different categories of people when diseases broke out.

While the *Heeren XVII* addressed a number of important issues, their solutions did not effectively tackle the problems caused by unscrupulous *volkhouders*, which became clear from a comment by the Zeeland chamber. The company may have wished to attract “only young and healthy people” of preferably Dutch descent but already in 1776 it turned out that these wishes had not been realized. Then the Zeeland chamber announced that it had (even more so than the other chambers) severe difficulties in manning its ships, to such an extent that it had not been able to dispatch the assigned number of ships. The number of potential crewmembers available on the labour market, matching the wishes of the VOC, was effectively beyond the control of the company; a number of chambers had great difficulty in manning its ships with personnel anyway, let alone with suitable people.³⁴⁰ These problems laid bare tensions between the policies as they had been formulated on a central level

³³⁸ NA 1.04.02/5153 “*Extract uyt de Resolutiën...*”

³³⁹ De Famars had suggested three meetings per week on the advice of the Amsterdam *equipagemeester* Titsingh.

³⁴⁰ NA 1.04.02 /69 (dd. 23.10.1776)

by the directors of the VOC and the realization of these policies by the individual chambers. In 1780, six years after the *Heeren XVII* had decreed that the chambers should only employ “young and healthy” people, the Zeeland chamber complained about the abominable quality of the people recruited by *volkhouders*. According to the local directors, these recruits belonged to the dregs of humankind (“*het uytschot van het Menselijk geslacht*”).³⁴¹ It became obvious that the qualitative proposals for a better crew had not led to any significant results in the years that had passed since 1774. One may assume that because of the continuing demand for large numbers of personnel, which could not be supplied by the normal labour market of the Republic, the chambers of the VOC were forced to continue to deal with these notorious *volkhouders*, even though the company was aware of the problems caused by these merchants in human capital.

Appraisal of experiments

When one wishes to assess the effects of the different measures that were taken to resolve the problems and tensions caused by the outbreak of *rotkoorts*, one is confronted by a number of issues. As we saw above, there was little that the VOC could effectively do with regard to the quality of the personnel it employed. As far as the change in provisions was concerned, purchasing these provisions seems (as was usually the case) to have been left to the individual chambers and therefore it is difficult to assess the effects of these measures. Moreover, we cannot be sure whether the suggested extra amounts of vinegar, juice etc., were actually used. The measures related to the way the ships were operated had been written into documents, but the problem was that it was only possible in hindsight to ascertain whether skippers had acted in accordance with these prescriptions (such as whether the water was dispensed in the way it should or whether the ventilators were used as prescribed - which is somewhat doubtful as we saw in the preceding section); but then, the company had to rely on written reports, which didn't necessarily reflect what had actually occurred *en route*. But even in the case that it might have become clear that skippers had sidestepped the prescriptions, it was not until 1785 (more than a decade after they had come

³⁴¹ NA 1.04.02/73, dd. 28.02.1780 (folio 225); Gelder, Roelof van (1997), p. 49. In 1776 Zeeland hadn't been able to equip all the ships it was supposed to deliver. As a result its share in the outward bound fleet had to be reduced significantly. Instead of equipping seven ships (as would have been the standard number according to the share of this chamber), the number of ships sailing on behalf of this chamber was reduced to six for 1777, further reduced to five for 1778 and then to just four ships for 1779 and 1780. The Amsterdam chamber had to provide the ships that Zeeland could not equip. (Cf. NA 1.04.02 / 69 (dd. 23.10.1776), 70 (dd. 11.10.1777), 71 (dd. 07.10.1778) and 72 (dd. 16.10.1779).

into force) that a punishment for non-compliance with these rules was introduced.³⁴²

However, there is a quantitative aspect that was and still can be assessed. That was the experiment that the *Heeren XVII* set in motion in 1772, when they suggested to experiment with a reduction in crew-numbers. Although the *Heeren XVII* relied for their evaluation on reports by the chambers, which seem to have been lost, in the surviving records of the VOC still almost every vessel is mentioned that was dispatched to the East Indies; in most cases information is available on its size, the crew-numbers involved and the death-toll for the first part of the journey (i.e. between the Republic and the Cape). This makes it possible to replicate the information that was available at the time.³⁴³ As far as *rotkoorts* is concerned, the death-toll between the Republic and the Cape is of interest; on that part of the journey the *rotkoorts* manifested itself most vehemently.³⁴⁴ During a number of years the experiment with reduced crew-numbers was discussed in the autumn meeting of the *Heeren XVII* (usually in late September or October) when the directors decided how many ships of which charter every chamber should dispatch to the East Indies from December onwards and well into the next year. In the meeting in which the experiment was first implemented (on 30 September 1772) it was decided that the “*praesidiale kamer*” (the presiding chamber, at that time the Amsterdam chamber) should carry out the experiment as its number of dispatched ships was large enough to make comparisons; the other chambers could join the experiment if they had the possibility to do so. The experiment was to continue until there was sufficient information available to come to a conclusion.³⁴⁵ However, the condition that similar ships, leaving on the same date, but equipped with a crew of a different size were to be compared limited the number of comparisons that could be made. Moreover, the volatility of the outbreaks also made it difficult to reach a

³⁴² NA 1.04.02/193 dd. 18.04.1785 and NA 1.04.02/5154

³⁴³ Thanks to the survival of large parts of the meticulous book-keeping of the VOC, this information is available to present-day researching historians. Between 1979 and 1987, Bruijn e.a. have constructed a large database Dutch Asiatic Shipping which is (in updated form) available at <http://resources.huygens.knaw.nl/das>. This database also contains the death-toll for the whole journey, the number of people that left the ships at the Cape and the number of those that came on board there, and in most cases the number of people arriving at the final destination.

³⁴⁴ This was also testified by the Rotterdam general surgeon (and former VOC ship's surgeon) Dirk Schuurman when he discussed the problems with *rotkoorts* in the Transactions of the *Bataafsch Genootschap*, as we saw in section 2.2. (*Verhandelingen van het Bataafsch Genootschap, Derde Deel* (1777), pp. 58-65).

³⁴⁵ NA 1.04.02/65 dd. 30.09.1772

conclusion.³⁴⁶ The experiment continued through 1773 and 1774, whereby from 1773 onwards all chambers were asked to send in reports in time for next year's meeting with details on the number of crewmembers that had fallen ill or had died.³⁴⁷ That now all chambers had to give information, may be linked to the difficulty of getting sufficient data. In autumn 1775, it was noted that still no sufficient information had become available and therefore the experiment should continue. Then, on 23 October 1776, the *Heeren XVII* considered that it had not been possible to conclude whether a smaller crew actually contributed to a smaller number of sick or to less mortality, that the number of those sick or dying because of the disease had – "Thanks to God's grace" – significantly decreased and that the smaller crews caused considerable problems of understaffing in the East Indies; they concluded therefore that the experiment should be ended. At the same time, it became clear that the Zeeland chamber in particular was struggling to get its ships fully equipped with personnel, to such an extent that it had not been able to dispatch all the ships it was supposed to send out. Instead of sending the designated number of ships out with a significantly reduced crew, the chamber had opted to dispatch a smaller number of ships with a somewhat less reduced crew.³⁴⁸

Using archival data, the mortality and the measure of (over)-crowdedness was already visualized in the two graphs presented in section 2.2. Now we look in more detail to the years surrounding the epidemic of the 1770s. The graph starts in 1750, showing the onslaught of the *rotkoorts* in the 1770s and then the experiments with a smaller crew up to the demise of the VOC in the 1790s. It ends in 1794, the final year in which the VOC dispatched ships to the East Indies, of which only two arrived. In graph 2.3, it is quite visible when the *rotkoorts* first manifested itself at the end of 1770 and in 1771 (a sharp peak in mortality); the Man-to-Ton Ratio was however not exceptionally high, compared to the years before and in those earlier years mortality figures were nothing out of the ordinary (apart from a peak in 1757 and 1758). Already in 1772 the Man-to-Ton Ratio became smaller (because of the experiments that had started in that year) and in 1774 (effectively just over a year after the official introduction of the partial experiment with smaller crews) the mortality started to drop to a level that was even lower

³⁴⁶ For instance, four similar ships of the Amsterdam chamber left on Christmas day 1772, with a crew of 243, 307, 323 and 355, ending up with a death-toll (*en route* to the Cape) of 30, 19, 31 and 30%. Two similar ships left in early May 1773, with a crew of 264 and of 300, with a death-toll of 18 and 17%. These (and more) data retrieved from the database Dutch Asiatic Shipping are given in Appendix A.

³⁴⁷ NA 1.04.02/66 dd. 16.10.1773, NA 1.04.02/67 dd. 8.10.1774 and NA 1.04.02/68 dd. 27.09.1775

³⁴⁸ NA 1.04.02/69 dd. 23.10.1776. For details on numbers, see appendix A

Graph 2.3 Man-to-Ton Ratio (right-hand axis) and mortality percentage (left-hand axis) between 1750 and 1794, calculated as an average for all ships leaving for the East Indies in each year for which sufficient information was available. In 1781 no ships left for the East Indies. The peak in mortality during the early 1770s was caused by *rotkoorts*. The peak in 1782 was (according to the DAS website and to Leuftink (1991/2008), pp. 110-111) caused by an outbreak of scurvy occurring in the small fleet that left the Republic in July of that year.

than before the onset of the disease. The decrease in the Man-to-Ton Ratio continued for almost a decade, well after the experiment formally came to an end; during this decade the mortality stayed at a low level, on a par with a previous low that had occurred during the early 1750s. This lasted for several years, until the upheaval caused by the outbreak and the aftermath of the fourth Anglo-Dutch war.³⁴⁹ At the height of the disease (in 1771) the Man-to-Ton Ratio was 0.30, dropping to an average of 0.23 between the years 1777

³⁴⁹ If we look at a possible overall correlation between crowdedness and mortality it emerges that no such correlation existed – in some years the (very low) correlation-coefficient sometimes even suggests a negative relation but in any case in almost every year it is too small to be significant. These correlation-coefficients are also given in appendix B. However, Régnier (2012) p. 480 mentions that on Atlantic crossings by the French navy in the mid-eighteenth century, the death-toll was (among a number of other factors) indeed dependent on crowding (taken as number of sailors per unit area of deck space).

and 1780, a decrease of more than 20%. Therefore the average crew (considering all ships) must have decreased by the same percentage. The extreme mortality, caused by *rotkoorts* had completely disappeared by 1774; the illness must therefore have vanished almost as suddenly as it had emerged in the last months of 1770. Whether the reduction in crew-numbers actually contributed to an improved health situation on board is questionable as was also realized by the *Heeren XVII*. Even so, the coincidence of a lower Man-to-Ton Ration and a lower mortality looks rather striking, even more so if one considers that the chambers were definitely not able to employ only crewmembers that were “young and healthy”.

A more detailed representation, concerning the separate development in actual crew numbers for the first and second charter is shown in graph 2.4.³⁵⁰ At the height of the disease (in 1771) the average crew on board of the ships of the first charter was effectively 339 (well above the standard number of 300) and then numbers dropped almost continuously to an average of 261 in the years 1777 to 1780. The second charter shows a similar picture, dropping from an average crew of 262 in 1771 (also well above the standard number of 225) to an average of 200 between 1777 and 1780.³⁵¹ In both cases the effective decrease was almost a quarter, and (in actual numbers) it was larger than what had been suggested in 1772 as an experiment. In the case of the first charter the decrease was seventy-eight compared to the proposed fifty, and in the case of the second charter it amounted to sixty-two compared to the proposed thirty.³⁵² As the experiment with a smaller crew was ended by the

³⁵⁰ From the 1750s onwards, the ships in the fleet of the VOC were standardized to such an extent that it is feasible to consider the two charters separately. However, after the fourth Anglo-Dutch war, standardization was temporarily in disarray. Because of the shortage of ships the VOC had to buy and hire a number of ships of different designs and tonnage; for details see Dillo (1992), Ch. 3.

³⁵¹ These calculations have been made using the information available at the database on the DAS website <http://resources.huygens.knaw.nl/das>. For details, see the years concerned in appendix C.

³⁵² In appendix C, ships with a crew smaller than the average crew (334 resp. 261) between 1761 and 1770, i.e. the decade before 1771 (the year in which the first onset of the *rotkoorts* appeared) have been represented in black italics. The ships with a crew equal of or smaller than the experimental size (i.e. fifty or thirty less than the official number) are shown in bold red italics. Only those ships have been incorporated for which sufficient data were available. Of the seven ships leaving at Christmas 1772 we see two ships with a smaller crew according to the decisions taken (earlier departures with a smaller crew had probably nothing to do with the experiment). In 1773 we find eight ships (out of twenty-eight) manned with such a smaller crew and in 1774 that number was nine out of twenty-six. On the other ships the size of the crew was in most cases also smaller than the earlier average. By the late 1770s almost all ships left with a crew, (much) smaller than the average crew in the decade before the outbreak of *rotkoorts*.

autumn of 1776, the continuing decrease in crew-numbers (occurring as it did on almost all vessels at the time) may well be attributed to the earlier mentioned problems with procuring crew by a number of chambers; as we saw the Zeeland chamber in particular had great difficulty in finding enough crewmembers. In the autumn of 1778 and 1779, the decision was reiterated that ships leaving before the first of January of the next year were allowed to have a crew of up to 350 in the case of the first charter and of 260 in the case of the first charter. However, when we look at the ships that set sail in the final months of 1778 and 1779, we see that not a single ship had a crew that exceeded the standard number, let alone that it carried the permitted even larger crew. Looking at these actual crew-numbers, we see that the dispatching of smaller crews continued until the outbreak of the fourth Anglo-Dutch war. In some recent publications, this effective reduction of overcrowding seems to have been overlooked. Leuftink (in *Harde Heelmeesters*, his book on medical care on seagoing ships in the eighteenth century) mentioned De Famars's suggestion to reduce the crew on the ships of the VOC but made no mention of this proposal being (experimentally and/or effectively) implemented. In her dissertation *Ship's Surgeons of the Dutch East India Company*, the historian Iris Bruijn wrote "Although, in 1774, the Gentlemen XVII ordered that overcrowding on board was to be avoided, the chambers could not actually enforce this."³⁵³ However, when we look at the numbers presented in graph 2.4, it is beyond any doubt that the average size of the crew dropped considerably in the wake of the *rotkoorts* epidemic and that this happened on the ships of all chambers for about a decade.

Whether the policy to send extra ships to the Cape with a surplus crew was successful seems questionable. Rather cynically, one might say that at first the ships seemed to prove the point that overcrowding played a major role in the death-rate *en route*. As a result, the net gains of transporting surplus crew were rather limited. On 30 December 1771, the Amsterdam chamber dispatched the *hoeker Zon* (450 tons) to the Cape with a crew of 185; it lost 55 persons *en route* (a death-rate of 30%) and it returned with 29 crewmembers of its original crew; it therefore delivered 101 persons at the Cape. The *Zon* left for the Cape again on 24 December 1772 with a crew of 196 people of which 41 (21%) died during the crossing. The vessel stayed at the Cape for local duties, so no definite calculation can be made of its efficiency in supplying the VOC with extra crewmembers. However, assuming that the usual crew of the *Zon* was about 45, one may estimate that 110 people became available at the Cape.³⁵⁴ The second extra ship that left for the Cape was the *Ouwerkerk*, a vessel of 1150 tons belonging to the Zeeland chamber. It left on 26 Aug 1772,

³⁵³ Leuftink (1991/2008), pp. 165-167; Bruijn (2009), p. 94, the mentioning of "1774" must be a mistake as decisions regarding overcrowding had already been taken in 1772.

³⁵⁴ The man -to-ton ratio for the *Zon* was 0.41 (first voyage) resp. 0.44 (second voyage).

Graph 2.4 Development in actual crew numbers for the first charter and the second charter between 1770 and 1780

Graph 2.5 Cumulative total number of extra personnel arriving at the Cape between 1771 and 1780 (in red, left hand axis), and the number of ships arriving every year transporting carrying those people (in blue, right hand axis).

The figures for the first voyage have been derived and calculated using information available at <http://resources.huygens.knaw.nl/das/detailVoyage/95174>, & <http://resources.huygens.knaw.nl/das/detailVoyage/98710>, again following the link to <http://vocopvarenden.nationaalarchief.nl>. The total crew of the *Zon* on its first homebound voyage was 47.

The figures for the second (outward) voyage are at <http://resources.huygens.knaw.nl/das/detailVoyage/95209>

carrying 515 people and it suffered 190 fatalities *en route*, a death-rate of 37%; the *Ouwerkerk* returned with 92 members of its original crew, the remainder of its returning crew of 119 was made up by crewmembers of other vessels. This means that at the most 233 sailors and soldiers were left at the Cape, available to serve the VOC in one way or another. On 20 October 1772, the *Bartha Petronella* (880 tons, for the Amsterdam chamber) sailed for the Cape. It lost 103 crewmembers out of its original crew of 368 (28%), and as it returned with 83 of its original crewmembers, this means that at a maximum 182 people might have been left at the Cape.³⁵⁵ After these first four voyages, the mortality figures and the Man-to-Ton Ratio were considerably smaller.

Only on the second voyage by the *Noordbeek* in 1775 there was a large number of fatalities, but because of the long duration of that particular voyage, it is likely that this was caused by scurvy.³⁵⁶ Looking at the effective numbers of extra personnel that were transported to the Cape between 1771 and 1780 (as shown in graph 2.5), it becomes clear that by 1776 the policy of sending extra sailors and soldiers to the Cape had in fact come to an end. By that time almost 2400 sailors and soldiers had arrived at the Cape to make up for the shortfall in numbers caused by the smaller crews that sailed on the regular fleet. That may seem a large number, but it amounts to about 500 people per year on average, which – taking into account that twenty-five to thirty ships were dispatched in the regular fleet every year – implied an average “spare” supply of about twenty sailors and soldiers for every of these regular vessels, which was far less than the reduction in numbers that had been tacitly realized.

The reduction in crewmembers on the *retourschepen* and the insufficient and shortlived policy of sending extra soldiers and sailors to the Cape must have caused problems for the High Government in Batavia. This may also explain the observation made by the historian Van Rossum that a rise occurred in the (admittedly reconstructed) number of Asian sailors employed in VOC’s intra-Asian shipping during the 1770s.³⁵⁷ This rise may at

³⁵⁵ According to a resolution by the *Heeren XVII* (NA 1.04.02/181, dd. 30.09.1772) the outward crew on the *Ouwerkerk* consisted of 199 soldiers, 300 sailors and 10 artisans and on the *Bartha Petronella* it consisted of 300 soldiers and 70 sailors. The man -to-ton ratio was for the *Ouwerkerk* 0.44, for the *Bartha Petronella* 0.42.

The figures have been calculated using information for the *Ouwerkerk* at <http://resources.huylgens.knaw.nl/das/detailVoyage/95194> & <http://resources.huylgens.knaw.nl/das/detailVoyage/98732> , and for the *Bartha Petronella* at <http://resources.huylgens.knaw.nl/das/detailVoyage/95200> & <http://resources.huylgens.knaw.nl/das/detailVoyage/98735> ; for both ships following the link to <http://vocopvarenden.nationaalarchief.nl>

³⁵⁶ Appendix D gives the details for all journeys that were specifically made to the Cape to transfer personnel.

³⁵⁷ Rossum, Van (2011) & Rossum, Van (2014) Ch. 3

first have been related to the high mortality *en route* between the Republic and Batavia, caused by *rotkoorts* and later to the smaller crews that continued to be dispatched after the epidemic. The resulting shortfall in numbers quite possibly contributed to the need for the VOC to man its ships in the intra-Asian traffic with a greater number of local sailors that used to be the case. However, it is also possible to turn the argument around and to argue that the VOC could afford to equip its *retourschepen* after 1772 with a smaller crew than usual because it could rely on a large existing reservoir of local Asian sailors. As Van Rossum has convincingly shown, employing local sailors was nothing new, as the VOC had employed local Asian sailors in its intra-Asian operations on a structural basis as early as the 1670s.³⁵⁸

Controlling health through centralization

In 1775, the issue of overcrowding reappeared on the agenda of the *Heeren XVII* because of a letter sent by stadholder Willem V. Among other issues, the stadholder raised the point of smaller crews again.³⁵⁹ The Amsterdam and Delft chambers and De Famars wrote comments on his letter.³⁶⁰ On the issue of overcrowding, the Amsterdam chamber re-iterated the decision to engage in comparative experiments with a smaller crew, and the Delft chamber referred very briefly to the resolution of April 1774. De Famars extensively compared the stadholder's remarks with the measures that already had been taken and found that all issues in fact had been dealt with – apart from the sluggishness of the *retourschepen*, which should (as he wrote) come as no surprise as the ships of the VOC were first of all designed as sturdy cargoships. De Famars agreed with the stadholder on a further reduction of the crew on the outward bound ships, with about a hundred people in total.³⁶¹ One might have expected that in the meeting of 5 November 1776, in which the stadholder's letter was discussed, the termination of the experiments (which had been decided upon about two weeks earlier) would have been mentioned; however, there is nothing in the minutes of the meeting to suggest that such a remark was made. Whereas the experiments with a smaller crew officially

³⁵⁸ Rossum, Van (2011), pp. 55-61 & Rossum, Van (2014), pp. 104-109

³⁵⁹ One of these other points was the introduction of conductors to prevent damage caused by lightning strikes. (NA 1.04.02/183 inserted after 30.9.1775)

³⁶⁰ NA 1.04.02/184 dd. 05.11.76. Somewhat surprisingly perhaps, the discussion in the meeting on the possible introduction of lightning conductors was more extensive than that on the issue of overcrowding. Possibly the impact of the *rotkoorts* epidemic had already somewhat subsided.

³⁶¹ De Famars also agreed with the stadholder on the excellent qualities of sauerkraut, suggested using sauerkraut instead of cucumbers, and he agreed on the benefits of making a stop at St Jago (on the Cape Verde Islands) to acquire fresh fruit and vegetables.

came to an end in 1776, the procedural measures of 1774 remained in force, which meant that the directors of the VOC continued to exert centralized control over its ships and officers.

The outbreak of *rotkoorts* turned out to be the incentive to put the subject of overcrowding prominently on the agenda of the VOC. As can be seen in graph 2.3, for most of the third quarter of the eighteenth century, the Man-to-Ton Ratio ranged between 0.27 and 0.32. When the average mortality rate suddenly shot up to almost 30%, the potential conflict was recognized between the health and wellbeing of the personnel of the VOC on the one hand and the need to transport large numbers of personnel on a limited number of ships to the East Indies on the other hand, a need that was created by the amount of sailors that the VOC needed for its shipping operations between the Republic and the East Indies and within the East Indies, and the amount of soldiers that were needed to guard the interests of the company in the East Indies. Due to the high death-rate in the East (and especially in Batavia), these numbers had to be supplemented on a yearly basis.³⁶² Health problems occurring on the *retourschepen* had therefore two consequences for the VOC: political and economic. Political in the sense that the disease threatened the policies pursued by the VOC in sustaining its commercial empire because of a lack of soldiers available for duties in the East Indies; economic in the sense of the logistical problems caused by the understaffing of the ships of the company within the East Indies and on the ships returning to the Republic. As we saw, it was the (rather short-lived) attempt to compensate for this shortage by sending ships with an extra supply of sailors and soldiers to the Cape was not quite successful; therefore a different solution was needed in the long term. Both in the preparation for the discussions by the *Heeren XVII* and in the discussions as such, we see a functional discrimination being used in order to work out where the problems might have originated and what possible solutions could be available.³⁶³ This entailed discriminating between experienced and inexperienced personnel, between those well-equipped and those ill equipped, between natives and foreigners, and between “young and healthy” and those that were elderly and unhealthy. As we saw before, this analysis had led to a suggestion to all chambers that they should only employ the “young and healthy”, that the health of the crew should be checked on boarding the ships and that people suffering from diseases should be rejected. However, the remarks from the Zeeland chamber of 1780 (and in fact their experiences since 1776) suggested that no change had effectively been realized, despite the expectations of the *Heeren XVII* in the early 1770s. The

³⁶² On the death rate in the East Indies, see Schoute (1929), hfdst. VII and figures given in table D (p. 198), table F (p. 202), table G and H (p. 220), table I (p. 236), table J (p. 237), table K (p. 238) and table O (p. 296).

³⁶³ The term “functional discrimination” was coined by Foucault (1980), p. 169

difficulties of finding common crewmembers in large enough numbers were probably the reason why during the final decades of the company's existence (even after the experiment with smaller crews had ended) the (over)crowdedness – with only very few exceptions – hardly ever returned to the levels that were common before 1772. This state of affairs resulted in continuous understaffing of the *retourschepen*, not so much on the outward journey when the ships were (as we saw) usually quite overstaffed, as well in the intra-Asian traffic and on the homebound voyages. In fact, the shortage of personnel was such that in the final decades of the eighteenth century Asian sailors were not only enlisted in the intra-Asian traffic but also on *retourschepen* returning to the Republic.³⁶⁴

Not explicitly mentioned in the discussions of the *Heeren XVII* was that the tension between keeping crewmembers healthy (with a view to rooting out the underlying causes of *rotkoorts*) on the one hand and sending sufficient crewmembers to Asia using a minimum number of ships could not be realized without some solution to the health problems in Batavia. If it had been possible to cure a larger part of the personnel that fell ill and died in Batavia, a smaller number of new crewmembers and soldiers to replace those that did not survive their contracts would have sufficed. That in turn could have made it possible to end the overcrowding on board. Although not mentioned in the discussions on *rotkoorts*, the health problems in Batavia (and the tensions that they created regarding personnel) had certainly not escaped the attention of the *Heeren XVII*. For instance, on 5 October 1767 they had written a *missive* to the Governor General and the High Government in Batavia in which they (rather tersely one gets the impression) reacted to repeated requests from the East Indies to send more personnel. The *Heeren XVII* stated that it seemed that those in the East were of the opinion that it only depended on the will of those in the Republic to find more people. However (they wrote), one had to take into account the dearth of sailors and soldiers available, which had resulted – despite the best efforts of the chambers – in the fact that a number of vessels had been dispatched with a smaller crew that should have been the case. Moreover, apart from fatalities occurring *en route* the main reason for the lack of personnel in the East Indies was the high mortality in Batavia

(...) To this should be added (we are very sorry to say so) the continuing mortality not only on several outward-bound ships but also in Batavia, where a large part of those people that were sent from here (i.e. the Republic) were

³⁶⁴ Boxer (1963), pp. 89-90, Bruijn (1976), pp. 230-231, Bruijn & Eyck van Heslinga, van (1984), pp. 17-19, Rossum, Van (2011), *passim* & Rossum, Van (2014) Ch. 3

carried off (i.e. by death), which is the main cause of the shortage (i.e. of people) in the East Indies.³⁶⁵

Nevertheless, the *Heeren XVII* promised that they would double their efforts to find a sufficient number of people. In a *missive* written in 1772, the *Heeren XVII* lamented the fact that the death toll in Batavia had increased during the year 1770, and they added

(...) But the attempts that the chambers continue to do for that purpose (i.e. to send sufficient personnel across) were to our deep regret to a large degree thwarted by the serious diseases and mortality that raged on the outward-bound ships despite all human precautions; and (which) most regrettably have been experienced on those (ships) that departed at the end of last year and in the beginning of this year.³⁶⁶

These *missives* highlighted the political and economic problems that were caused by the shortage of personnel available for and in the East Indies. The *missives* also showed that the *Heeren XVII* were well aware of the connection between the health situation in Batavia (as they had been for quite a number of years already³⁶⁷) whereas the 1772 *missive* emphasized the seriousness of

³⁶⁵ NA 1.04.02/336 dd. 05.10.1767 “*Hier komt bij tot ons bizonder leedwezen de aanhoudende sterfte niet alleen op verscheyde uytgaande scheepen maar ook te Batavia, waar door een groot gedeelte van het hier uytgesonde volk werd weggesleept, en het gebrek in Indië meerendeels ontstaat.*”

³⁶⁶ NA 1.04.02/337 dd. 05.10.1772 “*Maar de pogingen, die de kamers niet ophouden met dat oogmerk te doen, werden tot onse smerte grotelijks verijdel, door de swaare siektens en sterfte, welke onaangezien alle mensch mogelijk voorzorg op de uytgaande schepen regeeren; en alderbeklagelijkst zijn ondervonden op die, welke zo in het laatst van het voorleede, als in het begin van dit jaar, zijn vertrokken.*”

³⁶⁷ In July 1768, a letter arrived in Batavia in which the VOC explicitly expressed its concern about the high number of casualties in the Batavia hospital and in which they ordered an investigation by the High Government in the East Indies (Schoute (1937), p. 71). In fact, the *Heeren XVII* had already raised concerns about the high mortality in Batavia as early as 1753 (Schoute (1937), p. 70). Several measures had been taken at that time but to little avail. As a result of the 1768 letter a committee was set up which (within a few months’ time) made several proposals to improve the situation. J.C.M. Radermacher, member of the High Government, had already made a number of suggestions in a memorandum he had written in the autumn of 1767 (NA 1.10.46/ 99). In October 1768, the High Government agreed on a number of measures (Schoute (1937), p. 74) one of which was to extend the already existing *Buiten-Hospitaal* (Outer Hospital) which was situated outside the city in a healthier environment. However, the measures taken seem not to have had a significant effect on the death-rate (Schoute (1937), pp. 80-81). In 1780, the *Binnen-Hospitaal* (Inner Hospital) inside the walls of the unhealthy city of Batavia was closed and all patients were transferred to the *Buiten-Hospitaal*. In 1784, the High Government replaced an existing hospital on the island Onrust (opposite Batavia) that was constructed

the health problems besetting the VOC at the time. They also showed that the health situation contributed to rather continuous tensions between “Amsterdam” and “Batavia”.

To overcome the diseases, the *Heeren XVII* chose a mainly procedural approach, through which the number of prescriptions regarding the tasks of ships’ officers increased significantly, as is testified by the number of items in the so called *scheepsdoos*, the box that contained all documents concerning the way the *retourschepen* should be managed without counting charts, navigational instruments and sailing orders.³⁶⁸ Especially the earlier mentioned *Extract uyt de Resolutien* (dating from 2 April 1774) contained a large number of prescriptions, and it remained in force until the demise of the company, thus surviving for almost two decades beyond the original reasons for its introduction. In fact, punishments for non-compliance with these prescriptions were added as late as 1785. This suggests an ongoing attempt to centralize control (as far as logistically possible) by the VOC over its shipping operations, its ships and its skippers and officers, in order to get a grip on the tensions in the network. This process of centralized control signaled a move away from the originally conceived decentralized organizational model to a much more centralized enterprise. We will return to these policies and whether they contributed to a better control of the tensions of the VOC later in this chapter, after first having looked into what it meant to be on a disease-ridden ship from a less detached point of view than the one that was presented by Thunberg.

2.5 Tensions: personal perspectives and policies

Reflecting on the health situation on board of the ships of the VOC, one gets the impression that everybody involved was to some degree powerless against the outbreak of serious diseases. To combat these diseases the VOC relied on the use of machines for some time, on medicines and in increasing measure on procedures carried out by humans; in other words, against the powerful actants that the diseases represented, protective action was embodied in non-human actants such as machines or medicines, operated by or prescribed by human actors or it was contained in formal documents describing procedures. Machines to assist in combating disease among crewmembers were the *waterwerk* in the last decade of the seventeenth and

out of bamboo and sited in an unhealthy area with a stone building in a different, more healthy location. In the Republic the *Heeren XVII* complained about the costs associated with the construction of this new building (Dillo (1992), p. 101).

³⁶⁸ In 1757, the box contained thirty-nine instructions (NA 1.11.01.01/2086), by 1776 this number had risen to fifty and by 1794 to sixty-two (NA 1.04.02/5162).

the first decade of the eighteenth century and the *ventilator* during the second half of the eighteenth century. As far as medicines were concerned, we saw that in 1739 *Cortex Peruvianus* (*cinchona* or *koortsbast*) – considered as the most effective medication against intermittent fevers at the time – was introduced on the standard medication list.³⁶⁹ However, whether machines or medication were actually used (or whether prescribed procedures were followed to their letter and intent) once the *retourschepen* had left the Republic was something that could no longer be effectively supervised by the *Heeren XVII* when the ships had left. They had to rely on written statements and reports that (according to the regulations of 1695) became available halfway through the journey at the Cape of Good Hope and at the end of the journey, be it Batavia, Ceylon, Bengal or the Malabar Coast. These paper shadows created by skippers and officers were possibly not always a perfect mirror of what happened in reality. This meant that the *Heeren XVII* had it not completely in their power to enforce a course of action that was supposed to be carried out, either because a machine might not perform in the way it had been designed to do or because officers and operators (outspoken or silently) refused to work it or because officers and crew did not follow the procedures and courses of action that had been prescribed to them. In addition, as we have seen, the *Heeren XVII* were effectively powerless against the *volkhouders* or *zielverkopers*, because the required number of common sailors and soldiers kept surpassing the numbers that could be provided by the internal labour market of the Republic. All these potential conflicts added to the tensions within the network surrounding the VOC. But, independent of whether they were effective and obeyed or not, the technological and procedural approaches to combat diseases and to improve the health situation on board had a bearing on the wellbeing of the crewmembers, and we should therefore pay close attention to their experiences.

When considering the situation of common sailors and soldiers (the lower echelons on board of the ships or ashore), one gets the impression that they were powerless regarding more issues than just the diseases. Before they boarded their ship, they could not stand up against the *volkhouders*, who exploited them until embarkation, as was in sometimes graphic detail recorded in the essays discussed in section 2.2. After boarding their ship, inexperienced crewmembers in particular were no match against the more experienced crewmembers who robbed them of their possessions (as recognized in the essays and in the discussions by the *Heeren XVII*) nor against the officers on board, who – in most cases – kept a harsh system of discipline (as was explicitly mentioned in the essays) nor could they rise up against the

³⁶⁹ As we saw in section 2.2, in the essays published by societies in the 1770s, *Cortex Peruvianus* (*koortsbast*) was then still considered as the best available medicine against fevers.

(to them anonymous) body of the *Heeren XVII*. As far as diseases (such as scurvy and *rotkoorts*) were concerned, the crew seems to have been utterly powerless. That was – in a rather detached way - testified by Thunberg when he wrote “during the voyage we had constantly about a hundred and fifty patients on the list, till we had passed the line, and the most infirm and disabled part of the crew were carried off by death”.³⁷⁰ Thunberg does not mention the effects this state of affairs had on the crew but it is possible to get some idea of the feelings of ordinary crewmembers by looking at a number of surviving contemporary notes and diaries by such crewmembers. Although the number of written accounts left by ordinary crewmembers is small, it is possible to get some vivid impressions by also looking at writings by others who were directly involved.³⁷¹

The surgeon Nicolaus de Graaff, sailing on the *Makassar* in 1676³⁷² wrote about the situation on board after the ship had not been able to anchor at St Jago in the Cape Verde islands

When we were sailing near the equator the number of sick increased by the day; most of them had unbearable headaches, burning fevers, accompanied by a delirious state, with many of the crew dying, which also happened to my assistant Jan Danielsz Somer who on the night of 26 February - because of madness - jumped out of the *Konstapels poort* (i.e. a doorway in the side of the ship) and drowned (...) (When I visited the sick as usual on 5 March) Pieter Govertsz from Antwerp, sailing as soldier, planted a knife in his breast and died instantly; the knife entered near his collarbone and ended up in his heart (...) By God's grace (...) we anchored on 23 July in the roads of Batavia, having lost 34 persons and one female between our homeland and Batavia.³⁷³

³⁷⁰ Cf. the second quote from Thunberg's notes in section 2.2

³⁷¹ Cf. Dekker (1994) and Lindeman e.a. (1994). Dekker (p. 7) wrote “*Tegenover elke zeekapitein die mogelijk een verslag schreef, zijn er honderden schepelingen die zelfs hun handtekening niet konden zetten en om die reden geen verslag hebben geschreven* (Against every sea-captain who possibly wrote a journal, one finds hundreds of sailors who couldn't even put their signature on paper and therefore didn't write a journal)”. However, as Lottum, Van & Poulsen (2011) have shown, between 1750 and 1780, literacy among “ordinary” North European sailors amounted to 80% and in the case of Dutch sailors to even 87%. That makes Dekker's explanation somewhat questionable.

³⁷² According to <http://resources.huygens.knaw.nl/das/detailVoyage/92397>, the *Makassar* left the Republic on 13.01.1676 arrived at the Cape on 01.05.1676, left there on 22.05.1676 and arrived in Batavia on 23.07.1676. The journey was therefore much faster than the average one.

³⁷³ Graaff, Nicolaus de (1701), f. 118/(1930), pp. 139-140 “*Wij omtrent de Linie komende kregen dagelijks meerder sieken, en meestendeel met een onlijdelijke hoofdpijn, brandende koortsen verseld met rasernie, stervende veel van 't scheeps-volk, als ook een van mijn onder-meesters Jan Danielsz Somer, die vermids kranksinnigheid op den 26. Februarii woensdags 's nagts de Konstapels poort uitspringende verdronken is (...)* (en op den 5.

In May 1693, the *retourschip De Gouden Buys* left for the East Indies. Based on the official statements from the *watermaker* David Silleman and the carpenter Lourens Thysz, in 1695 a book was published which described the fateful journey of that ship.³⁷⁴

Then (i.e. in July/August 1693) in the vessel *De Gouden Buys* could be counted over forty dead and almost fifty sick. Seven to eight weeks we drifted near the equator which increased the sickness because of the intense heat, which meant that on some days six or seven people died and were given a seamen's burial (...) Around this time (i.e. when they finally crossed the equator) another seaman fell overboard and drowned. One night at evening prayers, all those that were still healthy attended and on seeing only thirty people, the skipper asked the quartermaster Harme Jansz whether this was the total number of healthy people, on which he replied that these were all the healthy ones, the rest being ill, which made the skipper - perplexed and sighing - cry out: "*Dear God! Have mercy on us, is this the whole of my healthy crew out of the 140 that should be still on board, what will happen to us*".³⁷⁵

In April 1766, the (German) physician Matthias Ha(a)fnier and his eleven years old son Jacob boarded the *retourschip Luxemburg*, where Matthias served as *oppermeester* (having earlier served in that role on a vessel of the Prussian East India Company in Emden), and his son as ships' boy. Jacob kept a diary

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(Maart) als ik volgens gewoonte de sieken besogt) heeft Pieter Govertsz van Antwerpen varende voor soldaat, hemselve met een mes in de borst gestoken, daar hij aanstonds van is gestorven; gaande 't mes bij 't sleutelbeen tot in 't hert (...)" Ibid., f. 119/p. 141 "*Komen door Gods genade (...) op den 23. Julii op de Rede van Batavia ten anker, hebbende tussen 't vaderland en Batavia 34. personen en een vrouw verloren.*"

³⁷⁴ The original text was reprinted (with annotations) in Gessel, Marieke van & Kieskamp, Andrea (1995)

³⁷⁵ Ibid., pp. 35-37: "*Als wanneer in 't Schip De Gouden Buys ruym 40. Dooden, en aan de kandt van 50. Sieken werden ghetelt: 7. a 8. Weeken dreven in stilte omtrent de Linie, om deselve te passeeren, 't gheen de sieckte door de groote hitte, meer en meer vermeerderde, soo dat'er op eenen dag wel 6. a 7. te gelijk sturven, en overboort wierden geset (...)* Omtrent desen tijdt viel weder een Matroos overboort en verdronck. Op sekeren Avond doen het Gebedt soude geschieden, quamen alle de gesonden in de selve, ende de Schipper ongeveer maer 30. Man by hem verneemende, vraagde den Schipper aan de Quaertiermeester Harme Jansz. of dit al het ghesondt Volk was, waarop hy antwoorde, dit al het gesonde, en de rest ziek te wesen, het welk den Schipper met verbaastheyt al suchtede dede Uytbarsten; Lieve God! Zegen ons, is dit al mijn gesondt Volk van 140. Zielen, dewelcke noch binnens Boort moeten wesen, wat wil dit noch worden." Eventually, in October 1693, *De Gouden Buys* ran aground near St Helena Bay (North of the Cape); seven people managed to get ashore of which only two survived and reached the Cape. The other five died on the way trying to get help, the rest of the crew had already died before the stranding or died shortly afterwards.

which was later published; in it he wrote about what happened on board in July or August 1766:³⁷⁶

Because of the excessive eating of the fruits of the island of *St Jago*, the greatest part of our crew had developed dysentery; soon followed by contagious fevers which – around the Equator where we didn't make any progress for three weeks - are fatal; not a day passed on which we didn't have to perform a seaman's funeral. (...) (Apart from the unbearable heat on the upper decks) an oppressive smell of disease and the groans of the sick made staying below-decks also unbearable. Our water started to go off partly because of the heat (...) ³⁷⁷

(...) Meanwhile the *rotkoortsen* had made such horrible progress that there was hardly any crew left to perform the work that had to be done. My father, having not spared himself in attending the sick, finally fell ill himself (...) so that he finally became confined to his bed, which he only left when he went to his grave (...)

(...) On 15 October 1766 we anchored at noon near Capetown (...) We had 61 dead and 130 sick on board of which a few died when they were brought into the open (...) ³⁷⁸

In August 1771, an anonymous passenger on the *retourschip Beekvliet* wrote

³⁷⁶ Haafner (1820), pp. 17-18, p. 21, p. 26. Several data in this published journal do not confirm to those in the databases "Dutch-Asiatic Shipping" and "VOC-opvarenden". According to these, the *Luxemburg* left on 25 June 1766 and arrived at the Cape on 8 December 1766, having lost 28 crewmembers on that part of the voyage. Jacob characterized the skipper as "elderly and furthermore decent" ("*bejaard en anders braaf*"). However, this was the first journey Klaas Roem made as skipper (he had started his career as third mate in 1751) and he remained skipper until 1780, which means that he can't have been very old on this particular voyage.

³⁷⁷ Haafner (1820), pp. 17-18: "*Door het onmatig gebruik van vruchten op het eiland St. Jago, was het grootste gedeelte van ons volk door den roodeloop aangetast geworden; spoedig voegden zich aanstekende koorts en daarbij, die onder de Linie, waar wij nu gedurende drie weken lagen, zonder eene mijl vooruit te kunnen komen, zoo doodelijk zijn; er verging dan ook geen dag, die niet een harer slachtoffers uit ons schip in den oceaan had zien nederzinken (...) terwijl, daarentegen, eene benauwde ziekteelucht, en het gekerm der zieken het verblijf tusschendeels even zoo onlijdelijk maakten. Ons water begon nu mede door de hitte te bederven (...)*".

³⁷⁸ Haafner (1820), p. 21: "*Middelwyl maakten de rotkoorts en zoodanige verschrikkelijke voortgangen aan ons boord, dat wij bijna geen volk genoeg overig hadden, om het scheepswerk te verrigten. Mijn vader, die zich in het bezorgen zijner zieken niet spaarde, werd eindelijk zelf ongesteld (...) totdat hij eindelijk genoodzaakt was, het bed te houden, - om hetzelfde niet dan met het graf te verwisselen.*"

Ibid., p. 26: "*(...) den 15 October 1766, kwamen wij, tegen den middag voor de Kaapstad ten anker (...) Wij hadden 61 dooden en 130 zieken aan boord, van welke laatste er nog eenige stierven, zoodra zij van tusschendeels in de opene lucht kwamen (...)*".

We are now in a desperate situation. Already fifty-five crewmembers have died and the scurvy rages so fiercely that on every day a few dead people are put overboard. Less than forty men on board have not been affected and are still healthy. Even the captain suffers from the disease. (He then described the symptoms in great detail.) On the 24th we sailed east (...) On that day three of our crew died, and in the night between the 24th and the 25th another four (...) On the 27th our chief ships' carpenter fell overboard. We sailed before the wind and were therefore forced to see him drown because we couldn't do anything (...) ³⁷⁹

On the *retourschip Slot ter Hoge*, Pieter Gerardus van Overstraete kept a diary when he sailed to Batavia in 1781.³⁸⁰ Scurvy and fevers caused a large number of casualties on the voyage between the Cape and Batavia. He wrote

Tuesday 10 April (...) All our surgeons have now fallen ill, and the one who had stayed healthy the longest is now a corpse (...) Nobody is able to take proper care of the sick. Many die because of a lack of surgeons and the worst of all is that we lack the medication that is needed (...). Our prospects are hopeless, the number of sick and dead increases by the day, and there is nobody who is able to cure them. (...)

Saturday 14 April (...) Not a single surgeon or physician was able to dispense medicines or to hold surgery. (...) The sick looked everywhere for somebody who was able to help, but they couldn't find anybody. The surgeon who was in the best state of health let it be known that he couldn't help them anymore and that he himself would be dead by tomorrow. (...) One sick sailor - either delirious or desperate - tried to kill himself. (...) Another sailor fell down from the mast through weakness. (...) A third one hanged himself in his bunk, a fourth and a fifth jumped deliberately overboard and drowned. (...)

Monday 16 April (...) To the left of me lays a mate who has the highly contagious *rotkoorts*. He is already at death's door and is completely delirious. One deck higher the captain crawls over the floor crying out because of the

³⁷⁹ These fragments are translated from the (edited) fragments in Roeper, Vibeke & Gelder, Roelof van (2002) pp. 71-72. They are based on an anonymous letter "*Brief van **** aan den heer **** uit Leando St Paulo, wegens zijn rampspoedige reize met het Oost-Indiesch schip Beekvliet* (z.pl., z.j., pp. 5-8)"

³⁸⁰ Van Overstraete was appointed as councillor at the Judicial Council for the East Indies in Batavia, was therefore a high ranking official and certainly no ordinary crewmember. However in his notes he wrote with much compassion about the plight of ordinary crewmembers. In the end (the ships' surgeons had all died) he had to stand in as ships' surgeon although he had no medical training. These fragments are translated from the (edited) fragments in Roeper, Vibeke & Gelder, Roelof van (2002) pp. 101- 105. The original manuscript of Van Overstraete's diary is at the Koninklijk Instituut voor Taal, Land- en Volkenkunde at Leiden. The dates in his journal are confirmed by those in the database "VOC-opvarenden", although the dates in the database "Dutch-Asiatic Shipping" are different.

pains in his body. One deck below, the *constabelsmaat* is dying and in front of me are all those that are ill, lying under the *halfdek*, either dying or groaning. (...) There is no escape, we are doomed and we will have to die one after another. Pity him who survives till the last (...)

Although the stories are different, they all paint a similar picture of utter despair - independent of one's hierarchical position - and of such a degree of hopelessness that sometimes crewmembers saw no alternative but to commit suicide, either by jumping (or "falling") overboard, falling down from the mast, hanging themselves or using a knife. Just as Schuurman remarked in his entry for the *Bataafsch Genootschap*, in the case of contagious diseases it seemed to make hardly any difference which hierarchal position one was in, as everybody on those large sailing machines could be affected in the same measure. Common crewmembers were harshly disciplined by skipper, officers and petty officers in the corporal sense of the word, in order to achieve the commercial purposes of the VOC, but the horrible corporal punishment meted out by diseases easily surpassed the notorious harshness of the staff of the VOC. As we saw, protecting or curing crewmembers from the often fatal onslaught of scurvy or the even more deadly contagious *rotkoorts* proved to be a very elusive prospect. Although officers might more easily escape scurvy because of their better and more varied provisions, contagious diseases such as *rotkoorts* could affect everybody on board. These diseases demonstrated the limit of the power of the VOC and its officers; on the affected ships, the officers were effectively powerless against the diseased sailors and soldiers and on the level as the company as a whole, the VOC struggled to get the disease under control. We might even say that for some time - as we read in contemporary accounts - the tables of discipline were turned, when (usually) powerless crewmembers wielded a great amount of power - albeit of a different kind than the one exercised by officers and officials - through the spreading of their illness.

The large numbers needed to realize a regular supply of sufficient ordinary sailors and soldiers seem to suggest that these people were seen as interchangeable and dispensable objects; they were needed for a number of years as sailors for the operation of the *retourschepen* of the VOC and its ships in the East Indies, as soldiers to defend the possessions of the VOC and (to a much lesser degree) as artisans in the East Indies. Although the company formulated a number of requirements which prospective sailors and soldiers should meet, the often occurring shortage of personnel on the labour market in the Republic forced the chambers in practice to accept almost anybody who was willing (or forced) to enlist as sailor and soldier. One may assume that the health of common crewmembers would not have attracted so much attention were it not for the logistical and economic problems that the sudden outbreak of severe contagious diseases (such as *rotkoorts*) created. Only once do we

come across explicit concerns for the wellbeing of sailors and soldiers and an acknowledgment of the importance of their work. In his extensive contribution to a collection of essays and letters (known as the *Supplement*), the chief ships' surgeon Lombard (writing in late 1776) explicitly recognized the important role that ordinary sailors played.³⁸¹ He wrote:

Considering the advantages brought about by shipping regarding commerce (...) one should reasonably recognize that sailors constitute a useful part of human society. Not only the officers, but also the sailors are so important for the prosperity, just as the militia is for the protection of the land; it is therefore impossible to spend too much effort and time in contemplating means to protect their lives and to shield them with the richly laden vessels from the manifold dangers to which they are exposed in such an uncertain element.³⁸²

By connecting the risks to which the sailors were exposed with the advantages brought about by trade, Lombard (whom we will come across in the next chapter) clearly acknowledged the importance of protecting common crewmembers, without blaming them for having brought any discomforts and perils upon themselves.

During the long eighteenth century, preventing, controlling or mastering diseases that took hold of the (mostly anonymous) crew seemed to be a futile undertaking, irrespective of whatever design the *Heeren XVII* invented, and apparently one just had to let nature run its course; even machines for ventilation of the areas between decks or for distilling drinking water from seawater and dispensing medication (assuming effective medicine was available in sufficient quantities, which – as we saw – was not always the case) were usually no match for the onslaught of an epidemic. When the final (and most severe) onslaught of contagious diseases occurred in the 1770s, the directors of the VOC settled for two quite different courses of action to overcome the tensions that had been created by the disease – the tensions that

³⁸¹ This *Supplement* was compiled by Daniël Radermacher, director of the Zeeland chamber of the VOC, to support his case for the re-design of the *retourschip* of the VOC; it will be discussed in the next chapter.

³⁸² Opening sentences of Lombard's *Memorie*, his contribution to the *Supplement* NA 1.04.02/11356 (unpaginated): "Wanneer men de voordelen welken de zeevaard aan den koophandel verschaft overweegt (en hoe groot van deze laatste den bloey van eene Staat afhangt,) zal men billijk erkennen moeten dat de zeelieden een nuttig deel der Menschelijke maatschappij uijtmaken. Buijten de officieren zijn nogtans de mattroozen van zoo een gewigtige nuttigheid voor de welvaard zoo wel als de militie tot de beveiliging des lands; derhalve kan 'er nooit te veel moeite aangewend en leedige uren aangelegt worden tot het uijtdenken van middelen om hun leven te bewaren, en om hun met de drijvende rijk geladene kielen voor de menigvuldige gevaaren aan welke zij op zoo een onbestendige element zijn blood gesteld te beveiligen."

arose between the perceived need to sail with smaller crews to prevent and combat the disease and the need to have a sufficient number of soldiers and sailors available in Asia. To achieve this, it was decided to experimentally reduce the number of crew on (some of) the company's ships and also to send extra ships to the Cape with surplus crew. The policy of sending extra ships was quietly discontinued after a number of years; the policy of reduced crews was quietly continued up to the fourth Anglo-Dutch war. In addition, a policy of disciplining nature by machines was replaced by a policy of disciplining humans – and especially officers who had their courses of actions extensively spelled out to them.

Regarding the disciplining of whole crews, of individual crewmembers and of diseases, three different forms of discipline can be distinguished. First, there is the corporal discipline that was kept on board through the harsh contemporary regime – as was vividly and critically described by Schuurman – and from which the crew members tried to escape if at all possible. The ships' surgeon Lombard convincingly showed this in an essay he wrote on the design of ships, as we will see in the next chapter. In the same essay, Lombard also made clear that a proposed redesign could make the ships much more efficient when controlling the crew. The selection of suitable crewmembers provides a link with the second form of discipline, that of the disciplining of the individual physical body; to this end, a suitable and sufficient provision of food and drink, a mixture of physical activity and rest, the provision of appropriate clothing and bedding and above all fresh and healthy air were considered to be essential conditions, not only on board of the ships but also during the weeks or months that had to be spent in lodgings ashore. Providing these essentials on board was a complicated process, but the VOC increasingly tried to control this from a central level, through procedural measures such as resolutions and decrees by the *Heeren XVII*, that had to be implemented by the local VOC chambers and by the officers on board. An effective disciplinary control of the numerous, independent *volkhouders* remained impossible, given the huge numbers of personnel that the VOC continually needed both for operating its *retourschepen* and to satisfy its need for personnel in Batavia and beyond. As was noticed, these numbers very often exceeded those that could be supplied from within the Dutch Republic. The third form of discipline, that of mastering the disease within the whole body of the crew was to be realized through prevention, first of all by the chambers being selective in appointing personnel, thereby linking this aspect with that of the disciplining of individuals as far as their health was concerned. However, as we saw, this could not be achieved due to the huge demands on the number of people that were needed on the ships and in Asia and therefore one had to rely instead on measures like efficient ventilation and the regular cleaning of the decks. Contaminated air had to be forced out of the crew's quarters by using

ventilators and clean air should let in by opening the hatches or by using cooling sails – when ventilators were discarded the only way to force contaminated air out was through the force of incoming fresh air. When despite these measures, *rotkoorts* manifested itself, healthy crewmembers should be separated from the sick as soon as possible, and those that had been in close contact with sick people should be given preventive medicine, of which the *koortsbast* (the bark of the Peruvian cinchona-tree) was explicitly mentioned and this effective medicine should also be dispensed to those suffering from the disease. The three different forms of discipline met within the socio-material ensemble of each *retourschip*, as we noticed in the first section of this chapter. All three forms interacted within this artificially, materially and socially constructed environment in the midst of a powerful natural and often hostile environment. Through storms and calms, heat and cold, wet and dry, the environment interacted with the ships and their crews in a continuous process that lasted for several months. The logistics of controlling a natural environment and the management strategies needed to discipline, control and dominate people became intertwined on the ships that ferried people across the seas and that were kept on course by these people.

As we have seen in the first chapter, the quest for standardization concerning the company's ships had yielded its first results in the late seventeenth century when the specifications of 1697 were laid down and it had on a technological level culminated in the designs of the 1740s. These designs were basically used until the company collapsed and stopped building its own ships in the late 1790s, although (as we will see in the next chapter) some changes were made along the way. Whereas these designs can be considered as "successful", machines such as the seawater distillators (in use at the turn of the seventeenth and eighteenth century and again very shortly around 1770) and ventilators (in use between 1746 and 1772/1791) were less of a "success". As we have seen that verdict was not predominantly based on technological arguments but on the outspoken resistance or silent refusal of its users. Any reliance on machines was then replaced by standardized and centralized procedures that increased in quantity and in details. Whereas the discarded machines (be it distillators or ventilators) offered skippers some scope for individual decision making or even invited them to do so, the opposition of skippers towards these machines contributed to the procedural approach that emerged as an alternative to a process of mechanization. There is some irony in the fact that the skippers themselves, either through their role as active anti-users (in the case of the *waterwerk*) or as tacit non-users (in the case of ventilators) can be thought to have contributed to a decline of their independence. A decentral individual assessment of skippers and other officers regarding the health situation on board was not only discouraged, it was explicitly replaced by a standardized, centralized and uniform approach

of the way the ships had to be operated. This shift from some individuality exercised by skippers at sea towards the uniformity imposed by the directors in the Republic implied a shift in power from skippers to directors, and led to an increased disciplining of skippers and officers through texts, orders and prescriptions. Where there first may have been tensions between machines and skippers now there emerged tensions between “Amsterdam” and skippers on matters such as route-finding and the charts that had to be used (as we will notice in the fourth chapter).

The procedural approach also endangered the independent position of the six chambers that had to comply with the procedures laid down by the *Heeren XVII*, thereby moving from VOC’s original federal structure to a more centralistic one.³⁸³ While this could create tensions between individual chambers and the *Heeren XVII* as overall directors, it could also create other tensions, such as between “Amsterdam” and “Batavia”, between skippers and the *Heeren XVII*, between reliability as seen through statistics and reliability as experienced by users. As we will see in the next chapters, these tensions became also visible in matters of ship design and in matters of navigation. In the third chapter we concentrate on the role the Zeeland chamber played in the re-designing of *retourschepen* and the role played by the small VOC factory in Canton when it questioned the current ship design. It also becomes manifest when (in the fourth chapter) we investigate what happened when the charts and sailing instructions of the VOC were found to be less than reliable and individual skippers, societies, official examiners of the VOC and (again) the Canton factory challenged the centralized opinion from the Republic. In both cases, societies became again involved with the VOC. Their commitment as we came across in this chapter was therefore not a singular event, but it continued and became if anything more important and outspoken, as we will notice. Detached reasoning, experiences and quantification played an important role in the discussion about advantages and disadvantages of the Zeeland re-design of the *retourschip* and of foreign or de-centrally produced charts and sailing instructions. Detached reasoning in the form of essays in Transactions of societies based on experiences, experiments and quantification was then considered neutral and trustworthy because they were interpreted as having been provided by (or scrutinized by) disinterested outsiders organized in a society. So, almost a century after an earlier discussion about the reliability of facts and figures, detached arguments, experiences and numbers were cast into a decisive role of

³⁸³ The culmination of this approach came in the last days of the company when the directors – in a final attempt to rescue what was left of the VOC – suggested to simplify the management of the company, which would mean a single united management thereby dissolving the six chambers, the separate storehouses and the laying off of (part of) its workforce, directors, servants and clerks (cf. NA 3.02.33/24 Letter dd. 12.03.1795)

trustworthiness. This could possibly open up a new phase of decentralized accumulation and circulation of knowledge and of decision making. Whether this - either in these specific cases or more generally - could help to resolve tensions will become visible in the next chapters.

3

NAVIGATING THROUGH *TRANSACTIONS*

NAVIGATING THROUGH TRANSACTIONS: DESIGNING SHIPS, SAFETY AND PROFITABILITY

In 1763, father and son Willem Udemans, master shipwright and assistant master shipwright at the VOC shipyard in Middelburg, Zeeland unveiled a new design for the standard series of *retourschepen* of the VOC. Although they heralded it as a definite improvement, the *Heeren XVII* - having sought advice of the other chambers of the VOC – were reluctant to accept this *three-decker* (as it was called) as the new standard. The fact that the protagonists of the new design had to make their point repeatedly over a number of years shows that it may not be assumed that the design and construction of a supposedly superior artefact is accepted without any resistance, even by those who seem to gain the most by it; the enlisting of a sufficient number of valued allies (either human or non-human) was (and is) clearly crucial.³⁸⁴ Users mattered, as became clear from the experiences of those who sailed on these ships; the artefact itself mattered as well, because it demonstrated what was accepted as the soundness of its design, in relation to health, nautical safety and profitability. However, this experiential evidence did not make sufficient impact, until the *Zeeuwsch Genootschap der Wetenschappen* (Zeeland Society of Sciences), a society in Vlissingen founded in the late 1760s, forged a link with the new design through the publication of a number of essays in its *Transactions*.³⁸⁵

I will argue that these essays played a crucial role in transcending the politicized debate within the VOC on the introduction of the new design. The *Zeeuwsch Genootschap* had provided an open forum on the question of ship design when it organized a competition on what should be considered as the best type of ship for the VOC. As was standard procedure within this society, only non-members were eligible for the prizes that were offered. Therefore the society could not control how participating individuals interpreted the question and responded in the way they did. This promised knowledge production went beyond individual interests and it positioned the society as a trustworthy knowledge broker open to public scrutiny. The two prize-winning essays then acted as an instrument of governance or closure in resolving a long-standing controversy within the VOC; a fact that that has not been given the attention it deserves. The combination of experience, public accessibility

³⁸⁴ This is an example of one of the most important insights that has been revealed by SCOT: the superiority of new inventions is rarely obvious but has to be agreed upon through (sometimes tough and long drawn out) negotiations in which numbers, experiences and the number of allies count.

³⁸⁵ For an extensive overview, discussion and interpretation of Dutch societies in the eighteenth century, see Mijnhartd (1987), *passim*. For the relation between these societies and the development of science during the Dutch enlightenment, see Roberts (1999).

and neutrality mattered. The experiential arguments in the essays that were published in the *Transactions* of the Zeeland society were made powerful by the neutrality that was accepted as embodied in the society's reliance on a prize essay protocol that was standard across Europe. As we saw in the previous chapter, when facts, figures and numbers were presented by persons or organisations that could be thought to have a personal, professional or political interest in these numbers, trust was often limited to those who shared these interests. In fact, the same had happened when experiential evidence regarding the new ship-design was originally presented. Re-routing of this evidence through a society which might be seen as transcending individual interests, finally added the trust necessary to lend authority to the collected experiences of users of these ships. In addition, the small number of three-deckers that had already been built according to the new specifications – albeit rather reluctantly condoned by the *Heeren XVII* – made important experiential contributions to the considerations that were voiced in the *Transactions*.

The re-routing of evidence was achieved through what the use of what the historian of science Steven Shapin has called “literary technology”.³⁸⁶ In developing this concept, Shapin draws on Robert Boyle’s admonition that “matters of fact (are to) be generated by a multiplication of witnesses”.³⁸⁷ This could be achieved in one of three ways. The first was “to perform experiments in a social space” with witnesses present when the experiment was carried out,³⁸⁸ the second was to report experiments in such a way that “readers of the reports (were able) to perform the experiments for themselves, thus ensuring distant but direct witnesses”.³⁸⁹ The third possibility (which concerns us here) is what Shapin named the “literary technology of virtual witnessing”.³⁹⁰ This technology implies that “circumstantial details of experimental scenes” have to be provided to “(assure) readers that real experiments had yielded the findings stipulated”.³⁹¹ Illustrations in the text were meant “to be a supplement to the imaginative witness provided by the words in the text”.³⁹² As we will notice, illustrations were precisely what shipwright Udemans added to his essay for the Zeeland society. Writers of essays should see to it that their text took the form of an experimental essay and not of an elaborate

³⁸⁶ Shapin (1984), *passim*. On “making knowledge impersonal” in general, see Porter (1995), chapter 1

³⁸⁷ Shapin (1984), p. 483

³⁸⁸ *Ibid.*, p. 488

³⁸⁹ *Ibid.*, p. 489

³⁹⁰ *Ibid.*, p. 491

³⁹¹ *Ibid.*, p. 493

³⁹² *Ibid.*, p. 492, Shapin added that at that time illustrations were very expensive means of communication.

philosophical text.³⁹³ “Matters of fact were to be produced in a public space: a particular space in which experiments were collectively preformed and directly witnessed and an abstract space constituted through virtual witnessing.”³⁹⁴ Both aspects of such public spaces were manifest in societies; the Royal Society was the forerunner of the many societies that emerged across Europe during the late seventeenth and the whole of the eighteenth century.³⁹⁵ These societies were sites where experiments were carried out by and for its members to be directly witnessed. They also produced texts, usually in the form of their *Transactions* (*Verhandelingen*) that served as means for virtual witnessing, not only for their members but for a wider public as well. As we will see below, the *Zeeuwsch Genootschap der Wetenschappen* was one of the first such societies established in the Dutch Republic.

The essays on three-deckers were not isolated writings, but can be seen as a continuation of earlier essays (discussed in the previous chapter) that had been published in response to the health problems that had confronted the VOC in the early 1770s. The essays on the health issue appeared too late to play a role in the decision-making process of the VOC, but the essays regarding ship design provided extensive arguments in favour of the new design. These essays became instruments that effectively and decisively influenced the decisions taken within the VOC. One finds their role explicitly mentioned in the minutes of the meetings of the *Heeren XVII*. The use of publicly published arguments in its decision-making shows that the VOC of the late eighteenth century was not always plagued by the stagnant, dithering and inward-looking process of decision-making that is often attributed to the company at that time. It shows that the directors of the VOC were positively responding to public scrutiny, used it to advantage in their decision-making process and acted in a similarly innovative way as when they took the decision to introduce measured design drawings in 1742.

The authors on the subject of three-deckers focused their attention on the advantages that were – according to them and to their sources - inherent to this new design. They argued that it would be possible to produce a healthier, more seaworthy, safer and more profitable ship. Their approach allowed the ships, the drawings of their design, and the experiences of those who sailed these ships to occupy a central position in the considerations and transactions of the *Heeren XVII*. According to the essays on the three-deckers, the design and construction of a three-decker with its different layers of decks introduced implied different layers of meaning. The new vessels were interpreted as powerful tools in asserting authority over human beings by

³⁹³ Ibid., p. 494

³⁹⁴ Ibid., p. 497

³⁹⁵ Ibid., p. 498

disciplining them in separated and still connected groups, which could help to combat and prevent diseases and which could lead to a more efficient and smoother handling of the ship. They were also seen as more effective in asserting authority over nature as they better stood up against the forces of nature. Finally, they were seen as improving the profitability of trade.

In this chapter, I interpret and analyse the essays about three-deckers from a perspective that fits with the time in which they were written. In the first section, I describe the events surrounding the introduction of the new design, the almost simultaneous emergence of the Zeeland society, and how the new ship-design and the new society became connected. From rather early years in the existence of the society, there was a connection between the VOC and the Zeeland society on a personal level through the person of Daniël Radermacher, who was director of the Zeeland chamber of the VOC and who had been appointed as one of the many (twenty-nine at the time) directors of the Zeeland society in 1769. This connection on a personal level became more outspoken when the society published essays on the health problems within the VOC, as we saw in the preceding chapter. The connection intensified even more when the *Zeeuwisch Genootschap* organized its competition on the most suitable ship design for the VOC. Whereas this might at first glance seem to prejudice the neutrality of the society, we should realize that the Zeeland society belonged (and was recognized as such) to the non-partisan “Republic of Letters” in the Republic and beyond. It followed the standard protocol for the organization of essay competitions, which implied that entries had to be submitted under a motto and could therefore be judged without the judges being aware of the identity of the writer.³⁹⁶ In publishing treatises and essays, these societies used the standardized literary technology of the time, as we saw described by Shapin.

The aspects of the new design that were discussed in the two prize winning essays can be conveniently separated into two main categories. The first of these, which will be considered in the second section, is the topic of safety combined with health issues. Increased safety meant increased seaworthiness leading to a more effective mastering of winds and waves, an easier and safer way to handle the ship, a better way of disciplining the crew because of better overall visibility on deck and increased possibilities to physically separate healthy crewmembers from those that had fallen ill on different levels. The contribution of three-deckers towards a more profitable trade forms the subject of the third section. In the essays, experiential proof of

³⁹⁶ We find the procedure mentioned in *Verhandelingen van de Hollandsche Maatschappij der Wetenschappen, Deel I* (1754), page four and five of the *Voorrede* (unpaginated), in *Verhandelingen van het Bataafsch Genootschap eerste deel* (1774), pp. xxx-xxxi and explicitly repeated in the announcement of the Zeeland competition on VOC’s ship design in *Verhandelingen Zeeuwisch Genootschap, Zesde Deel* (1778), pp. xiv-xv

increased profitability was offered based on VOC's current tea transactions with China. Comparing the amount of precious cargo that could be stowed on ships of the classic design with the amount that could be carried by a three-decker showed the superiority of this new design.

In the fourth and final section, I examine how the discussions and decisions of the *Heeren XVII* regarding the introduction of the new design were guided and governed by the *Transactions* of the Zeeland society. It also becomes clear that there had been a shift in the "technology of trust", moving from the idea of "gentlemanly trust" (as we noticed in the previous chapter) towards reliance on experiential evidence that was made possible through the "literary technology" of "virtual witnessing". Now experiential evidence was seen as politically disinterested and neutral, filtered as it was through the socially and culturally sanctioned procedures of a society.

3.1 Setting the scene: a new design and a new society

In the eighteenth century, Walcheren (the most important part of the Dutch province of Zeeland) was still an island. It would take until the 1870s before it was connected with the Dutch mainland by means of a railway across the newly constructed *Sloedam*. Before the construction of the dam, travelling to and from Middelburg (capital of Walcheren and seat of the Zeeland chamber of the VOC) was at best a time-consuming affair and at worst rather risky because of the sea-inlets that had to be crossed by boat.³⁹⁷ Maybe this geographical isolation contributed to a sense of independence in the people of Walcheren in general and in the directors and employees of the VOC Zeeland chamber in particular.³⁹⁸ It is almost certain that it made controlling the Zeeland chamber and its shipyard by the *Heeren XVII* a rather cumbersome affair. This made it not any easier for the VOC to implement there its policy of centralization and standardization regarding shipbuilding, a policy that had

³⁹⁷ An example of the risks associated with the crossing of the wide rivers separating Zeeland and Brabant from the northern part of the Netherlands, is the drowning of prince Johan Willem Friso, the prospective successor to stadholder Willem III. On 14 July 1711, the prince had to cross the *Hollands Diep* on his way to The Hague to settle a disagreement with the Prussian king on the inheritance of Willem III. In turbulent weather, the prince boarded a ferry across the *Hollands Diep*, but his coach was swept overboard and he drowned. Apparently, the representatives of Zeeland who were appointed to attend the meetings of the *Heeren XVII* preferred to travel all the way to Amsterdam by sea, using the yacht of the Zeeland chamber.

³⁹⁸ In the early 1600s during the founding of the VOC, the position of the Zeeland chamber *vis-à-vis* the Amsterdam chamber already caused some controversy. In the next chapter we will come across another example of the independence of the Zeeland VOC chamber which concerned the production of its own charts.

been given a definite boost by the introduction of the 1742 designs as we have seen in the first chapter. Walcheren's geography was advantageous in the sense that Zeeland was the only chamber of the VOC with direct deep-water access to the sea. This meant that unlike the other chambers, it had no need to lessen the draught of its ships to counteract any shifting shallows at the entrance to its harbour.³⁹⁹ This was borne out by what occurred during the late 1730s, the 1760s and the early 1770s, when the Zeeland chamber decided to capitalize on its geographical position and proposed to adapt the current design of VOC's *retourschepen*. In all these cases, the master shipwrights at this local VOC shipyard seem to have been in the habit of acting first and asking permission later. Walcheren's geography was disadvantageous in the sense that it was (at least geographically) not connected to the other provinces of the Republic. Further, unlike Holland, Friesland, Groningen, Utrecht and Gelderland, it did not have a university of its own; during the eighteenth century the *Illustre School* in Middelburg only seems to have existed to allow the local magistrates to confer the title "professor" on valued clergy, physicians or rectors of the Latin school.⁴⁰⁰ Establishing a society in Zeeland with a nationwide membership can therefore be seen as an alternative attempt to further scholarship in Zeeland, to stimulate technological innovation and to advance social and cultural prestige and authority.⁴⁰¹ In due course, the new ship design and the new society became closely connected. First, the events leading up to that connection will be described.

Introducing a new design

On 3 November 1763, Willem Udemans Sr and Willem Udemans Jr (master shipwright and assistant master shipwright at the VOC shipyard at Middelburg) suggested to change the two main charters of the *retourschepen* of the VOC (those of 140 ft. and of 150 ft. in length) into three-deckers.⁴⁰² As was common at the time, the existing *retourschepen* were conceived as a *kuilschip*, which meant that there was a *kuil* or "waist" between the forecastle

³⁹⁹ Although the fact that the shipyard was situated within the town of Middelburg on a tidal free basin behind a set of locks meant that the width of the ships that could be built was restricted by the size of these locks.

⁴⁰⁰ Mijnhardt (1986), p. 24 and Zuidervaart (2008), p. 66

⁴⁰¹ Mijnhardt (1986), pp. 1-3

⁴⁰² This proposal is mentioned in NA 1.04.02/177 dd. 4.4.1764. Willem Udemans Sr was master shipwright at the VOC-yard between 1750 and 1780; his son Willem Udemans Jr was assistant master shipwright at the same yard before succeeding his father in 1780 as master shipwright. He remained in that position until 1795. The smallest charter of *retourschip* measured 125 ft. in length, but that type was hardly built at all.

Fig. 3.1 Engraving after a drawing by W. Udemans Jr of a *retourschip* as a *kuilschip*, i.e. with a classic waist (top) and converted into a three-decker (bottom); published in *Verhandelingen uitgegeven door het Zeeuwsch Genootschap der Wetenschappen, Zevende Deel* (1780), inserted after p. 360

and the campaign. The idea of building ships in the form of a completely closed three-decker was – as such - nothing new. In the Dutch Republic, the navy had –rather unsuccessfully - experimented with three-deckers in the 1690s.⁴⁰³ According to father and son Udemans, foreign East India companies, such as the English, the French, the Danish and the Swedish already successfully used three-deckers.⁴⁰⁴ Regarding seaworthiness, the presumed advantage of a ship with a complete top deck instead of the usual *kuildek* was that it was less prone to taking in a large amount of water when battling storms and heavy seas. Moreover, a three-decker offered more covered space and as a result, it could accommodate between 80 to 90 people extra. This meant that it became possible to send more sailors or soldiers to the East Indies, which was important because of the continuous shortage of personnel there. That shortage was mainly caused by the great number of people that

⁴⁰³ Loeve (2001), pp. 46-48; Jong, Johan de (2010), chapter 2.1

⁴⁰⁴ Cf. the memorandum by Udemans Sr and Jr, attached to NA 1.04.02/177 dd. 4.4.1764; Bruijn e.a. (1979-1987) Part 1, p. 48; Loeve (2001), pp. 24-25

died in Batavia due to the outbreak of a disease that is now supposed to have been *malaria*, as discussed in the previous chapter.⁴⁰⁵ In their meeting on 4 April 1764, the *Heeren XVII* discussed the request from the VOC Zeeland chamber to build three-deckers, and – having taken notice of a preliminary advice of the Amsterdam chamber – they referred the matter to the other chambers for further advice, that was to be discussed in the next meeting of the *Heeren XVII*. Meanwhile, the Zeeland chamber was allowed to finish one ship (the *Pallas*) as a three-decker on an experimental basis.⁴⁰⁶ When the advice of the five other chambers arrived, it turned out that their shipwrights (to which they had obviously referred the matter) raised objections, sometimes in rather strong words.⁴⁰⁷ They argued that the fact that these ships had a higher hull would lead to increased instability. Increasing the draught as a remedy against this instability would create problems for the other chambers when using these ships because of the shallows between the local ports of these chambers and the open sea. Another argument invoked against the three-decker was that there would be a lack of fresh air, which could compromise the health of the sailors. A third argument was that the distance (in both senses of the word) between officers and crew would disappear: in the usual configuration, the area behind the main mast was the exclusive domain of officers and passengers, while the forecastle and the area below the waist was the area for the crew; the *kuil* served as a visible demarcation between the two areas.⁴⁰⁸

From the point of view of the *Heeren XVII*, a decision to allow different chambers to build different types of ships – which might have seemed an obvious solution – would contravene the outcome of the long drawn out and difficult process of standardization that had taken about fifty years and had finally resulted in the standard designs of 1742; in addition they feared that it might cause antagonism between the chambers.⁴⁰⁹ As mentioned in the first chapter, severe problems with the standard *retourschepen* had triggered the introduction in 1742 of three new standardized designs of *retourschepen*, drawn by Charles Bentam, whose use of measured drawings signalled an

⁴⁰⁵ Brug, P.H. van der (1997) and (in more detail) Brug, P.H. van der (1994), chapter 4.

⁴⁰⁶ NA 1.04.02/177 dd. 04.04.1764

⁴⁰⁷ When – in 1740 – the *Heeren XVII* responded to a scathing critique of the States of Holland on the seaworthiness of the *retourschepen* of the VOC, they remarked that in matters of design they had followed the advice of *equipagemeesters* and shipwrights because “*Bewindhebberen moettende de Konstenaars gelooven in haar konst*” (“the Directors had to believe the Artists in their art”), cf. Jong, Johan de (2010), p. 66. Also, in the discussions surrounding the new standard design of *retourschip* in the 1740s, shipwrights had been consulted, cf. *ibid.*, pp. 68-74. Consulting shipwrights in matters of shipbuilding and ship design was therefore not unusual.

⁴⁰⁸ An extensive overview of these objections is given in Loeve (2001), pp. 26-31

⁴⁰⁹ On this standardization process: Jong, Johan de (2010), *passim*

innovation in commercial shipbuilding in the Republic.⁴¹⁰ For many decades to come, the VOC would be the only builder of commercial vessels in the world to make use of measured drawings.⁴¹¹ Whereas the introduction of measured design drawings by the VOC in 1742 can be interpreted as a radical innovation as it signalled a move away from the way ships had been designed and built prior to that year, it also displayed characteristics of a conservative, system-stabilizing innovation because the innovation was instrumental in stabilizing the system of the VOC as a whole.⁴¹² However, the events surrounding the introduction of the three-decker show that the original innovation of 1742 threatened to lead to conservatism as shipwrights and directors appeared to have been taken hostage by the standardization that had been part and parcel of it.

From the *minuut resolutie* of the meeting on 18 October 1764 it emerges that the *Heeren XVII* postponed a decision and decided to wait for the outcome of an experiment, in which the *Pallas* was to be compared with two other new vessels, the *Vreeburg* (built at Delfshaven) and the *Wa(a)lenburg* (built at Rotterdam).⁴¹³ These other two ships were the ships that had been built according to changes proposed by Van Zwijndregt, VOC's master shipwright at Rotterdam. They were of a wider design to give them a smaller draught, the reason for that being that the estuaries near Delfshaven and Rotterdam became increasingly shallow. The request had been discussed in a meeting of the *Heeren XVII* on 11 October 1763, and permission had then been granted although the other chambers had been invited to comment on the proposal.⁴¹⁴ A few months later these comments had been received, in which the shipwrights of all other chambers argued against the changes. Zeeland argued that it would mean a return to the unsatisfactory pre-1742 design. It did so by producing drawings of the pre-1742 design, the current design and the Rotterdam/Delft design, which clearly showed the alleged similarity. Amsterdam feared for excessive lurching which could lead to the loss of masts and sails, and the vessels would be slow, difficult to manoeuvre and would not be able to sail close hauled. Hoorn was afraid that the ships would be

⁴¹⁰ Charles Bentam was master shipwright at the yard of the Amsterdam admiralty at the time. He had originally been employed at the British naval dockyard in Portsmouth: Jong, Johan de (2010), pp. 37-39

⁴¹¹ Jong, Johan de (2010), chapter 5

⁴¹² On these aspects of innovation within the VOC, see Jong, Johan de (2010), *passim*; for a general discussion of radical, conservative and system-stabilizing innovations see Hughes (1986), Hughes (1987) and Misa (2004), chapter 5. Whereas Hughes seems to imply that conservative inventions do not lead to innovation, Misa recognizes the existence of "system-stabilizing modes of innovation".

⁴¹³ NA 1.04.02/59 dd. 18.10.1764(*minuut resolutie* refers to the actual notes taken at the meeting).

⁴¹⁴ NA 1.04.02/58 dd. 11.10.1763

unseaworthy and Enkhuizen wondered whether the proposed advantages would be realized and demanded a drawing by Rotterdam/Delft. All chambers made suggestions for better ways to confront the problems Rotterdam and Delft were facing, but nevertheless the *Heeren XVII* (on 31 March 1764) reconfirmed their decision to allow the building of two experimental vessels.⁴¹⁵ It is unclear whether the yards in Rotterdam and Delft returned – as was requested of them – to the original design. In their seminal work *Dutch Asiatic Shipping in the 17th and 18th Centuries*, the historians Bruijn, Gaastra and Schöffer suggest that Rotterdam and Delft continued to build their ships according to their changed design.⁴¹⁶

Comparing the first three-decker with the adapted Rotterdam/Delft ships seems a bit odd, as the *Pallas* was a ship of the first charter and the other two belonged to the smaller second charter. Moreover, when we look at the arguments against the three-decker, we see that these arguments were completely different from the arguments against the Rotterdam/Delft changes. Just like the *Pallas*, the *Walenburg* sailed on to China and returned safely from China.⁴¹⁷ On 7 October 1764 (i.e. before the meeting of the *Heeren XVII* took place), the *Pallas* made a first attempt to sail from Rammekens (Zeeland); the ship returned to Rammekens the following day and it actually left for the East Indies on 20 November 1764.⁴¹⁸ The fact that the ship was ready to sail before any objections could have been discussed gives the impression that the Zeeland chamber had gone ahead without waiting for an official approval – just as it had done more than twenty-five years earlier when it had gone ahead with the building of experimental ships, that were designed for fast sailing.⁴¹⁹ This impression is reinforced by the fact that the positive outcome of the official dimensions of the *Pallas* had already been reported in a meeting of the *Heeren XVII* on 30 October 1762.⁴²⁰ As the three inspectors (one each from the Zeeland, Delft and Rotterdam chamber) did not make any remarks at all, there can hardly be any doubt that the *Pallas* was at that time constructed as a *kuilschip* and that the ship was later converted into a three-decker, apparently without prior notification. This may also explain

⁴¹⁵ NA 1.04.02/177 dd. 31.03.1764 which also contains the arguments of the other chambers. For the Zeeland drawings one has to consult the provisional minutes of that meeting (NA 1.04.02/58 dd. 31.03.1764).

⁴¹⁶ Bruijn e.a. (1979-1987) Part 1, p. 48

⁴¹⁷ The *Vreeburg* was obviously not involved in the comparison as it left not in November 1764 like the *Pallas* and *Walenburg* but in April 1765; moreover it sailed to and from Batavia, and by the time it left Batavia the other two ships had already arrived back in the Republic from China.

⁴¹⁸ See <http://resources.huygens.knaw.nl/das/detailVoyage/94968>

⁴¹⁹ Jong, Johan de (2010), pp. 63-64

⁴²⁰ NA 1.04.02/57 dd. 30.10.1762

the fact that almost two years went by between the measuring of the *Pallas* and the moment it actually entered into service.

On 26 July 1766, the *Pallas* successfully returned from its first voyage, having sailed to China and back, and on 25 March 1767 the Zeeland chamber got permission to build more three-deckers, by which time the *Pallas* had already left for its second voyage.⁴²¹ Apparently, the chamber had gambled on a positive outcome because before the first return of the *Pallas* two more three-deckers had been built, a vessel of the first charter (the *Willem de Vijfde*) and a vessel of the second charter (the *Rijnsburg*).⁴²² After the formal permission by the *Heeren XVII*, seven more three-deckers were built at the yard at Middelburg, all of the first charter.⁴²³ In the same meeting when permission to build more three-deckers was given, the *Heeren XVII* asked the Zeeland chamber to provide the Amsterdam chamber with the exact measurements and specific technical details of its three-deckers, in order that the shipyard in Amsterdam could build an experimental three-decker as well; Amsterdam had asked for this information after it had received favourable reports on the *Pallas*.⁴²⁴ Just over a year later, officials of the Amsterdam chamber must have been able to inspect the three-decker *Pallas* for themselves, because on 18 June 1768 the *Pallas* returned from China with a cargo for the Amsterdam chamber.⁴²⁵ In fact, all next voyages (consisting of three *retourreizen* and a final voyage to Batavia in 1779) of the *Pallas* were made on behalf of the Amsterdam chamber, departing and arriving at Texel. This makes it quite likely that the *Pallas* was maintained in between voyages at the Amsterdam yard, in the process crossing the Zuyderzee and thereby probably demonstrating that the suggested problems of an increased draught were not as serious as had been predicted. A number of the other originally built three-deckers also sailed on behalf of the Amsterdam chamber; during the 1770s this concerned the ships *Willem de Vijfde*, *Rijnsburg*, *Oostkapelle*, *Botland* and *Mars*, while during the 1780s the *Zeeduin* and the *Stavenisse* were a number of times operated by and on behalf of that chamber.⁴²⁶ Apparently,

⁴²¹ For the return of the *Pallas*, see <http://resources.huygens.knaw.nl/das/detailVoyage/98554>, for the decision of the *Heeren XVII* see NA 1.04.02/ 61 dd. 25.03.1767. The second outward voyage of the *Pallas* is at <http://resources.huygens.knaw.nl/das/detailVoyage/95026>.

⁴²² See <http://resources.huygens.knaw.nl/das/detailVoyage/95048> and <http://resources.huygens.knaw.nl/das/detailVoyage/95074>

⁴²³ These seven ships were the *Oostkapelle*, *Botland*, *Ouwerkerk*, *Europa*, *Zeeduin*, *Mars* and *Stavenisse*.

⁴²⁴ NA 1.04.02/61 dd. 25.03.1767 (folio 29)

⁴²⁵ <http://resources.huygens.knaw.nl/das/detailVoyage/98597>

⁴²⁶ Apart from the last homebound voyage of the *Pallas* on which part of the cargo was destined for the Zeeland chamber, all these voyages were exclusively on behalf of the

all these ships must also have managed to cross the Zuyderzee to get to Amsterdam for repairs. Nevertheless, it seems that Amsterdam never built a three-decker at its own yard at the time.⁴²⁷

In 1772, the Zeeland chamber proposed to lengthen the largest charter by five feet, and – not surprisingly perhaps – a vessel of that size (the three-decker *Europa*) was already under construction.⁴²⁸ It could carry 25 *last* (approximately 50 tons) extra, but other chambers argued that ships of this size could not be accommodated by the “camels” that were needed to carry *retourschepen* across the Zuyderzee.⁴²⁹ At the same time, Zeeland asked for permission to build three-deckers on a regular basis but on 3 October 1772 the *Heeren XVII* provisionally suspended the building of three-deckers (although the *Stavenisse* could still be finished as a three-decker); on 9 April 1773, they suspended the building of three-deckers altogether. Possibly the Zeeland chamber had gone too far by again creating a *fait accompli* through the construction of the *Europa*. A letter by the Delft chamber (dated 15 March 1773) arguing that the building of three-deckers should be continued as these ships were more suitable for voyages to China and Japan, had no effect on the decision to withdraw permission, but it may have contributed to the decision by the *Heeren XVII* that existing three-deckers should be predominantly used on the routes to Japan.⁴³⁰ It is remarkable that the Zeeland proposal met with more resistance from the *Heeren XVII* than the Rotterdam/Delft proposal, although the Zeeland three-decker kept the shape of the hull as it was. One reason may have been that there was very little chance that the other chambers would follow the Rotterdam/Delft adaptations, considering that the local circumstances were different and the opposition that had been voiced, a second reason may have been that (as was noticed in the first chapter) the number of ships built by both Rotterdam and Delft was much smaller than the number of ships built by the Zeeland yard, let alone the Oostenburg yard in Amsterdam. Finally, in the apparent move towards to centralized

Amsterdam chamber. Details have been derived through

<http://resources.huygens.knaw.nl/das>

⁴²⁷ This seems to be confirmed by remarks made by Radermacher in 1788 (cf. the last section of this chapter).

⁴²⁸ NA 1.04.02/65 dd. 18.04.1772

⁴²⁹ Camels were floating docks that were attached to each side of a ship to lessen the draught of the ship. Smaller sailing vessels were then used to tow these camels plus ship across the shallows in the Zuyderzee; the most notorious of these shallows was “Pampus” the sandbank that blocked the entrance to Amsterdam’s harbour. This argument is mentioned and refuted by Lombard in *Verhandelingen Zeeuwisch Genootschap, Zevende Deel* (1780), pp. 297-298

⁴³⁰ NA 1.04.02/65 dd. 03.10.1772 and NA 1.04.02/66 dd. 09.04.1773; Bruijn e.a.(1979-1987) Part 1, pp. 48-49; Loeve (2001) pp. 37-38; the Delft letter (dd. 15.03.1773) is attached to NA 1.04.02/66 (9 & 10.04.1773).

standardization which had become very noticeable from 1742 onwards, the thought of Middelburg as a second - independently minded - centre may not have appealed to the directors of the VOC.

Meanwhile, the issue of health that had been invoked as one of the arguments against the three-decker (repeated in a letter written by stadholder Willem V concerning the health issue on 29 August 1775) had taken on an added poignancy when, during the early 1770s, the number of crewmembers that fell ill and died on the outward voyages had risen to unprecedented figures as was shown in the preceding chapter.⁴³¹ As we then also saw, the emergence of these serious health problems *en route* led to extensive discussions within the VOC and to a number of publications in the *Transactions* of societies in an attempt to find a solution. The fact that three-deckers offered the possibility to accommodate people on separate decks could be interpreted as advantageous in these circumstances because it made it possible to separate a large number of sick crewmembers from those still healthy. Apart from the issue of health, matters of seaworthiness, safety and carrying capacity continued to emerge in the discussion about the advantages and disadvantages of three-deckers. This became apparent in the *Supplement voor eene Memorie* that was presented to the *Heeren XVII* and the directors of the other chambers of the VOC by Radermacher, director of the Zeeland chamber of the VOC; this collection of essays and experiential evidence was composed in response to the critique by the Amsterdam chamber on the concept of three-deckers.⁴³² However, the *Supplement* did not give the *Heeren XVII* cause to revoke their earlier decision. This was probably because the *Supplement* was seen by them as just as biased as the Amsterdam critique had been interpreted by Radermacher. It seemed an impasse had been reached.

*Establishing a society*⁴³³

In July 1765, twelve gentlemen came together in the Zeeland town of Vlissingen (on the island of Walcheren) with the intention to discuss French journals and French learned texts. By the end of the year, their number had increased to seventeen and they decided to formalize their meetings under the name of *Genootschap ter bevordering van nuttige kunsten en wetenschappen te Vlissingen* (Society for the advancement of useful arts and sciences of Vlissingen). They considered that societies had sprung up all over Europe in the past century, but scarcely in (as they called it) *Vereenigd Nederland*

⁴³¹The letter by Willem V is in NA 1.04.02/183 inserted after the resolutions of 30.9.1775.

⁴³²NA 1.04.02/11356 (January 1777) unpaginated (transl.: “supplement to a memorandum”); see also Loeve (2001) pp. 40-49

⁴³³This section draws on *Verhandelingen van het Zeeuwsch Genootschap der Wetenschappen, Eerste Deel* (1769), pp. i-xlvi and on subsequent *Transactions*.

(United Netherland). About a decade earlier (in 1752), the *Hollandsche Maatschappij der Wetenschappen*⁴³⁴ had been established in Haarlem. The aim of the Zeeland society was “to honour the alone wise God above all, to be an advantage for all mankind and especially for fellow countrymen, and to advance all sorts of useful arts and sciences”.⁴³⁵ In March 1768, the founders decided to invite more members to their *Genootschap* and in November of that year, they asked whether Willem V, stadholder of the Republic, would be willing to act as its protector; in December 1768, Willem V accepted their request. In January 1769, eight directors were appointed, a number that increased considerably over time. By the end of February of that year, Radermacher, director of the Zeeland chamber of the VOC joined their ranks as the tenth director of the *Genootschap*; he remained in that post until the end of 1789. By the end of July 1769, the number of directors had risen to twenty-nine, and by the end of August, there were fifty-one ordinary members.⁴³⁶ Meanwhile, on 4 March 1769, the town government of Vlissingen had officially recognized the society and on 23 March, the States of the province of Zeeland did so as well. Consequently, it was decided to change the name into *Zeeuwsch Genootschap der Wetenschappen te Vlissingen*.⁴³⁷ The *Zeeuwsch Genootschap* explicitly positioned itself among the ranks of existing societies, referring to similar institutions in England, Germany, France, Italy, Sweden, Denmark, Russia, Norway and other parts of Europe. Among its early members one finds – apart from dignitaries from Zeeland – a number of university professors from the Republic and also members of the *Hollandsche Maatschappij*, of the *Royal Society* in London, of the Imperial Academy in Petersburg, of the *Académie Royale* in Paris, the Royal Swedish Academy in Stockholm and of the *Kurfürstliche Akademie* in Mannheim. In 1771, Carel Linnaeus became a member; in 1775, Leonard Euler and his son Johann Albert Euler joined the society. By the end of October 1776, the number of directors had increased to sixty-seven. Among these were five directors of the Zeeland chamber of the *West-Indische Compagnie* (the Dutch West India Company), another director was the president of the group of main participants of that company in Amsterdam. From the Zeeland chamber of the VOC two directors were

⁴³⁴ (transl.) “Holland Society of Sciences”

⁴³⁵ As described in the first article of the law of the society (*Verhandelingen Zeeuwsch Genootschap, Eerste Deel* (1769), p. xi): “*Den alleen wyzen GOD op 't hoogst te verheerlyken, het gantsche menschedom en voornaamlyk den Landgenooten voordeelig te wezen, en allerleye nuttige kunsten en wetenschappen voort te planten, zal het voornaam doelwit van dit Genootschap blyven*”

⁴³⁶ Of the twenty-nine directors, the majority consisted of regents, (former) mayors, or high-ranking civil servants; the president was councillor and former mayor of Flushing. One of the directors was also director of the Dutch West India Company.

⁴³⁷ (transl.) “Zeeland Society of Sciences at Flushing”

represented within the society's board and one high ranking employee of the VOC in the East Indies had also become director. In 1778, Jacob Radermacher (a nephew of Radermacher) was appointed director of the Zeeland society; although by that time he had moved to Batavia in the East Indies, where he became the driving force behind the establishment of the *Bataviaasch Genootschap van Kunsten en Wetenschappen*, and of the first masonic lodge in Batavia.⁴³⁸ A few years after the *Zeeuwsch Genootschap* had been established, more societies were founded in the Dutch Republic, such as the *Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte* in Rotterdam (1769) and the *Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen* in Utrecht (1773).⁴³⁹

Fig. 3.2 Titlepage of the first *Transactions* of the *Zeeuwsch Genootschap*

The Zeeland society published its first set of *Verhandelingen* (*Transactions*) in 1769, which contained mostly medical and theological essays, reflecting the profession of the majority of its members. Later *Transactions* contained usually a rather eclectic mixture of essays, most of which displayed an experimental or experiential character, thus serving as vehicles for “virtual witnessing”.⁴⁴⁰ In that respect, they were no exception to the publications of other societies or academies, including those of much more illustrious ones such as the *Académie des Sciences* in Paris.⁴⁴¹ Many of these societies had a rather practical and utilitarian orientation and concentrated their efforts on the improvement of the wider

⁴³⁸ (transl.) “Batavia Society of Arts and Sciences”

⁴³⁹ (transl.) “Batavian Society for Empirical Philosophy” resp. “Provincial Utrecht Society for Arts and Sciences”. For an extensive overview, discussion and interpretation of Dutch societies in the eighteenth century, see Mijndhardt (1987), *passim*.

⁴⁴⁰ For instance, in *Verhandelingen Zeeuwsch Genootschap, Negende Deel* (1782) one finds a treatise on *Waarneeming van twee wanschapen kinderen* (“Observations on two disfigured children”) by H. Mirandolle van Ghert (pp. 270-274), an extensive treatise by Leonard Euler regarding *Récherches sur une Nouvelle Espèce de Quarrés Magiques* (“Research into a new type of magic squares”) (pp. 85-239), and observations on the *Voorbijgang van Mercurius over de zon* (“Transit of Mercury across the face of the sun”) by J.P. Fokker (pp. 473-480)

⁴⁴¹ Fay (1932), pp. 261-262 and McClellan III (1985), pp. 114-116

society from which they emerged. It has been suggested that many societies, although striving to attract an international membership, in effect turned into centres of a regionally oriented spirit, eventually leading to the paradoxical outcome that internationally minded organisations helped to create a national or even regional patriotism.⁴⁴² Looking at the *Zeeuwsch Genootschap*, one sees that it is no exception to this characterisation.⁴⁴³ As was the case with most societies, the Zeeland *Transactions* not only contained entries by its members but also prize winning essays written in response to competitions that were open to interested non-members. For instance (as we saw in the preceding chapter) in 1774, the Zeeland society initiated a competition on symptoms, causes, cures and prevention of *rotkoorts* on board of the ships of the VOC. Answers were received in 1776 and two years later the two prize-winning essays were published in the society's *Transactions*. These two essays were also published in a separate volume as "*Twee verhandelingen over de besmettelijke rotkoorts*" (Two treatises on the contagious jail-fever). The reason for the publication of this separate volume was given as "to facilitate the circulation (of the two essays) among surgeons and others, especially those employed on the ships of the VOC". The initiative for the separate publication came from Pieter Gillissen, the printer of the *Zeeuwsch Genootschap*; his intention was to sell the separate volume to seafarers. He added that this booklet would also further the objectives of the society.⁴⁴⁴ This suggests that the society and the printer had practical applications specifically on their mind, although the printer possibly also had the idea that he could make some profit out of the publication.⁴⁴⁵

As will be extensively described below, the society became again involved with the policies of the VOC when it organized in 1777/78 an essay competition on which ship design would be the most suitable for the purposes of the company. The winning essays were published in the 1780 *Transactions* of the society. As it turned out these publications played a very important role in settling the dispute within the VOC about the Zeeland design. The society remained active in matters of health and ship design; the same volume of the *Transactions* in which the essays by Lombard and Udemans were published

⁴⁴² Faÿ (1932), pp. 263-265

⁴⁴³ For more on the *Zeeuwsch Genootschap*, see Mijnhardt (1987), chapter IV and Mijnhardt (1985), passim

⁴⁴⁴ *Twee Verhandelingen* (1778), *Voorbericht* ("om dezelve te gemakkelijker te doen komen in handen der Heelmeesteren, zoo anderen, als vooral zulken, die zich op de Schepen, in dienst der Oost-Indische Maatschappij, bevinden"). Gillissen's letter (dd. 26 May 1777) is in ZA 26.1/62 folio 151; his letter was written when he had just started printing the *Verhandelingen*.

⁴⁴⁵ It is doubtful whether the winning essays were read in a meeting of the *Zeeuwsch Genootschap*. The surviving minutes do not provide any suggestion to that effect.

contained two questions regarding that subject. The first was a wide-ranging question concerned with the best way to promote the health of the crew on board of the ships of the VOC and to prevent diseases occurring.⁴⁴⁶ Several aspects had to be considered, such as how to build the ships, how to accommodate the crew on board the ships, how to feed and clothe the crew, how to prepare and store food supplies, how to prevent diseases and how to keep ships clean.⁴⁴⁷ The second was a more specific technological question concerning the best form of the bow of ships and the form of the submersed part of a ship's hull in general; that question was inspired by a remark in Udemans's essay.⁴⁴⁸ In both competitions the gold medal for the best solutions was paid for by the Batavia society. Partly to maintain links with kindred societies in the Republic and partly because of the lack of suitably scholarly inclined members in Batavia, the *Bataviaasch Genootschap* had decided to sponsor competitions organized by societies in the Republic, like the *Bataafsch Genootschap*, the *Hollandsche Maatschappij der Wetenschappen* and the *Zeeuwsch Genootschap*. In most cases, the societies in the Republic were free to decide on the subject of the competition; some managed to find a subject that had a bearing on the East Indies. It may be that by not formally insisting on a certain subject, the *Bataviaasch Genootschap* could – in a way – circumvent restrictions posed on it by the High Government in the East Indies, as a condition for its recognition by that government had been that the society should not become involved with subjects related to the policies of the VOC; societies in the Republic were not subject to these restrictions. In 1784, the prize winning answer to the first question written by Johannes Harger (doc. med. at Rotterdam) was published in the tenth volume of the *Transactions*.⁴⁴⁹ By way of introduction, Harger began with extolling the virtues of the three-deckers, and mentioned the fact that such a three-decker was now being built outside Zeeland, by the Delft chamber on its yard at Delfshaven.⁴⁵⁰ The

⁴⁴⁶ Groot (2009), pp. 113-114 rather curiously suggests that this question was not connected with the East Indies, nor was the later ("practical-technical") question about the shape of a ship's hull.

⁴⁴⁷ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. XVI-XVII and XXI

⁴⁴⁸ The question was suggested by A. 's Gravezande in a letter dd. 06.10.1779 to Radermacher (ZA 26.1/62 folio 35). He referred to a remark by Udemans in his essay regarding the apparent incompatibility between the speed of a vessel and its manoeuvrability and suggested that this problem might be a suitable topic for a competition, either for the *Zeeuwsch Genootschap* or for the *Bataviaasch Genootschap*. The question appeared for the first time in *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. XXI-XXIV and was repeated in *Verhandelingen Zeeuwsch Genootschap, Negende Deel* (1782), pp. L-LII

⁴⁴⁹ *Verhandelingen Zeeuwsch Genootschap, Tiende Deel* (1784), pp. 313-496

⁴⁵⁰ *Ibid.*, p. 319 (that vessel was almost certainly the *Roosenburg*, which the Delft yard was permitted to build in 1780). On page 338 (footnote *b*), Harger wrote that he had already

winning essay to the second question, published in the eleventh volume, was written by M. Garnier de St. Julien, *capitaine en premier au Corps-Royal de Génie de France* from Bayonne.⁴⁵¹ The fact that a captain in the royal French army submitted an answer to a question that had been put forward by a Dutch society financed by a similar society in the East Indies shows the extent of the circulation of knowledge at that time. It is even more interesting in that it shows that a connection could have existed between French shipbuilding methods, which were based on what may be called formal knowledge, and the shipbuilding practice of the VOC that was based on an experiential approach, enhanced by the use of design-drawings, introduced by a master shipwright from England.⁴⁵²

Connecting design and society

Although father and son Udemans had presented their three-decker design as an improvement, it met with strong opposition within the VOC. Shipwrights of the other chambers used various arguments to argue against the new design, probably the most important being their impression that the draught of these ships would make their use impracticable because of the shallow passages between the open seas and the ports of the other chambers.⁴⁵³ No mention was made of problems that might be encountered in the East Indies, but there – at least at Batavia – ships were anchored in the roadstead near the harbour anyway. The problem that the draught of ships was too large had in fact been at the root of the problems of seaworthiness that had confronted the VOC in the run up to the new designs of 1742. That might also explain why the *Heeren XVII* were not quite taken with the prospect of change, having negotiated their

finished this part of his answer before he received the copy of the *Verhandelungen* in which Lombard's and Udemans's answers had been published.

⁴⁵¹ *Verhandelungen Zeeuwisch Genootschap, Elfde Deel* (1786), pp. 3-88; the translation of the writer's profession reads "First captain in the Royal French engineering corps"

⁴⁵² From the 1750s onwards, in French (naval) shipbuilding matters like displacement, metacentric height and resistance were calculated at the design stage of ships. This was performed by using numerical methods that had been introduced by Duhamel de Monceau (inspector general of the French navy) as a substitute for the infinitesimal calculus approach that was originally used to solve these matters. Although Duhamel's handbook *Elémens de l'Architecture Navale* in which he published these tools was translated into English and Dutch, it took several decades before the French mathematical/geometrical approach filtered through to English and Dutch ship-design and shipbuilding. See Pritchard (1987), Nowacki & Valleriani (2003), Nowacki (2006), Nowacki (2007), Ferreiro (2007), Ferreiro (2009); for an overview Jong, Johan de (2010), section 4.1

⁴⁵³ As we already saw, the increasing problems with these shallows had been the main reason why the Rotterdam and Delft chamber had proposed their changes to the 1742 design.

way out of these earlier problems and finally having settled on a standardized design that allowed them to get a firm grip on the standardized production process of their *retourschepen*.⁴⁵⁴

At first glance, the only connection between the new design and the new society seems to be that both originated in the province of Zeeland. However, if one takes a closer look it becomes clear that the society became distinctively involved in resolving the controversy regarding the new design. Whereas a connection between the VOC and the Zeeland society existed on a personal level through the person of Daniël Rademacher, in his twin roles as director of the local VOC chamber (and member of the *Heeren XVII*) and as one of the many directors of the *Zeeuwsch Genootschap*, this connection deepened when the Zeeland society published two essays on the problems of *rotkoorts* within the VOC. The society's explicit involvement in the discussions surrounding the new design occurred when the society agreed to organize a competition regarding the question of which ship design was the most suitable for the purposes of the VOC. On 29 July 1777, amidst the still undecided debates on the three-decker design, Rademacher (as of one of the many directors of the *Zeeuwsch Genootschap*) suggested that the society could organize a competition regarding the question which design of *retourschip* was the most suitable for the purposes of the VOC, concerning its voyages between Europe and the East Indies and within the East Indies. As usual, the society would be responsible for receiving and judging the answers, although Rademacher offered to pay for the usual gold medal for the best entry. His suggestions were received and accepted with "much pleasure and to general acclaim" (*met groot genoegen en algemeene goedkeuring*).⁴⁵⁵ The answers (that were sent to the secretary of the Zeeland society) were judged by a panel of six expert judges none of whom was employed by the VOC anymore. Looking at the numerical representation of directors of the VOC within the board of ordinary directors of the *Zeeuwsch Genootschap*, it seems unlikely that the *Zeeuwsch Genootschap* had a specific close relation with the Zeeland chamber of the VOC, as compared to the local chamber of the West Indian Company, the other major company in the Republic. Considering its partly regional orientation, it made sense for the Zeeland society to engage in this matter as it had a bearing on the own province. It had done so several times before as becomes clear if one looks at the overview of subjects in its first twelve *Transactions*.⁴⁵⁶ The actual question was an extensive one:

which ships, belonging to the Dutch East India Company, either 140, 150 or 155 feet in length, with an open or closed waist, otherwise called three-

⁴⁵⁴ Cf. chapter 1 and (in more detail) Jong, Johan de (2010), chapter 3

⁴⁵⁵ *Verhandelingen Zeeuwsch Genootschap, Zesde Deel* (1778), pp. viii-ix

⁴⁵⁶ Drijfhout, A. (1789) *Beredeneerd Register Zeeuwsch Genootschap* (etc.)

deckers, are in general the most suitable, useful and most profitable for its service, both between Europe and the East Indies as well as in the Indian seas.⁴⁵⁷

Explicit consideration ought to be given to matters of draught, manoeuvrability, adverse conditions, on transporting the greatest number of healthy crew to the East Indies, on the separation of sick crewmembers from healthy ones and finally on how much more cargo a 155-ft. vessel could carry compared to a 150-ft. vessel. It was emphasized that experiential answers were looked for; mere theoretical or speculative answers would be deemed insufficient. This confirmed to an important aspect of “literary technology” that we noticed above: writers of essays should see to it that their text took the form of an experimental essay and not of an elaborate philosophical text.⁴⁵⁸

There were three entries to the competition, all of which were judged by a panel of six judges. This panel consisted of three skippers employed by the VOC (all of which had retired by the time they offered their verdict and two of which had sailed on three-deckers), two rear admirals of the Zeeland admiralty who had been skippers with the VOC in the past and a medical doctor from Middelburg. The fact that the three skippers involved had retired from the VOC meant that they were in a position to offer an unbiased judgement without the risk of jeopardizing a future career within the company; the same of course applied to the two judges who were employed by the Zeeland admiralty. The physician was the only person who still had some professional connection with the VOC as examiner of the company’s ships surgeons although that was by no means his only occupation. Four judges favoured the essay by Lombard, two the one by Udemans; the third entry was rejected by all.⁴⁵⁹ Therefore, the *Zeeuwsch Genootschap* awarded the

⁴⁵⁷ The question (“*Welke schepen, behoorende aan de Nederlandsche Oost-Indische Compagnie, van 140, 150 en 155 voeten lang, zoo met een openen, of gedekten kuil, anders genoemd driedekkers, zijn in allen deele de bekwaamste, nuttigste, en voordeeligste voor Haaren dienst, zoo tusschen Europa en India varende, als in de Indische zeeën zelve gebruikt wordende?*”) was posed in the program of the *Zeeuwsch Genootschap* for 1777 and was (re)published in *Verhandelingen Zeeuwsch Genootschap, Zesde Deel* (1778), pp. xii-xv and *Ibid.*, *Zevende Deel* (1780), p.xiii. It should be noted that the only VOC *retourschip* with a length of 155 ft. was the Zeeland built three-decker *Europa*.

⁴⁵⁸ *Verhandelingen Zeeuwsch Genootschap, Zesde Deel* (1778), pp. xii-xv

⁴⁵⁹ The skippers were Abraham In’t Anker (skipper with the Zeeland chamber of the VOC between 1761 and 1770), Johan Splinter Stavorinus (skipper with the Zeeland chamber of the VOC between 1768 and 1778) and Cornelis Pietersz. (skipper with the Zeeland chamber of the VOC between 1763 and 1777, commander of the homebound fleet in 1777). J.S. Stavorinus (1739-1788) was appointed captain in the Zeeland admiralty in 1766; later he made two voyages for the VOC. The first of these took place between 1768 and 1771,

surgeon Ezechiël Lombard the gold medal for his essay; meanwhile, Lombard was employed by the Zeeland chamber of the VOC as *opper-chirurgijn* (chief surgeon) at Cheribon on the island of Java. Willem Udemans Jr, who by that time had succeeded his father as master shipwright at the VOC shipyard at Middelburg, received a silver medal for his essay.⁴⁶⁰ Udemans was initially not quite sure whether his essay was going to be published. In the letter to the *Zeeuwsch Genootschap* in which he unveiled the identity behind his motto, Udemans insisted that his essay should be published together with Lombard's essay. If this request could not be granted, he would not accept the silver medal and he would publish the text himself.⁴⁶¹ In 1780, both prize-winning essays were published together in the seventh volume of the *Transactions* of the *Zeeuwsch Genootschap*; this allowed contemporary readers (and it allows us) to see that Lombard and Udemans agreed on a perspective in which they granted a central position to the ships and to the experiences of those who sailed these ships. The essays not only appeared in the *Transactions* but also in a separate volume.⁴⁶²

the second between 1774 and 1778. His accounts on these voyages (which we will come across in the next chapter) were posthumously published in 1793 resp. 1797/98; they were translated into English, French, German and Swedish. He was accepted as a member in the *Zeeuwsch Genootschap* on 26 July 1774. In 1788 he was promoted to rear admiral in the Zeeland admiralty. Cf Bruijn (2008), p. 57, *Verhandelingen Zeeuwsch Genootschap* Deel 4 (1775), pp. xiii-xxii and <http://resources.huygens.knaw.nl/das> under "Stavorinus". The two rear admirals were Maarten Haringman (skipper with the Zeeland chamber of the VOC between 1747 and 1756; in 1756 appointed captain in the Zeeland admiralty, in 1766 promoted to rear admiral and given the post of *equipagemeester* (director) of the admiralty yard at Vlissingen; member and director of the *Zeeuwsch Genootschap*) and Cornelis Vis (skipper with the Zeeland chamber of the VOC between 1744 and 1751; in 1751 appointed captain at the Zeeland admiralty; in 1766 promoted to rear admiral and in 1782 to vice-admiral). The medical doctor was Servaas van de Copello from Middelburg, member of the *Zeeuwsch Genootschap*. He was examiner of the ship's surgeons of the *Middelburgsche Commercie Compagnie* (a trading company engaged in the African-American slave trade) and of the VOC Zeeland chamber as successor to Paulus de Wind; cf. NNBW (1911-1937), Deel 7, pp. 321-322. Loeve (2001, p. 64) only mentions Haringman and Vis as judges, and he suggests that no skippers with experience on three-deckers were members of the panel. However, ZA 26.1/62 contains letters written to the directors of the *Zeeuwsch Genootschap* between March and May 1779 by each of these six judges, in which they gave their considered judgement. Moreover, Pietersz and Stavorinus had been skipper on three-deckers as well as on ships with a waist.

⁴⁶⁰ *Ibid.*, *Zevende Deel* (1780), pp. 203- 299 and pp. 300 – 360

⁴⁶¹ ZA 26.1/62 folio 28 & 29 (letter by Udemans dd. 06.09.1779)

⁴⁶² *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. 203-299 & pp. 300-360. A copy of the separate small volume containing only the essays by Lombard and Udemans and the appendices by Radermacher is at the *Zeeuws Archief* (ZA 157/1216). In

Lombard and Udemans argued (as we will see in the next section), that experience showed that three-deckers allowed a more effective mastering of storms and waves, that they were easier and safer to operate, that they assisted in disciplining the crew and that they made a re-ordering of the crew possible, leading to a healthier (or – depending on one's point of view - less unhealthy) environment for the crew, especially during the outward journey. In addition (as will be shown in the third section) the ships offered more cargo space, especially on the homebound journey, and were therefore better geared to a profitable trade. The arguments of the two writers slightly differed: Lombard wrote extensively about matters of health, invoked his own experiences in that respect and gave a first-hand account of the Canton tea trade whereas Udemans explicitly commented on the behaviour of these ships in adverse conditions, quoting several skippers. Nevertheless, their conclusions were similar: both considered a fully enclosed three-decker of 155 feet (which implied the enlarged first charter) to be the most suitable design.

The essays experientially linked the design of the *retourschip* with health, safety and profitability; by publishing these essays using the literary technology of virtual witnessing the society positioned itself as a neutral and trustworthy knowledge broker concerning the introduction of a new design. Under the umbrella of the society, the essays used crewmembers and diseases, storms and high seas, and the tea trade to China as arguments in favour of a new design.⁴⁶³ Eventually, this turned out to be a decisive factor in the acceptance of the new ship design, as will be described and discussed in the final section of this chapter. Although the initiative of Radermacher might be construed as prejudicing the results of the competition, one should remember that the procedure for the competition was exactly the same as for all other competitions of the society. Entries had to be submitted anonymously (as usual under a motto) to the secretary of the Zeeland society and they were judged by expert judges chosen by the directors of the society. Because of this procedure, the judges were unaware of the identity of the writers. The writers only disclosed their identity after the mottos of the prize-winning essays had been announced. This standard procedure ensured that the aspect of virtual witnessing was untainted by possible personal preferences.

In both publications, the essays by Lombard and Udemans were followed by a number of appendices supplied by Radermacher. These appendices consisted of a number of comments, extracts from skipper's journals, letters and testimonies regarding ships of classic and of three-decker

this volume, Udemans's illustrations are missing; they seem to have been cut out at some later date.

⁴⁶³ One gets the impression that the matter of health had not been laid to rest by earlier decisions of the *Heeren XVII* or by the publication of earlier essays.

design and the acceptance letter of one of the judges from which it becomes clear that he was asked by the directors of the Zeeland society for that role. Radermacher's earlier mentioned *Supplement voor eene Memorie* (which had contained a number of these testimonies) had been written in his capacity as VOC director and it had been addressed by him to the *Heeren XVII* and the directors of the other VOC chambers. It had been based on much of the material that was later used by Lombard and Udemans in their essays. However, because the specific intention of the *Supplement* had been to re-open the policy discussion within the ranks of the *Heeren XVII*, it could be seen as a rather politicized publication and – possibly just because of that – it had failed to do so. Transferring the experiences of users from the offices of the VOC to the writing desks of essayists via the chambers of a society eventually succeeded in de-politicizing the issue. Even when the main topics remained the same (nautical safety, the resurfacing theme of keeping crewmembers safe from disease and matters of profitability), the experiential evidence now belonged to the neutral and trustworthy realm of a society.

3.2 The importance of safety

Lombard's experiences

Despite the fact that Ezechiël Lombard was a surgeon and therefore probably had no formal nautical training, he gave extensive answers to the specific nautical sub-questions that had been posed. Reading his answers it becomes clear that he drew heavily on his experiences as a ships' surgeon with the Zeeland chamber of the VOC. Before dealing with the sub-questions, Lombard explained that a longer vessel was less liable to pitching in heavy seas which meant a smaller risk of losing part (or all) of the rigging and which also meant that the vessel was less prone to drifting. As he had sailed extensively (both on classic *kuilschepen* and on three-deckers) he was in a position to make an informed judgement. The same applies to his description of the way the crew was able to operate the rigging more easily and speedily on board of a three-decker. He added that a three-decker was also more suited to situations of armed conflict, as the guns – being positioned below the top-deck – could be operated without interfering with the operation of the rigging on the top-deck; this in contrast to classic ships where the guns and the rigging had to be operated on the same "*kuildek*". When we look carefully at the wording, it becomes apparent that Lombard borrowed extensively from a letter written in November 1772 by skipper Jan Siereveld, a letter that had earlier appeared in

the *Supplement*.⁴⁶⁴ The fact that Lombard did not mention the earlier publication of these considerations may be explained by the fact that papers related to the management of the VOC were subject to secrecy. It remains intriguing how Lombard came by the letter in question. One possibility is that Radermacher allowed him to see a copy; another possibility is that Siereveld himself showed it to him or discussed these matters with him, as Siereveld was the skipper with whom Lombard was bound to sail for China in October 1777. On the matter of draught, Lombard compared figures for a standard three-decker of 150 ft. with those for the *Europa* of 155 ft., which showed that - when these ships were launched - the longer ship had a slightly smaller draught than the shorter one. The numbers showed that there was no ground for the objections voiced by other chambers about the problem that large three-deckers had a larger draught than smaller ships of a similar design. Lombard credited Willem Udemans Jr for providing these numbers, which had already been discussed by the *Heeren XVII* in their meeting on 18 April 1772 and which had subsequently also been published in the *Supplement*.⁴⁶⁵

Lombard explained that – because of the relative ease of operating the rigging – a three-decker could be managed by a smaller crew than a classic ship, which was advantageous when running these ships in the inter-Asian traffic (e.g. between the East Indies and China or Japan), where the crew was usually rather small. Apart from the fact that the running rigging was conveniently and well-ordered at hand on the uninterrupted top-deck and that the crew had no need to climb up and down narrow stairs when moving from fore to aft (and back), the most important advantage was that the commanding officers had an uninterrupted view of the goings-on at the top-deck: the crew on duty had nowhere to hide. Because of the new lay-out the crew could be effectively controlled and disciplined by a small group of officers from their commanding position at the *campagne* (quarterdeck). As Lombard scathingly remarked, on *kuilschepen* (especially at night or in adverse conditions) about one quarter of the crew was continually missing because they were hiding behind chests, bunks and amongst the sick.⁴⁶⁶ Separating the sick crew members completely from the healthy crew (on a

⁴⁶⁴ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. 206-209, as compared to *Supplement* NA 1.04.02/11356, unpaginated (pages 4-22). There is also an extensive piece by Lombard himself in the *Supplement*, unpaginated (pages 51-70).

⁴⁶⁵ *Ibid.*, pp. 210-212, NA 1.04.02/65 dd. 18.4.1772 and *Supplement* NA 1.04.02/11356, unpaginated (pp. 48-50)

⁴⁶⁶ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), p. 218. In a footnote Lombard observed that these people were usually those who were the biggest talkers while still ashore, but during a storm at sea “they move upwards as slowly as – if I may say so – a thief who is led by the henchman up the stairs” (“zo traag naar boven treden als, dat ik mij zo uitdrukke, een dief die door den beul den leer wordt opgeleid”).

different deck) made such behaviour less likely, and - moreover - by closing some hatches the crew could no longer escape their duties. They knew that they would always be seen and that there was no escaping that fact. Apart from the handling of the sails, dropping or raising anchors was more easily performed on three-deckers, as the anchor-cables could not interfere with the rigging because the heavy anchor-ropes were positioned on the deck just below the top-deck. Lombard's reasoning leads to the conclusion that it was easier to discipline the crew on a three-decker than on a ship of classic design. The three-decker itself was also easier to discipline, which became clear when he discussed the manoeuvrability of these vessels.⁴⁶⁷

Fig. 3.3 View from the *campagne* (quarterdeck) on a classic *kuilschip*; drawing by Jan Brandes, made while he travelled on the *retourschip Holland* in 1778/9. On a three-decker, the lower deck in front would have been raised considerably, providing a much more uninterrupted view. Note the almost complete absence of crewmembers in this picture. (Rijksmuseum Amsterdam NG-1985-1-144)

⁴⁶⁷ Ibid., pp. 213-219

On the topic of how three-deckers in practice mastered waves, wind and shores, Lombard quoted the skippers Tomassen and Van Voors who were enthusiastic about the qualities of (different) three-deckers concerning their ability to sail closer to the wind, to hold a course close to the wind and to sail free from a dangerous lee shore. Both skippers were of the opinion that three-deckers were superior to *retourschepen* of the classic design and (according to Tomassen) even more so than the changed design from Rotterdam and Delft. Tomassen, skipper on the *kuilschip Damzigt* had sailed home from the Cape of Good Hope in 1766 in the company of the three-decker *Pallas* and of the *kuilschip Walenburg*, that had been built according to the Rotterdam/Delft modifications. He mentioned in his log that because of the poor performance of the *Walenburg*, the *Pallas* (and to a lesser degree the *Damzigt*) had to slow down for several days and had to steer a more downwind course to let the *Walenburg* catch up.⁴⁶⁸ Van Voors (master of the three-decker *Botland*) wrote that he had been able to beat against the wind to get his vessel into the roadstead of the Cape of Good Hope, a feat that was the more remarkable as he managed to do so in very strong winds, whereas vessels of a classic design could only perform such manoeuvres in much calmer conditions.⁴⁶⁹ Drawing on his own experiences during the months that he had been surgeon on board the 155 ft. three-decker *Europa*, Lombard argued that three-deckers were far less susceptible to take over large amounts of water during a storm, compared to “waisted” ships. Three-deckers were able to shed most (if not all) of the water that threatened to engulf the ship thanks to their continuous upper-deck, whereas in “waisted” ships huge amounts of water remained standing in the lower part of the deck, making the ships sluggish and unstable, often leading to the loss of rigging or even complete masts and in several reported cases causing the drowning of crewmembers below decks.⁴⁷⁰ To make his point more forcefully, Lombard quoted the numbers concerning the total loss of VOC *retourschepen* originally presented by Radermacher in the *Supplement* and compared these to the fact that of the ten three-deckers that had been built between 1763 and 1773, only one had gone down. In 1772, on its way to Canton, the *Rijnsburg* (the only three-decker of the second charter) had to cope with two typhoons in quick succession. On that occasion, alleged recklessness of the skipper (the gunports of the vessel had not been secured

⁴⁶⁸ According to the DAS website the *Walenburg* arrived on 26 June 1766 at Goeree, the *Pallas* on 26 July 1766 at Rammekens and the *Damzigt* on 27 July 1766 at Texel; this suggests that the *Walenburg* managed the voyage from the Cape to the Republic in two months’ time, which would have been remarkably fast. However as the ships were (according to Tomassen) still together on 7 July near the Azores, the date of arrival of the *Walenburg* must have been 26 July 1766.

⁴⁶⁹ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. 220-223

⁴⁷⁰ *Ibid.*, pp. 223-244

while battling the first typhoon and riding out the next typhoon behind its anchors) and insufficient knowledge of the South China Seas contributed to the wrecking of the ship.⁴⁷¹ Lombard's conclusion was that three-deckers were significantly better suited to the dangers of typhoons in the seas between Java, China and Japan. In fact, in 1773, the *Heeren XVII* had acknowledged this when they – in the same meeting when they decided to suspend the building of three-deckers – had stipulated that existing three-deckers should be used as often as possible on the routes to and from Japan.⁴⁷² Actually, from 1764 onwards, on average one three-decker (dispatched by the Zeeland chamber) sailed to Canton in the flotilla of four ships that travelled to China.⁴⁷³ Just as the route to Japan, the voyage to Canton led across the typhoon-ridden South China Sea. One almost gets the impression that the three-deckers were designed with the explicit purpose of mastering typhoons in mind.

Having argued that nautical considerations showed that the three-decker was the obvious choice for disciplining crew and mastering seas, storms and shores, Lombard went on to discuss the health issue. Following the wording of the question it was not a matter of coming up with a design for an ideal crew, but instead one had to consider which type of ship was most appropriate for transporting a healthy crew in as large numbers as possible and also which type of ship offered the best possibilities for accommodating a large number of sick crewmembers, and offered the best possibilities for their recuperation and for separating healthy crewmembers from the sick.⁴⁷⁴ This points to another way through which the crew needed to be disciplined, whereby the layout of the vessel had to assist in (re)arranging a great number of people for various purposes. Considering the case of a healthy crew, Lombard wrote that three-deckers were provided with a great number of hatches, grids and ventilation ports which provided ample ventilation on the

⁴⁷¹ Ibid., p. 224 (footnote f). At that fateful voyage the *Rijnsburg* was operated on behalf of the Amsterdam chamber. In the next chapter the going down of the *Rijnsburg* and the problems caused by inaccurate charts will be extensively discussed. The urgency of having the tea (that had already been bought) shipped to the Republic inspired L'Heureux and Van Braam Houckgeest, the chief of the VOC factory and the *supercarga* (chief merchant) in Canton at the time, to purchase a replacement vessel from the Portuguese governor at Macao. After a local refit, this ship – originally called *S. Simão* and renamed *Herstelder* – took the cargo destined for the Republic. See Mulder (1944), pp. 621-630, Liu (2007), p. 101-111 and Dyke, Paul A. van (2005/2007), p. 145; also <http://resources.huygens.knaw.nl/das/search> (“name of ship”= “herstelder” – results after 1772). The *Herstelder* remained in the service of the VOC and it made a number of return voyages until it was wrecked in the East Indies in 1783.

⁴⁷² NA 1.04.02/66 dd. 09.04.1773; also Loeve (2001), p. 38

⁴⁷³ Derived through <http://resources.huygens.knaw.nl/das/search>

⁴⁷⁴ Designs for a healthier crew have already been discussed in the preceding chapter.

two upper decks; in addition he argued in great detail that the ventilation (especially during wet and windy conditions) was far superior to that available on *kuilschepen*. It was therefore easier to maintain a flow of fresh air between decks, which aided the recovery of the sick. Lombard did not mention the use of ventilators, which is rather surprising given the fact that Udemans explicitly mentioned the repositioning of ventilators in his original proposal to the *Heeren XVII*.⁴⁷⁵ The existence of a completely covered upper-deck meant that a greater number of crew could be accommodated. Lombard provided a number of detailed calculations, the outcome of which showed that a 150 ft. *kuilschip* could accommodate 380 persons in total and a 140 ft. *kuilschip* a total of 326, whereas a 150 ft. three-decker could carry 520 persons in much healthier and safer conditions. In a footnote, Lombard mentioned that at the Cape of Good Hope he had even seen French and Spanish three-deckers (coming from Mauritius, l'Orient or Manielhas/Manilla) with crews numbering between 500 and 800, which were able to complete their journeys with only a small loss in numbers.⁴⁷⁶ The French probably used Triewald's system for ventilation, which – according to contemporary sources – was more effective than the ventilators used by the VOC.⁴⁷⁷ Whether that contributed to a better survival rate will probably forever be shrouded in mystery.

When diseases occurred on board, Lombard interpreted a three-decker as advantageous for a number of reasons. The first had to do with the fact that – in case of a great number of sick – the topmost of the two upper decks could be used as a large sickbay, effectively separating the sick from the healthy. At the time, the common opinion in the medical profession was that *nadeelige uitdampingen* (damaging effluvia) had the tendency to move upwards, which meant that in this way the lower of the two upper decks was kept free of these damaging forces. Lombard explained that the death toll on the maiden trip of the *Europa* in 1772/73 would have been far greater had it not been for the effective separation of the sick and the healthy. Two-thirds of the crew of 353 had been infected with a *rotziekte* during their stay at the *volkhouders*, and when the *Europa* left the roadstead at Rammekens for the open sea, already 54 of these had been confined to the sickbay.⁴⁷⁸ In addition, preventing the crew from getting wet was also much more easily achieved, as

⁴⁷⁵ This suggests that the resolution of 1746 regarding the use of ventilators was not always adhered to anymore, a state of affairs that was also implied by Bicker (1801), pp. 57-60. However, Thunberg's experiences (as mentioned in chapter 2) paint a different picture.

⁴⁷⁶ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. 260-266

⁴⁷⁷ Bicker (1801), pp. 20-21 and 58-59; see also the preceding chapter.

⁴⁷⁸ This *rotziekte* ("rotting disease") is the same disease as the *rotkoorts* that was discussed in the preceding chapter. In contemporary English it was known as hospital- or jail-fever. How Lombard came by the figure of two-thirds remains unclear; maybe he based it on the number of crewmembers that eventually fell ill.

he had already shown.⁴⁷⁹ Following Lombard's reasoning, by using vessels designed with a continuous top deck, the crew could be more effectively divided into two groups and separated (which was therefore safer for the crew that was still healthy) than was the case on a *kuilschip*. In addition to the safety from the elements offered by the three-deckers to crew and cargo, the new design was therefore also interpreted as an effective solution for the recurring health problems on the *retourschepen* of the VOC.

In a first appendix, Lombard argued that there ought to be no problem regarding the camels that were needed to ferry a 155 ft. vessel across the Zuyderzee. He pointed out that the Amsterdam admiralty owned camels that could accommodate vessels of different dimensions, allowing for a margin of up to 25 or 30 feet in length. In comparison, the extra 5 feet in length of a larger *retourschip* was almost negligible. He also calculated that the extra displacement of a 155-ft. vessel amounted to $25\frac{3}{4}$ last, whereas the extra weight in materials was $22\frac{1}{4}$ last, a positive outcome of $3\frac{1}{2}$ last, leading to a lesser draught than a 150-ft. three-decker. This calculation was identical to the one presented by Udemans as will be seen below. A second appendix concerned the presumed instability of three-deckers. One gets the impression that the debate about the assumed instability of three-deckers continued, despite the fact that five years earlier the Delft chamber had argued that the argument about instability was not valid.⁴⁸⁰ Lombard wrote that a small amount of extra ballast could easily counterbalance any increased instability caused by the extra weight of the upper deck. In addition, he remarked that in his experience some *kuilschepen* were even more unstable than three-deckers.

Willem Udemans Jr's illustrations

Udemans discerned two aspects within the original question. The first regarded the usefulness of ships regarding the preservation of life of those on board, which was - apart from health issues - predominantly related to the way ships were able to master adverse conditions. The second aspect was which type of ship was the most advantageous regarding the transport of commercial goods without damage. The opening sentences of his essay show a striking resemblance to those of his *Korte Verhandeling van den Nederlandsche Scheepsbouw*, written in 1757. This similarity might have given a clue about the identity of the anonymous writer of the essay. In 1757, he wrote

Shipbuilding and seafaring are the greatest and most prominent pillars on which the prosperity of our Republic is established, therefore it goes without

⁴⁷⁹ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. 275-287

⁴⁸⁰ As formulated in the Delft letter (dd. 15.03.1773) that was discussed in a meeting of the *Heeren XVII* on 9 and 10 April 1773 (NA 1.04.02/66).

saying that the building of ships is one of the most useful and most needed arts; because seafaring is nothing without shipbuilding and shipbuilding is nothing without seafaring (...) ⁴⁸¹

and twenty years later he remarked:

Shipbuilding and seafaring in the Netherlands are without any doubt, one of the greatest pillars on which its prosperity and wealth rest, implying that the art of shipbuilding is one of the most needed, useful and (...) very difficult arts (...). ⁴⁸²

In the years between 1757 and 1777, Willem Udemans Jr (1723-1797) had been assistant master shipwright at the VOC-yard at Middelburg from 1750 onwards, serving under his father who was master shipwright and building up his expertise. Together they had formulated the original proposal to introduce three-deckers. Upon the death of his father in 1780, Willem Jr succeeded him as master shipwright until the demise of the VOC in 1795; he also designed a number a ships for the Zeeland admiralty. According to a number of biographical sources, he was also an accomplished draughtsman and painter.⁴⁸³ The fact that Udemans illustrated his essay with two drawings by his own hand is not only testimony to his drawing skills but it also confirms remarks made by Shapin about how illustrations (expensive as they might be to produce) could play an important role to kindle the imagination and understanding of readers.⁴⁸⁴

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⁴⁸¹ *De Korte Verhandeling van de Nederlandsche Scheepsbouw, zo in Theorie, als in Practijk, Meetkunstig vertoond* (A Short Treaty on Dutch Shipbuilding, both theoretical and practical, geometrically shown) was published in 1757, dedicated to the directors of the VOC Zeeland chamber and printed by Pieter Gillissen who later also became the official printer of the *Zeeuwsch Genootschap*. The quote is on page 1 (“*De Scheepsbouw en Zeevaart de grootste en voornaamste zuilen zijnde, waar op de welvaart onzer Republiek is gevestigd, zoo is buiten tegenspraak, het bouwen van Scheepen eene der nuttigste en noodigste konsten; dewijl Zeevaart zonder Scheepsbouw, en Scheepsbouw zonder Zeevaart, niets is*”

⁴⁸² *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), p. 300 (“*De scheepsbouw, en de zeevaart der Nederlanden, onbetwistbaar, eene der grootste zuilen zijnde, waar op derzelver welvaart en bloey rust, zoo volgt ook dan daar uit, dat de scheepsbouwkunst eene der noodzakelijkste, nuttigste, en (...) zeer moeilijke konst is* (...)”

⁴⁸³ Nagtglas dl. 2 (1893), pp. 799-800, Hoving & Lemmers (2001), p. 111

⁴⁸⁴ Shapin (1984), pp. 491-492 discusses visual representations in a text by Boyle “.. the images imitated reality and gave the viewer a vivid impression of the experimental scene. (...) The images served to announce that ‘this was really done’ and that it was done in the way stipulated; they allayed distrust and facilitated virtual witnessing” (the quote is on p. 492)

When Udemans wrote about the health issue, his reasoning (although less extensive) was similar to that of Lombard, but he explicitly linked the health issue with technological details of his new design, referring to a drawing of the classic and of the new design (fig. 3.1 in this chapter). By pointing to details of the drawing, he explained how a three-decker offered more space for accommodating the crew; the design provided an extra fully covered deck while at the same time it remained possible (even in adverse conditions) to maintain better ventilation than was possible on a *kuilschip*. The extra room for the crew had the added advantage that it was possible to separate the sick from the healthy. On a *kuilschip*, a maximum of forty patients could be accommodated in the partly covered part of the *kuildek*, and then only in favourable conditions. Otherwise, separate accommodation for the sick might temporarily be achieved by letting the ship's carpenter construct a wooden partition across the *tussendeck* but such a separation could never be as effective as the separate decks on a three-decker. Udemans not only quoted the skipper J.S. Stavorinus regarding his (favourable) experiences with placing a large number of sick crewmembers on the upper deck of his three-decker, but also the "*beroemde scheeps opper chirurgijn*" (the famous chief ships' surgeon) *E. Lombaard*; therefore it is hardly surprising that his conclusions on the health issue were the same as those reached by that "famous surgeon".⁴⁸⁵

Udemans answered the questions about manoeuvrability and ability to sail close to the wind separately. First he considered manoeuvrability and argued (just like Lombard had done) that raising anchors was more easily performed on three-deckers because of the fact that the running rigging was operated from the continuous top-deck, whereas operating the anchors took place the second deck below the top-deck. This meant that the whole operation of leaving port was easier and more quickly performed than on a *kuilschip*: because when the anchors were being raised, the sails could simultaneously be made ready. Once ships were under sail, it did not matter much whether one sailed on a *kuilschip* or a three-decker, unless the conditions turned windy or even stormy. In that case, the superiority of the three-decker showed itself again. On a *kuilschip*, in those conditions the leeward side of the vessel was under water most of the time, which meant that operating the running rigging turned into an awkward (and possibly a quite risky) affair. On a three-decker however, even in a gale the top-deck remained dry, which made operating the sails much easier and safer. Considering the ability of ships to sail close to the wind to avoid a lee shore, Udemans first offered a rather theoretical argument. As the problem to sail free from a lee

⁴⁸⁵ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. 337-355. On page 351, Udemans mentioned that Lombaard was still employed by the VOC and that he had just left on a voyage to China. It is interesting to note that Lombard and Udemans referred to each other's work, while they took part in the same competition.

shore mostly occurred during unfavourable conditions, it was important that one was able to operate or change the sails quickly and - as he had just argued - in that respect a three-decker was far superior to a *kuilschip*. Udemans added that a *kuilschip* was more susceptible to drift to leeward because of the large area within the *kuil* (or waist) that was exposed to the wind. Using an experiential argument, Udemans (just as Lombard had done) quoted from the log held by skipper Thomassen regarding his experiences with the *Pallas*, the *Damzigt* and the *Walenburg*. Scathingly, Udemans added that one should not pay any attention to the *Walenburg*, as it was built to different specifications and therefore had an even more square and coarse bow than the former 145 ft. vessels that had been rejected by the VOC in 1742.⁴⁸⁶ The experiential proof, offered by Thomassen, supported Udemans's opinion that a three-decker was far superior in sailing close to the wind than a *kuilschip*.⁴⁸⁷

Adverse conditions such as storms and high seas not only caused the loss of many lives but also the loss of valuable cargo, wrote Udemans, and the ability of ships to withstand these conditions was therefore of great importance to society. Before discussing how three-deckers were better in coping with adverse conditions, Udemans first argued that the presumed disadvantages of three-deckers, a greater draught and a greater instability, were of no significance. Recognizing the problems that were presented by the shallows near Texel and Goeree (the roadsteads serving the other VOC-chambers), he stated that measurements on existing 150-ft. three-deckers had shown that their extra draught (when empty and compared to an empty *kuilschip* of the same size) was only one and a half inch and therefore negligible. On this matter, Udemans quoted his own measurements (the same that had been used by Lombard) to show that a 155 ft. three-decker had in fact a slightly lesser draught than a 150-ft. vessel of similar design. Udemans went to some pains to explain that the difference could not have occurred through a longer building time causing the wood to dry out. In addition he made some calculations on the extra weight of materials used and compared these to the extra displacement of the vessel, a calculation that showed that the extra displacement more than compensated for the extra weight. On the topic of instability, he argued that experience had shown that an extra ballast of nine last could compensate the extra weight of the complete upper deck (5¾ last). This extra ballast permitted to carry the same amount of sail as on a *kuilschip*. As a result, a fully laden three-decker had a draught that was four inches more

⁴⁸⁶ Ibid., p. 317. Udemans wrote “NB. Men moet het schip *Waalenburg* hier niet in aanmerking nemen, dewijl het naar een andere constructie was gebouwd, zijnde nog vierkanter en groover van boeg, als de oude Compagnies schepen van 145 voet, die in het jaar 1742 waren afgekeurd (...)”

⁴⁸⁷ Ibid., pp. 309-319. On the 1742 and subsequent changes, see Jong, Johan de (2010), chapter 3 and 4.

than that of a fully laden *kuilschip*, which, compared to the usual draught of twenty feet, he deemed not significant at all.⁴⁸⁸

Having dealt with these presumed disadvantages, Udemans went on to deal theoretically and experientially with storms and high seas. Referring to a drawing by his own hand (fig. 3.4), he described the problems faced by the crew on a *kuilschip* when sailing downwind and being hit by a storm. Taking down the sails in that situation meant that the ship could not avoid the breaking waves anymore, and as a result the *kuil* (waist) would become filled with water, the vessel would become top heavy and unstable and the risk of going down would become very real (as shown in the left hand side of the picture - *Figuur I*). The only remedy was turning the vessel against the wind (trying to reach the so called “laid to” position as shown in the right hand side of the picture - *Figuur II*), but then there was the risk that the vessel could not turn any further than with the wind on the quarter, which would only worsen the situation and lead to even more waves breaking into the *kuil*. To illustrate this point, Udemans quoted from the journal of skipper De Roo on the *kuilschip* *Bleyswyk*, who once had experienced great trouble in saving his ship during a storm and who lost nineteen crewmembers because they drowned below decks.

By contrast, in similar conditions a three-decker would shed most, if not all, of the water that came on board. In fact, the only reason why a three-decker would have to lay to was to prevent the windows of the aft cabins being shattered by the waves. Even the dangerous position with the wind on the quarter posed no great risk as (again) any waves breaking across the ship would easily be shed. That the theoretical considerations about the superiority of the three-decker design in this respect were borne out in practice was shown by quotes from letters written by the skippers Cornelis Pietersen (also spelled as Pietersz) and J.S. Stavorinus. They described how a three-decker was much more suited to riding out a storm than the *kuilschepen* they had skippered before. Stavorinus also commented on the superiority of three-deckers regarding health issues. A third letter written by skipper Van Es concerned a voyage to and from Japan, during which the three-decker *Stavenisse* proved to be superior in weathering typhoons and other less severe storms than its companion the *kuilschip* *Bleyenburg*. Considering its proven ability to master typhoons, it was probably no coincidence that between 1775 and 1779, the *Stavenisse* was exclusively used in the intra-Asian traffic, just as the *Europa* had stayed in Asia after its third outward voyage.⁴⁸⁹ Considering this experiential evidence, Udemans concluded that also in this respect, three-deckers were indeed far superior to *kuilschepen*.

⁴⁸⁸ Ibid., pp. 320-322

⁴⁸⁹ This can be inferred from <http://resources.huygens.knaw.nl/das/search> (“name of ship” = “Stavenisse”)

Fig. 3.4 A *kuilschip* on a downwind course during a storm (left-hand side / *Figuur I*) and on a course against the wind (right-hand side / *Figuur II*). Engraving after a drawing by W. Udemans Jr, published in *Verhandelingen uitgegeven door het Zeeuwisch Genootschap der Wetenschappen, Zevende Deel* (1780), inserted after p. 360

Udemans added a few remarks about other prejudices regarding three-deckers. The first was that the number of crewmembers accommodated on the upper deck would contribute to the vessel's instability. He refuted this by calculating that an extra ballast of five last would be more than sufficient to counteract the extra weight. The second prejudice concerned that the small boat had to be placed in a more elevated position than on a *kuilschip*. He argued that the small weight and the slightly higher location of that boat could have no effect whatsoever on the overall stability. His conclusion was clear: three-deckers were the obvious choice to increase safety, not only as *retourschip* between Europe and the East Indies, but even more so in East Asian waters. He immediately proceeded with the final sub-question on the extra cargo that could be loaded onto a 155-ft. vessel. Through theoretical calculations on displacement, Udemans concluded that an extra cargo capacity of almost 43 last (i.e. 86 tons) was attained, and experiential evidence showed that in 1776 the *Europa* had brought home an extra cargo of tea, measuring 25

last (i.e. 50 tons); a point that will be further discussed in the section on profitability.⁴⁹⁰

Radermacher's appendices

In addition to the two essays Radermacher had ten appendices added in the same volume of the *Zeeland Transactions*. Most of these consisted of letters or extracts from logbooks, covering the years between 1766 and 1779. The first appendix reiterated the earlier mentioned comparison between the three-decker *Pallas*, the (classic) *kuilschip Damzigt* and the re-designed *kuilschip Waalenburg*. Of this last ship it was mentioned that “on its next outward journey it came floating upside down towards the French island of Ouessand near Brest”, a remark that shows scant appreciation for the qualities of its design.⁴⁹¹ An interesting appendix is number eight, a letter by Cornelis Pietersz, master of the three-decker *Botland* and commander of the fleet returning from Batavia to the Republic in 1776/1777.⁴⁹² Pietersz wrote that the directors of the *Zeeuwisch Genootschap* had invited him to judge the three entries together with Radermacher and others.⁴⁹³ However, there is no evidence that Radermacher took part in the judging as the archives of the *Zeeuwisch Genootschap* only contain the letters of Pietersz and the five other judges.⁴⁹⁴ Pietersz explained that his considerations and advice were based on his experience as a sailor. He was very critical in his comments on the third entry, whose writer was not always in favour of three-deckers. Pietersz argued that the writer did not offer sufficient experiential proof, and whenever the anonymous writer found fault with three-deckers, Pietersz used

⁴⁹⁰ *Verhandelingen Zeeuwisch Genootschap, Zevende Deel* (1780), pp. 302-309

⁴⁹¹ *Ibid.*, p. 363: “by zyne volgende uitreis, het onderste boven aan het Fransche Eiland Ouessand over Brest is komen aandrijven”. In fact, the *Waalenburg* was wrecked on its third outward voyage; see <http://resources.huygens.knaw.nl/das/detailVoyage/95123>

⁴⁹² *Ibid.*, pp. 378-388. On Pietersz's voyage as commander, see

<http://resources.huygens.knaw.nl/das/detailVoyage/98789>

On this website Cornelis Pietersz is called Kornelis Pietersen; rather confusingly there are two skippers of that name in the same period. The Cornelis Pietersz meant here is the one sailing to and from Rammekens. To add to the confusion, on the website of the National Archives he is called Cornelis Pieterse. He originated from the German island of Zilt (Sylt), see Bruijn (2008), p. 59. Also

<http://vocopvarenden.nationaalarchief.nl/detail.aspx?ID=371919&gerepatrieerdmetschip=tr>

ue

⁴⁹³ For the name of the others, see the end of section 3.1. Udemans quoted an earlier letter by Pietersz in which Pietersz stated that he preferred three-deckers to *kuilschepen* (*Verhandelingen Zeeuwisch Genootschap, Zevende Deel* (1780), pp. 330-331)

⁴⁹⁴ ZA 26.1/62 contains these six letters, written to the directors of the *Zeeuwisch Genootschap* between March and May 1779.

his own favourable experiences to refute him.⁴⁹⁵ He found it hard to choose between the other two essays; in the end he preferred Lombard's essay because it answered the questions in the order they were posed and because Lombard offered his arguments and his proofs in a more general way.⁴⁹⁶

Mastering safety through a ship design

In the previous chapter it was argued that attempts to construct an ideal crew through a policy of strategically disciplining prospective crewmembers and the *volkhouders* who provided these people, did not meet with any significant success. Improving the unhealthy situation by introducing stricter regulations for *volkhouders* and through carrying out health checks on the crew prior to boarding the ships proved impracticable or impossible, to a large extent because the number of people needed for manning the ships of the VOC continually exceeded the numbers that could be supplied and controlled from within the Dutch Republic. Neither had the use of apparatus to improve the situation on board been very successful. The use of distillation machines to produce fresh drinking water from seawater had been discontinued after experiments at the turn of the eighteenth century and a short retrial in 1769 had not led to a lasting re-introduction. Ventilators to clean noxious airs were still routinely installed on board of the ships, but their use was apparently very dependent on the (sometimes reluctant) cooperation of the skippers in charge – so much so that the use of ventilators during homebound voyages was formally abolished in April 1772 (in the midst of the on-going discussions about the health problems) and that in March 1791 ventilators were completely abolished. The measures introduced by the VOC to improve the health situation relied heavily on a policy of extensive prescriptions to skippers and officers. One gets the impression that one of the arguments that was used in favour of the new design was its ability to assist in disciplining the crew and their communal health while *en route* to the East Indies. This became clear from remarks made by Lombard about the superiority of the three-decker design in controlling and disciplining the crew. One point stressed by him was that the design, consisting of three complete decks, made it possible to divide the crew in spatially different layers. This meant that when the need would arise for separating the sick from the healthy to prevent contact

⁴⁹⁵ Possibly the anonymous writer was Laurens Hauteppen (or Houtepen) who had skippered the *Vosmaar*, which was used as an example in the third essay. Pietersz had been skipper on the same vessel but was not impressed by the way it behaved. Anthonie Leertouwer had also skippered the *Vosmaar*, but he cannot have been the writer, as he had died in Batavia on 8 March 1771. See <http://resources.huygens.knaw.nl/das/search> ("name of ship" = "vosmaar") and <http://vocopvarenden.nationaalarchief.nl/detail.aspx?ID=1111202>

⁴⁹⁶ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), pp. 378-388

between these two layers, the new design offered obvious advantages over the classic design. His second point was that the design allowed a better view of the ship itself and of the activities of the crewmembers that were on duty and their whereabouts. It was much more difficult than on a *kuilschip* to escape the watchful eyes of the officers.

In their arguments related to the safety of *retourschepen*, seen from a nautical perspective and a health perspective, Lombard and Udemans used experiential evidence to show that it was possible to combine in one design a more seaworthy and healthier ship. By concentrating on the ships and the experiences of those who sailed on these ships, both writers showed that these two aspects could go hand in hand. The design had the added bonus (as will be shown in next section) of being more profitable. However, we should remember that protagonists like Udemans, Radermacher and Lombard had to make their point repeatedly over a number of years; as was said in the introduction to this chapter, one cannot assume that the design and construction of a supposedly superior artefact will be accepted without any resistance, even by those who will be in a position to reap the dividends of this new artefact. In the gradual process of acceptance, users mattered (as became clear from the experiences of skippers and surgeons) and the artefact itself mattered, because it allowed Udemans, Lombard (and Radermacher) to produce experiential proof of the soundness of the new design, regarding the aspects of health, of nautical safety and of profitability. In his role as director of the VOC Zeeland chamber, Radermacher had been the first to use these experiential arguments in his *Supplement*; Lombard and Udemans renewed and refreshed these arguments in their essays for the *Zeeuwsch Genootschap*, transferring them to the level of neutral and trustworthy societies. This then showed that knowledge (as “spokesperson” for a network of humans and non-humans) mattered; through the arguments developed in the *Transactions* of the society this knowledge became publicly accessible. The new knowledge was the more powerful as it was based on experiential evidence and it had passed the test of being awarded a prize in a competition. The judging had been done by persons of authority, whose identity was unknown to the writers and who didn’t know the identity of the writers either; therefore the refereeing was in the double sense of the word carried out anonymously. The authority of the referees rested on three pillars, not only were they high ranking experienced seamen or a medical doctor, they also belonged to the higher echelons of society and three of them were members of the society. This procedure, which was current practice in (Dutch) societies at the time, was meant to safeguard the disinterested character and authority of prizewinning texts.

3.3 The pursuit of profitability

The three-decker also promised to be advantageous regarding a third objective: it offered more space for commercial goods on the homeward journey and could thereby contribute to the profitability of VOC's trade. Whether the three-decker had indeed the power to deliver that objective will be discussed in this section. We follow Lombard and Udemans in the arguments they developed on the profitability of the three-decker. This means that their experience-based reasoning concerning VOC's trade (and in particular the Canton-based tea trade) takes centre stage; the issue of profitability will be considered from their contemporary perspective. The VOC did not enter into the business of ship design and shipbuilding for its own sake, but it did so with the explicit purpose of facilitating its trading activities; it is therefore not surprising that the aspect of trade was explicitly mentioned in the questions formulated by Radermacher.⁴⁹⁷ During the two centuries of its existence, the VOC tried to establish, maintain and – if possible - enlarge a monopoly on the international spice trade and to increase its grip on the intra-Asian trade. During the late seventeenth century, changes in taste and fashion caused an increased demand in Europe for Asian textiles and for coffee and tea. In the decades around the turn of the seventeenth and eighteenth century, the VOC expanded its fleet of *retourschepen* to more than twice its original size in order to respond to these increasing demands; partly also because the new types of merchandise needed relatively more space on board than the classic produce such as pepper and spices.⁴⁹⁸ The company could afford to build the new ships because it could borrow money against low rates. That seemed to prove a point made at the time by Josiah Child, director of the English East India Company and writer on economic subjects, who argued that the promotion of shipping and low interest rates (such as occurred in the Dutch Republic) were among the main causes of prosperity.⁴⁹⁹ However, from the end of the seventeenth century onwards, the VOC had to compete with an increase in trade and shipping by other European powers, especially to the

⁴⁹⁷ One should note that the (English) East India Company pursued a different policy in that it rented its ships from private ship-owners and (after its initial years) was not engaged in shipbuilding activities of its own.

⁴⁹⁸ Vries, Jan de & Woude, Ad van der (1995/2005), pp. 509-510

⁴⁹⁹ Vries, Jan de & Woude, Ad van der (1995/2005), pp. 507-509; Child (1668) "Fifthly, Their contriving and building of great Ships to sail with small charge, not above one third of what we are at, for Ships of the same Burthen in England; and compelling their said Ships (being of small force) to sail always in Fleets, to which in all times of danger they allow Convoy" (...) "Lastly, the lowness of Interest of Money with them." However, Child's remarks regarding "the small charge" cannot have applied to the number of sailors on board of the ships of the VOC but must have been related to the ubiquitous *fluyts*

Asian continent. Whereas the VOC had succeeded in establishing a monopoly on the spice trade from the East Indies, it had not been able to do so regarding the trade with the Asian continent. According to the historian Liu, the effect was that the VOC lost part of its grip on the profitable intra-Asian trade. The fact that many VOC officials in the East were liable to corruption and involved in private trade did not help in reversing these unfavourable developments either.⁵⁰⁰ There seems, however, to exist no unanimity among economic historians about the absolute and relative importance of the intra-Asian trade. De Vries and Van der Woude have suggested that in the closing decades of the seventeenth century increasing restrictions on the trade in gold and silver from Japan resulted in a sharp decrease in the profitability of the intra-Asian trade, and that the result of this trade did not improve during the eighteenth century. One of the effects of these trading restrictions was that the VOC needed to transfer large amounts of silver to Asia instead of being able to rely on Japanese silver for the partial financing of its Asian trade; the only valuable metal that still could be exported from Japan was copper.⁵⁰¹ On the other hand, the historian Shimada claims, “Japanese copper won itself an unassailable position as a significant commodity in the intra-Asian trade of the VOC”.⁵⁰² On a more general level, the historian Steur suggested that until 1765, the volume of the intra-Asian trade actually increased compared to the trade between Asia and the Republic.⁵⁰³ As we will see later, current day interpretations of the profitability of the tea trade in particular diverge in a similar way. This reinforces the idea that one should follow the arguments of contemporary eighteenth century writers instead of twentieth or twenty-first century commentators, the more so as this section is not meant as a commentary on specific eighteenth century economic subjects, but instead tries to assess (without prejudice) contemporary commercial arguments used at the time for the promotion of a new ship design.

Profitable tea transactions

Mirroring the expansion of the fleet in the late seventeenth and early eighteenth century, from 1742 onwards the VOC embarked again on an impressive program of renewal of its fleet, using the innovation of measured drawings as a means to establish increased standardization.⁵⁰⁴ The VOC had

⁵⁰⁰ Liu (2008), p. 39. The fact that (excessive) private trade may also have been an underlying cause in the abolishment of distillation apparatus was described in the previous chapter.

⁵⁰¹ Vries, Jan de & Woude, Ad van der (1995/2005), pp. 506-508

⁵⁰² Shimada (2005), p. 167

⁵⁰³ Steur (1984), p. 26

⁵⁰⁴ Jong, Johan de (2010), chapter 3 and 4

no problems in finding enough artisans and workers to operate its shipyards and warehouses in the Republic.⁵⁰⁵ This stood in sharp contrast to the problems the VOC had in securing the large numbers of common sailors and soldiers, needed for the operation of its fleet and for the expansion and protection of its factories overseas. That led to what (in the first chapter) has been called two different classes of employees, on the one hand a class of almost invisible dispensables such as soldiers and common sailors, and a class of highly visible indispensables such as merchants, officers, artisans and officials.⁵⁰⁶ As was explained in the previous chapters, the majority of the soldiers and a large number of the common sailors did not survive their stay in the East Indies, could therefore not enter into the service of the VOC again and had to be replaced on a continuous basis to have a sufficient number available of soldiers for the protection of VOC's land-based interests and of crewmembers for the running of VOC's shipping activities between the Republic and the East and within the East Indies. As was shown in the second chapter, the continuous demand for new personnel was by contemporary writers interpreted as the main cause of the health problems on the *retourschepen* confronting the VOC in the early 1770s. Suggestions for a different approach to employing crewmembers could (as we saw) not be effectively implemented and so (as was argued above) a different ship design might be able to (at least partially) mitigate the health problems. According to its protagonists, this design could also have a positive effect on the amount of trade goods that could safely be shipped from the East to the Republic. Two reasons were given; first, the new three-decker design was interpreted as safer in the local conditions in the seas between the East Indies, China and Japan, second, the amount of cargo (especially voluminous cargo) that could be carried was larger.⁵⁰⁷

The ability of ships to carry a larger volume of trade became increasingly important as a growing part of VOC's trade consisted of tea, which took up a relatively large volume compared to its weight. From 1756 onwards, the VOC had introduced a system whereby tea was directly bought in Canton (China) and shipped back to the Republic, instead of the former system whereby tea – shipped by junks to Batavia – was indirectly purchased via Chinese merchants in Batavia. The new system operated under the auspices of a separate *Chinasche Commissie* (China Committee), which had been set up by the *Heeren XVII* with the task to organize and supervise a direct

⁵⁰⁵ Vries, Jan de & Woude, Ad van der (1995/2005), p. 535-536, Jong, Johan de (2010), pp. 90-97

⁵⁰⁶ Jong, Johan de (2011), p. 198

⁵⁰⁷ Moreover, the experimental 155-ft. three-decker could not only carry a more voluminous but also a heavier payload.

Fig. 3.5 View of the foreign factories at Canton (drawing by William Daniell, approximately 1785); the Dutch VOC factory can be seen at the righthand side of the picture http://upload.wikimedia.org/wikipedia/commons/8/82/Canton_factory_site.jpg

tea trade.⁵⁰⁸ This meant that the High Government in Batavia was almost completely bypassed, thereby preventing officials from Batavia and elsewhere to make private profits from the China trade, which they and many company officials in the East Indies continued to do in all other areas and trades. The only role that Batavia had to play was to see to it that Asian merchandise destined for Canton – such as pepper and tin – were brought onto the *retourschepen* when the ships made a stop in Batavia to let all of the soldiers and part of the sailors disembark and to have small repairs carried out. In case not all ships destined for China arrived on time in Batavia, the High Government had to provide a replacement vessel so that the Chinese tea (and other commodities) could be shipped to the Republic in time. On their return voyage, the Canton flotilla sailed straight for the Republic, bypassing Batavia completely and only making the compulsory halfway stop at the Cape of Good Hope. In addition, the *cargas* (merchants) in Canton were more strictly controlled than those in the rest of Asia.⁵⁰⁹ The combination of voluminous

⁵⁰⁸ Jörg (1978/1982), pp. 34-45 and Liu (2008), chapter 1

⁵⁰⁹ The *Chinasche Commissie* had drawn up highly detailed instructions for all members of staff in Canton; at the Cantonese factory decisions on trade matters had to be taken in a meeting of the director and all merchants, a formal resolution had to be drawn up with the reasons behind the decision and in case of a majority decision with explicit reference to opinion of the minority. The staff at Canton had to produce extensive reports on the trade that had been carried out, had to stick to a meticulously prescribed and very detailed system of bookkeeping and – on return in the Republic – they had to wait on board until they were given permission to leave without taking any luggage with them. Their belongings and

commodities and the typhoon-infested waters of the South China Sea seemed ideally suited to the new three-deckers. In addition to the earlier mentioned multi-layered usability of the three-deckers regarding the disciplining of humans and the mastering of nature, Lombard showed experientially that the three-decker could also be a powerful tool in improving the profitability of VOC's direct tea trade. Through theoretical calculations on displacement, Udemans had already concluded that the 155 ft. three-decker offered an extra cargo capacity of almost 43 last (i.e. 86 tons); according to him, evidence showed that in 1776 the *Europa* brought home an extra tea cargo of 25 last (i.e. 50 tons) as compared to a 150 ft. vessel.

The remarks made by Lombard on the subject of the extra cargo capacity of a 155 ft. three-decker were much more extensive. He gave details about a flotilla of four ships that had sailed to and from Canton in 1775/1776. The incoming trading goods from all ships (almost exclusively originating from Batavia) were delivered at the Dutch factory on the same day (19 September 1775) which suggests that the ships arrived together.⁵¹⁰ Lombard did not mention letters or journals written by skippers, so one gets the impression that he quoted from personal experience. This all the more likely because this *oppermeester* (first surgeon) on the *Europa* was also actively engaged in observing the way the tea was packed and in experiments to establish what caused the deterioration of the (cheaper) teas *en route* to the Republic.⁵¹¹ The ships concerned were the *Europa*, which was loaded with a

luggage were examined at the premises of the VOC before it was handed back to them. In case of irregularities it was confiscated. These detailed instructions are to be found in NA 1.04.02 /4543 dd. 10.10.1759, see also De Hullu (1923), passim & Liu (2008), pp. 26-34.

⁵¹⁰ Liu (2008), pp. 189-190 (appendix 2). The *Indiaan* carried *polemierten* (a woollen cloth produced in the Republic) and the *Indiaan* and the *Europa* carried some lead (which also came from the Republic). The rest of the merchandise destined for Canton (such as tin from Bangka, pepper and other spices) had been loaded onto the ships at Batavia. In addition the four ships brought bullion and coins from Europe to Canton to the value of almost 0.84 million guilders. The *Morgenster* had not sailed directly from the Republic but had joined the flotilla in Batavia as a replacement for the *Huis te Spijk*, which had apparently left the Republic too late to arrive in time in Batavia (Jörg (1978/1982), Appendix I, p. 199). The *Morgenster* had arrived in Batavia as early as 13 December 1774, so it may have been engaged for some time in "local" traffic in the East Indies. For details, search under the ship's names at <http://resources.huygens.knaw.nl/das/search>

⁵¹¹ Lombard wrote an essay about his observations and experiments *Verklaring over de oorzaak van het bederff, 't welk de thee Congo en mindere soorten, tot de thee Boeij toe, dikwils ondergaat met het vervoeren van China tot in Nederland, en dan aanwijzing der meest geschikte middelen, om dit bederff te voorkomen* (Explanation of the causes for the deterioration that often occurs in the case of Congo tea and lesser sorts up till Boeij tea during transport from China to the Netherlands, followed by an indication of the most suitable means to prevent this deterioration). This essay was apparently written around

return cargo of 1,053,617½ *pond*. The 150 ft. *Morgenster* carried a load of 946,738½ *pond*, the similar-sized *Indiaan* a cargo of 978,916 *pond* and the 140 ft. *Jonge Hugo* took 769,138¼ *pond*.⁵¹² The cargo of the *Europa* was therefore almost 53 tons (i.e. 11 %) more than that of the *Morgenster*, almost 37 tons more than the *Indiaan* and over 140 tons extra compared to the *Jonge Hugo*. Somewhat confusing is Lombard's remark that – compared to the *Jonge Hugo* – the *Europa* had loaded approximately 71 *last* (i.e. over 140 tons) extra plus also 53 ordinary cases of porcelain, six cases of Nanking linen, eleven cases of silk cloth, 145 bundles of porcelain and 50,000 *pond* (almost 25 tons) extra ballast. That would imply – over and above the extra amount of tea – an even larger increase in carrying capacity compared to ships of the usual design. The draught of the *Europa* after loading was (fore) 21½ feet and (aft) 22½ feet, that of the *Morgenster* 20¼ and 22 feet. This suggests that the *Europa* was more evenly loaded and shows that the predictions of Udemans were vindicated as it turned out that this large three-decker had a draught that was only slightly larger than that of the vessel of classic design while carrying a significantly larger payload. Lombard made no mention about the draught of the other two vessels, which may be explained by the fact that the *Indiaan* and the *Jonge Hugo* left the roadsteads near Canton already on 18 October 1775, whereas the *Morgenster* and *Europa* did not leave until 10 January 1776.

When we compare Lombard's figures with those given by Udemans, the differences are small; theoretical calculations by Udemans showed an extra cargo capacity of 43 *last*, whereas in practice it turned out to be between 37 and 53 *last*, an average of 45 *last* therefore; apparently, Udemans got his predictions right. A puzzling thing is that in his essay Udemans mentioned an extra tea cargo of 25 *last* for the *Europa* as compared to a 150 ft. vessel. How Udemans came by that figure is not clear, as the *Europa* was the only ship that returned to Rammekens (for the Zeeland chamber), the other ships calling at Texel (for the Amsterdam and Enkhuizen chambers). Udemans would therefore hardly have been in a position to establish the extra tonnage, let alone the extra amount of tea that was carried, as compared to the other ships. Looking at the value of the cargo (although not mentioned by Lombard in his essay), one sees that the *Europa* carried goods to the value of 644,352 guilders, the *Morgenster* of 597,349 guilders, the *Indiaan* of 577,632 guilders and the *Jonge Hugo* of 444,196 guilders.⁵¹³ The auctioning of the teas alone in

1780, based on his experiences in 1774 and 1776. The essay ended up in England when the English took the VOC vessel *Parel* in 1781. Cf. Blussé, L. (2013), *passim*

⁵¹² The (Amsterdam) *pond* equalled 494 grams
(<http://www.meertens.knaw.nl/mgw/maat/263>)

⁵¹³ The values can be found on <http://resources.huygens.knaw.nl/das/search>; for the *Europa* see voyage 7956, for the *Morgenster* [voyage 7957](#), for the *Indiaan* voyage 7943, for the *Jonge Hugo* voyage 7942.

the Republic produced a result of 2,789,411 guilders.⁵¹⁴ As this figure did not include the profits made in Canton on the sale of the incoming cargo (such as pepper and tin) and the profits made in the Republic on the sale of other goods from China, such as porcelain, linen and silk, the total result must have been better still. In these figures, profits that were made through private trade are left out of the equation, but then these profits did not contribute to the results of VOC and its chambers. Moreover, as was explained above, the trade to and from Canton was regulated in such a way that private trade was a rather marginal affair compared to what happened elsewhere around the factories of the VOC.

Stretching ships and profits

Lombard wrote that, if the whole flotilla had consisted of 155-ft. vessels, they would have been able to bring home “*eene importante, meerdere aanbrenging*” (an important extra cargo) of more than 465,055 *pond*, or 116¼ last (about 230 tons) in tea. However, Lombard did not mention the extra costs involved in building, equipping, manning and maintaining these larger ships, but then the VOC did also not consider the depreciation of the value of the ships when calculating profits. The cost of building or repairing ships was calculated under the heading of *equipage*, which meant that it was regarded as a one-off within the total cost of equipping a fleet.⁵¹⁵ One also gets the impression that – at least in the case of the four ships mentioned by Lombard – the size of the crew bore no direct relationship to the size of the ships; the three ships of the first charter had a crew of 105 sailors (*Europa*), 95 sailors (*Indiaan*) and 110 sailors (*Morgenster*), the *Jonge Hugo* of the second charter was manned by 95 sailors. This meant that the larger *Europa* did not require a larger crew than smaller ships and could therefore be considered relatively cheaper to operate.⁵¹⁶

⁵¹⁴ Based on Liu (2008), p. 231 (Appendix 6 / 31 May 1777 [for 1774-77])

⁵¹⁵ In 1763, Udemans had calculated that building a three-decker of 150 ft. involved an extra cost of 2000 guilders compared to a *kuilschip* (NA 1.04.02 / 58 dd. 03.11.1763). In 1788, Van der Hoop calculated the cost of a fully equipped vessel of the first (150 ft.) charter at 200.000 guilders; in 1793 Udemans calculated the building costs of the hull at 150.000 guilders, plus 34.000 guilders for mast, sails etc. (Dillo (1992, Bijlage 9 and 10). For the VOC policies, see Gaastra (2001/2007), p. 158

⁵¹⁶ Figures retrieved through <http://resources.huygens.knaw.nl/das>. The first person who explicitly took the size of the crew into account when calculating costs was Udemans in his 1793 comparison of costs between *retourschepen* and *pinkschepen*; this comparison is published in Dillo (1992), Bijlage 9. A *pinkschip* was specifically designed to carry freight; compared to a *retourschip*, it was cheaper to build and it could be operated by a much smaller crew.

Graph 3.1 Value per ton cargo, originating in Batavia, Ceylon and Canton (at five year intervals). Instead of 1790, the year 1791 has been used because of incomplete values on the DAS website about the Canton and Ceylon trade for the year 1790. No values are available for the Canton trade of 1735 and 1795 because in those years no ships left Ceylon for the Republic.

Cargos from China consistently had a considerably greater value than those originating in Batavia or in Ceylon, which cannot have gone unnoticed at the time.⁵¹⁷ When considering the value of cargos shipped from Batavia, the historian Gaastra showed that the value fell rather sharply during the course of the eighteenth century.⁵¹⁸ Looking more in detail, one sees that this was not caused by a decrease in the tonnage or volume of trade but by a decrease in the value per ton. In graph 3.1, the value per ton is represented for the Batavia

⁵¹⁷ Looking at the vessels that left Canton in 1775/1776, we can see that in 1779 and 1784, the *Morgenster* took cargos from Ceylon, valued at 438,164 guilders, resp. 433,848 guilders, which was below the value it took from Canton earlier; in 1778/9 and in 1781, the *Indiaan* travelling from Batavia had cargos valued at 173,798 guilders resp. 133,785 guilders, in 1778/9, the *Jonge Hugo* carried a cargo from Batavia to the value of 109,089 guilders. Both ships had on those occasions a cargo that was far less valuable than the one they took from Canton. On the *Morgenster* see <http://resources.huygens.knaw.nl/das/search>, voyage 8040 and 8108; on the *Indiaan* voyage 8020 and 8078; on the *Jonge Hugo* voyage 8019. The *Europa* only made two return voyages from China; from 1779 until it was wrecked in 1784, it was used exclusively in the intra-Asian traffic.

⁵¹⁸ Gaastra (2001/2007), p. 135 - Tabel 19 (in the heading “honderdduizend” must be read as “million”)

trade, the Ceylon trade and the Canton trade between 1730 and 1795; 1730 being the first year that a *retourschip* sailed from Canton to the Republic and 1795 being the last year that VOC ships left from the East Indies and China for the Republic. One sees that the value per ton in the Canton trade fluctuated between 500 and 600 guilders per ton over the whole period, if anything increasing in value as time went on; against that stands a rather sustained fall in the value of the Batavia trade, from 350 guilders per ton to 119 guilders per ton. The value of the Ceylon trade fluctuated rather strongly; starting from 100 guilders per ton in 1730 (way below the Batavia value) it went up to 400 guilders in 1750 and then after some ups and downs it ended at 200 guilders in 1791, almost one and half times as much as the Batavia value. In 1730 the value per ton in the Canton trade was just two times as much as in the Batavia trade and about four times as much as the Ceylon trade. By 1791/1795 the Canton value was more than five times as high as the Batavia value and three and a half times as high as the Ceylon value.⁵¹⁹ It should therefore come as no surprise that Ezechiël Lombard – writing in the late 1770s - was of the opinion that the direct tea-trade from Canton was a valuable asset for the VOC, seeing that at that time it was three to four times as valuable as the Batavia trade. A decade earlier in the 1760s, Isaac de Pinto (writer of stage-plays and of economic treatises) had compared the East India trade with other sources of income in the Republic. The economic historian Jonathan Israel quoted him as saying that

(...) every one of the main props of the Dutch Golden Age economy - long-distance trade, Baltic commerce, the herring and whale fisheries, and industry - had been largely ruined, the only exception being the still flourishing East India traffic (...).⁵²⁰

If one looks at what De Pinto actually wrote, one sees that he argued that two pillars (and not just one as Israel suggested) remained to sustain the Dutch economy: “The exclusive spice trade, and the herring fishery, are the only advantages she has left for her preservation, and to support her in that commerce, in which she meets with competition.”⁵²¹ Whether Pinto was aware

⁵¹⁹ See appendix E, which gives the value per ton for merchandise from Batavia, Ceylon and Canton for the years 1730 at five years intervals until 1795. Numbers are based on <http://resources.huygens.knaw.nl/das>. Instead of 1790, the year 1791 has been chosen because on the DAS website almost all values for the Canton and the Ceylon trade are missing for the year 1790.

⁵²⁰ Israel (1995/1998), p. 1002

⁵²¹ This is the contemporary English translation of De Pinto (1774), p. 199. The original quote is in De Pinto (1771), p. 242: “*Le seuls avantages qui lui restent pour sa conservation & pour soutenir le commerce du concurrence, c’est le commerce exclusif des Epicerie & la pêche du Hareng*”

of the profits from the Chinese tea trade remains an open question. Whereas the returns of the spice trade kept diminishing, the tea trade remained a stable and profitable business of which people at the time were aware, and which can still be reconstructed today.

There has been extensive debate about the pros and cons of the direct tea trade in which the VOC engaged during the eighteenth century. According to De Vries and Van der Woude, the new trade in textiles, tea and coffee was not as profitable as the trade in spices, causing a decline in profits for the VOC.⁵²² However, their figures show per decade the gross profit margins on all goods sold by the VOC compared to the gross profit margins on all goods of the China trade;⁵²³ they compare the index of profitability (defined as the proportion between the relative portion of a good in the total sale value compared to the relative portion of the same good in the total purchase value) related to diverse categories of goods with the index of profitability for all goods of the China trade; and – moreover - this last comparison only presents figures for a restricted number of years (1648-1650, 1668-1670, 1698-1700, 1738-1740 and 1778-1780).⁵²⁴ That makes it quite difficult to get an accurate picture regarding the profits of the tea trade as such. Nevertheless, their conclusion seems to be that it would have been more profitable for the VOC to concentrate on its original trade in spices. Against this, the historian Steensgaard has argued that “the spices remained an important part of the business of the VOC, perhaps most importantly in the trade within Asia, but in the trade to Europe it was a trade with a small potential for growth”.⁵²⁵ Steensgaard also remarked, “the *Heeren XVII* estimated the annual Dutch and English company requirements for pepper at 7.2 million *pond*”. He added that the combined total pepper import of the two companies hardly changed until the middle of the eighteenth century. He suggested that an expansion of the pepper imports made no commercial sense as “the market had reached a point of saturation already in the seventeenth century”.⁵²⁶ In addition, one should consider that, even if the European pepper trade - one of the mainstays of the VOC – would have been still flourishing, the volatility in the supply of pepper was such that the amount of pepper available could suddenly be halved from

⁵²² Vries, Jan de & Woude, Ad van der (1995/2005), pp. 510-512

⁵²³ Vries, Jan de & Woude, Ad van der (1995/2005), p. 504 (Table 10.4.1)

⁵²⁴ *Ibid.*, p. 511 (Table 10.4.2)

⁵²⁵ Steensgaard (1990), p. 121

⁵²⁶ Steensgaard (1990), p. 120

Fig. 3.6 The weighing of a chest of tea in Canton around 1770. On the chest (also on those in the background) the insignia of the Amsterdam chamber of the VOC is visible. To the left a group of three Dutch merchants; behind a table a Dutch and a Chinese clerk note down the results. Gouache by an anonymous Chinese artist. (Rijksmuseum Amsterdam NG-1981-12-A)

one year to the next. It would therefore have been a risky affair to put all one's cards on an expansion of the European pepper trade. The volatility was not only brought about by natural causes such as "prolonged draught, heavy rainfall, earthquakes or elephants" but also by the complications involved in the "politico-military support for local rulers."⁵²⁷ A possibility to circumvent the problem of this unpredictability might have been to build up a pepper supply of several years' worth (which would have been a complicated affair anyway) but that would have entailed tying up large amounts of money in supplies. Despite all these difficulties, the average amount of pepper shipped to the Republic remained fairly constant at an average of 4.5 million *pond* a year.

One gets the impression that, to compensate for the losses run up in the intra-Asia trade and for the unpredictable pepper trade, the VOC tried to diversify into new and promising produce and products. It seemed to make good sense to engage in the trade in new fashionable commodities even if that trade might have been somewhat less profitable than the classic trade, as the alternative would have been to leave that part of the market to foreign (predominantly French or English) competitors. A convenient spin-off of the tea trade was that the experienced downturn in the intra-Asian pepper trade could be compensated by shipping large amounts of pepper to Canton to partly finance the tea trade; the profit made on pepper in Canton amounted to 200%.⁵²⁸ However, the most important commodity sold in Canton was tin; this metal was in great demand in China, partly for use in daily religious ceremonies and partly used as foil for lining the tea chests in which the tea was exported abroad. By using tin and pepper (and small quantities of other fine spices) as intermediate commodities that were procured cheaply in the East Indies and were in great demand in Canton, a large saving could be had on the amount of precious metals that otherwise would have to be shipped from the Republic.⁵²⁹ The exchange of South East Asian goods for Chinese tea contributed much to the continued success of VOC's tea trade, and this makes it understandable why Lombard made his remarks on the profitability of the Canton trade, that of tea in particular.⁵³⁰ Against later interpretations of a steady downturn in the fortunes of the VOC in the second half of the eighteenth century, it is interesting to note that quite different opinions were voiced at the time. Moreover, the tea trade with China was largely taken out of

⁵²⁷ Jacobs (2000), pp. 58-59

⁵²⁸ Jacobs (2000), pp. 71-72; Liu (2008), pp. 47-48

⁵²⁹ On tradeable commodities, see Liu (2008), pp. 44-47

⁵³⁰ Liu (2008), p. 63; Jörg (1978/1982) p. 38 (note 119) mentions that the gross profit on goods taken to China from Batavia (such as pepper, spices, tin etc.) produced a profit of 80 to 100% (well below the 200% for pepper as mentioned by later authors) whereas cloth and silver from the Republic only yielded a small profit.

the hands of intermediate local factors in Batavia and elsewhere in Asia, and the VOC merchants in Canton were controlled directly from the Republic, bypassing the High Government in Batavia and thus reducing the possibilities of employees to make personal profits. Of course, calculating profits at the time was not a straightforward process because such calculations were made from different perspectives (depending on whether it concerned Amsterdam, Batavia, smaller factories such as Canton or individuals) and this led to a complex system of decision-making – as we saw above, even in hindsight economists arrive at quite different conclusions about the profitability of VOC's trade.

The contemporary observations and opinions of Lombard and Udemans are confirmed through recent research; re-examination of available evidence has pointed to a more positive interpretation of VOC's tea trade than had been previously the case. Jörg (1978/1982) and Liu (2008) showed that the direct tea trade was more profitable than the trade in other products. Jörg wrote that until the fourth Anglo-Dutch war broke out in 1780, the tea trade was a "thriving state of affairs", partly thanks to the profits made by smuggling teas from the Republic into England (in which especially the Zeeland chamber of the VOC participated). Liu's research led him to conclude, that "between 1757 and 1781 (...) the VOC profited from the Chinese tea trade for as long as twenty-three years without a break (...) making a gross trading profit of 94 per cent on average". Liu suggested that "tea was the easily the most profitable product in which the VOC dealt in the second half of the eighteenth century (...)." ⁵³¹ He mentioned that not all chambers took part in the tea trade every year, but if we take a look at the auctions that were held by the chambers after the introduction of the direct tea-trade (i.e. from the late 1750s onwards) we see that the Zeeland chamber always played an important part in that trade (in some years even surpassing Amsterdam in the value of tea that was auctioned). ⁵³² When we consider the numbers given by Liu (concerning the years of the direct tea trade), it emerges that 56% of the proceeds of the tea trade was generated by the auctions in Amsterdam, 31% by those in Zeeland and the rest by the other chambers. ⁵³³ The larger chambers therefore took

⁵³¹ Liu (2008), p. 142 and pp. 145-146

⁵³² Ibid., p. 120 and Appendix 6

⁵³³ These auction proceeds are given in Liu (2008), Appendix 6 (Delft obtained 2.7%, Rotterdam 3.6%, Enkhuizen 2.4% and Hoorn 4.1%). Comparisons have been made starting with the year 1762 (the first ship taking part for Zeeland in the direct China tea trade arrived in *patria* in June 1761, which means that the result of the auction is mentioned under 1762 by Liu) and ending with the year 1788 (according to *Memorieboek Pakhuismeesteren* (1918), p. 56 from the autumn of 1788 onwards all tea from the warehouses of the different chambers was auctioned in Amsterdam, so it is impossible to ascertain which tea belonged to Zeeland).

more than their official share of 50%, resp. 25%. Zeeland's comparatively large share (about a quarter more than might be expected) may at first sight seem somewhat curious, considering its rather isolated geographical position. However, its nearness to England offered excellent opportunities to engage in the smuggling of teas into that country. According to a contemporary source

(...) the province of Zeeland was the most suited for the contraband trade; also Vlissingen flourished: Veere and Middleburg profited indirectly. The ports of South Holland participated, and Amsterdam was the warehouse that everything supplied".⁵³⁴

This state of affairs may help to explain the specific importance that Lombard and Udemans attached to the tea trade.⁵³⁵ When we assess Lombard's and Udemans's conclusions, it becomes clear from the numbers they give that the new 155 ft. three-decker *retourschip* could carry at least 8% cargo extra compared to a classic 150 ft. *retourschip* of the first charter, and at least 30% extra compared to a classic *retourschip* of the second charter. No figures are given for the extra cost of building this 155 ft. vessel, but it seems reasonable to accept Udemans's figures of 2000 guilders extra for a three-decker, and to add 3,5% for the extra materials involved compared to the hull of a 150 ft. vessel – only the length had increased, the other dimensions were not changed – which would lead to an amount of approximately 5250 guilders extra. The total extra expenditure in the building of the larger hull would then amount to 7250 guilders, i.e. about 5% extra; the rigging (mast, sails and rope-work) did not lead to any higher costs as they were the same as on a 150 ft. vessel.⁵³⁶ The resulting extra costs involved could easily be offset by the extra payload that could be carried; the more so as there was obviously no need to increase the number of crewmembers as was shown by the numbers involved on the homebound journeys from Canton in 1775/1776. The conclusion must therefore be that Udemans and Lombard put up a quite convincing case, supported by experiential first hand evidence, for the increased profitability that could be realized by using 155 ft. vessels in the Canton tea trade.

⁵³⁴ Voute (1787), p. 8 ("De Provincie Zeeland was het gelegenste tot den Contrabandehandel; ook was Vlissingen in vollen bloei: Veere en Middelburg hadden 'er een indirect voordeel bij. De Zeehavens van Zuidholland deelden 'er mede in , en Amsterdam was het magazijn dat alles leverde")

⁵³⁵ Jörg (1978/1982), p. 39

⁵³⁶ See Udemans's figures as presented in footnote 515.

3.4 Discussions, decisions and knowledge

Sixteen years after the first introduction of a new - and allegedly superior - design for VOC's *retourschepen*, it became publicly known to those connected with societies in the Republic that the VOC had been reluctant in accepting this new design. Two essays, published in the *Transactions* of the *Zeeuwsch Genootschap*, extolled the virtues of these new vessels, based on experiences of various users and considering several different aspects such as (nautical) safety, health of the crew, and profitability of trade. Interestingly, these essays (received under a motto, and therefore judged without prior knowledge of the names of the writers) had been written by persons who were – because of their societal status – possibly not eligible for membership of the society that published their writings.⁵³⁷ In the first section of this chapter, the emergence of a connection between the Zeeland design and the Zeeland society was explored. As we saw in the second chapter, in earlier *Transactions* of the Zeeland and the Rotterdam society, essays on health problems had constructed links between such diverse actors as crewmembers, *volkhouders*, ventilation, discipline and diseases. However, then the suggested solutions to the health problems did not critically assess the design of the ships as such. The next two sections of this chapter showed that the later Zeeland essays experientially connected the redesigned ships with the health of crewmembers, the mastering of storms and high seas, and the profitability of the tea trade to China, and emphasized their superiority compared to the classic design. In this section I argue that these essays became an important part of the complex logic of decision-making within the VOC and that they played a crucial role in the transactions of the *Heeren XVII*, in due course leading to a way of accepting the three-decker design without alienating some of the chambers that were initially opposed to it. The essays were able to construct a bridge between the quest for centralization and standardization within the upper echelons of the VOC and the desire for local independence and decision making of at least some of its chambers.

Discussions and decisions

The outcome of the competition, organized by the Zeeland society, on ship design was that the advantages of the Zeeland three-deckers were made public in a neutral context. Within a short timespan it also had a decisive effect on the discussions within the meeting of the *Heeren XVII*. On 1 November

⁵³⁷ The exception to this status rule seems to have been the *Bataviaasch Genootschap* at Batavia which had a more open policy of acceptance, possibly because of the dearth of potential members.

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Fig. 3.8 Detail of the insertion in the *minuut resolutie* of the meeting of the *Heeren XVII* on 1 November 1780 (NA 1.04.02/73 dd. 01.11.1780). Photo by the author, taken at the National Archives on 11.11.2015.

1780, shortly after publication of the seventh volume of the *Zeeland Transactions*, the *Heeren XVII* decided to leave the choice of whether or not to build *retourschepen* as three-deckers or as *kuilschepen* to the master shipwrights of those chambers that had been instructed to build new ships at the time (i.e. Zeeland, Delft and Hoorn). An earlier decision to leave the choice whether or not to build three-deckers to all chambers was modified because some delegates from the Amsterdam chamber argued that there were still “some difficulties present in the locality of that chamber”, even though it seems that Amsterdam was then the only chamber to voice objections.⁵³⁸ The decision as it was taken means that the assumption - made in existing literature - that on the basis of the outcome of this meeting all chambers were giving the freedom to do as they saw fit cannot be sustained.⁵³⁹ It is clear that the *Heeren XVII* had read the prize-winning entries by Lombard and Udemans in the *Verhandelingen* because there is an insertion in the provisional minutes of that meeting, saying “having read the essays regarding the usefulness of three-deckers, that had been written in response to a premium promised by a member of this assembly”.⁵⁴⁰ The fact that the insertion was made shows the importance the meeting must have attached to the essays. By the end of September 1780 (i.e. prior to this meeting), the directors of the VOC had been

⁵³⁸ As can still be seen in the provisional minutes of the meeting (NA 1.04.02/73 dd. 01.11.1780 “*eenige zwarigheden welke in het locale van die kamer (i.e. Amsterdam) resideerden*”). This is another example of being fortunate enough to be able to glimpse beyond the “paper shadow”.

⁵³⁹ This assumption is in Bruijn e.a. (1979-1987) Part 1, p. 49 and in Loeve (2001), p. 66

⁵⁴⁰ Insertion in the provisional minutes of the meeting (NA 1.04.02/73 dd. 01.11.1780 “*na gelezen te hebben de verhandelingen over de nuttigheyt der driedeks schepen, welke op eene uitgelooftde premie van een lidt deezer vergadering het ligt hadden gezien.*”)

given access to the relevant parts of the Zeeland *Transactions*. Director Radermacher of the Zeeland chamber of the VOC and director of the *Zeeuwsch Genootschap* probably himself had seen to that, as can be deduced from letters written by directors of the Zeeland and Hoorn chambers of the VOC, dated 21 and 25 September 1780. In these letters they thank Radermacher personally for having received a copy of the booklet containing the two essays and the appendices. The Hoorn letter of 25 September 1780 added "(...) wish sincerely that your attempts may lead to increased safety for the ships of this nation and for the ships of the company in particular (...)"⁵⁴¹, which shows that the directors of the Hoorn chamber now also seemed to be convinced by the arguments about safety, whereas similar arguments in the earlier *Supplement* had apparently produced no effect. Having decided to leave the choice on whether to build three-deckers or not to the chambers currently involved, the *Heeren XVII* went on "to thank director Radermacher for his generous and disinterested efforts" for his promotion of the advantages of three-deckers and his refutation of objections.⁵⁴²

The result of the decision was that Zeeland immediately returned to the building of three-deckers; the *Gouverneur-Generaal de Klerk*, which was under construction at Middelburg at the time, was finished as a three-decker and so was the *Schelde*, which the Zeeland chamber had also been assigned to build. The vessel that the Delft chamber was about to build according to a resolution of that same meeting (which was to be named the *Roosenburg*) was also constructed as a three-decker; this is less of a surprise than it may seem when one remembers the fact that - as mentioned in section 3.1 - that chamber had at an early stage acknowledged some advantages of three-deckers. It is not clear, however, whether the Hoorn built vessel (called the *Avenhorn*) was finished as a three-decker.⁵⁴³ One may say that the concept of the three-decker had ultimately safely arrived in Delft and could now be

⁵⁴¹ These letters are in ZA 157/523 dd. 21.09.1780 and 25.09.1780 "(...) wenschen van harten dat uw (...) aangewende pogingen mogen dienen tot meerdere beveilijging van de scheepvaart dezer natie in het gemeen en van de compagniesschepen in het bijzonder (...)". The booklet is the same volume that was mentioned at the beginning of section 3.2.

⁵⁴² NA 1.04.02/73 dd. 01.11.1780 "*de bewindhebber Radermacher voor deszelfs edelmoedige en belangeloze pogingen (te) bedanken*"; Loeve (2001), p. 66

⁵⁴³ NA 1.04.02/222, under the heading *Scheepen dies aantimmering* (dd.17 April 1781) mention is made of the fact that the *Gouverneur-generaal De Klerck*, the *Schelde* and the *Roosenburg* had been constructed as three-deckers, regarding the *Avenhorn* no decision had been taken. No later mention can be found on the way the *Avenhorn* was constructed. That the *Roosenburg* was constructed as a three-decker can also be deduced from a remark made by Johannes Harger in *Verhandelingen Zeeuwsch Genootschap, Tiende Deel* (1784), p. 319> according the DAS website, the *Gouverneur-generaal De Clerck* was built in 1779 (!), the *Schelde* in 1780, the *Rozenburg* in 1780 and the *Avenhorn* also in 1780.

appropriated by this chamber.⁵⁴⁴ However, the *Heeren XVII* did not give permission to the Zeeland chamber to build its proposed 155 ft. three-deckers. This is remarkable as one of the aspects explicitly dealt with in the essays concerned the extra amount of cargo that these ships could take on board, especially on the lucrative journeys in the strictly controlled Canton tea trade. This gives the impression that economic considerations may at that time not have been the most pressing issues on the mind of the *Heeren XVII*.

It has been suggested that the decision to leave the choice to (some of) the chambers amounted to dithering and indecisiveness on the part of the *Heeren XVII*.⁵⁴⁵ However, an alternative explanation seems more likely. The explicit mentioning of the essays on the usefulness of three-deckers points to the fact that they functioned as (what may be called) an effective instrument of governance, in that they provided the *Heeren XVII* with a seemingly neutral vehicle for resolving the disagreements about the new design and for overcoming the politicized debate that had earlier prevented the VOC from reaching a decision that would be acceptable to all parties; traces of that debate still emerged in the remark regarding the difficulties within the Amsterdam chamber. In addition, the decision as it was taken by the *Heeren XVII* seems to point to an acceptance of the fact that their centralizing approach to governing the VOC (not only as a result of the centrally guided ship design and building process but also visible in the approach that had been taken in the wake of the health problems of the early 1770s) might cause some unease (to say the least) within some or all chambers who still cherished the independence granted to them by the original decentral organization of the VOC. By referring to unbiased expert advice in the *Transactions* the *Heeren XVII* created sufficient leeway to accept a local innovation on a central level while still keeping all chambers “on board”.⁵⁴⁶

The fact that the essays functioned in the way they did makes it clear that there had been a shift in the “technology of trust”. The “gentlemanly trust” of the seventeenth century that we encountered in the preceding chapter had been replaced by the “literary technology” as described by Steven Shapin. Societies like the *Zeeuwsch Genootschap* and (possibly even more importantly) their *Transactions* acted as brokers of trustworthy and neutral knowledge through the circulation of these *Transactions* to an “enlightened” readership. At the end of the seventeenth and the beginning of the eighteenth century, the concept of “gentlemanly trust” had still been central during the introduction of

⁵⁴⁴ Rather fittingly, in 1794 on its last voyage (from Canton to the Republic) the *Roosenburg* (Delft’s first three-decker) sailed for the Zeeland chamber, the origin of its design.

See <http://resources.huygens.knaw.nl/das/detailVoyage/99138>

⁵⁴⁵ Loeve (2001), p. 82

⁵⁴⁶ Cf. Hoppe (2002), pp. 27-29

distillation machines, and – as we have seen in the preceding chapter – it had eventually failed, because of an unsurmountable conflict between different layers of (dis)interestedness. On the one hand there had been the interest of the protagonists of the machine who had tried to convince the VOC by presenting a disinterested set of facts, figures and experiential proof and on the other hand there had been the interest of skippers who had presented their facts, figures and practical experience with equal force. During the last decades of the eighteenth century, we see a policy emerge within the VOC in which societies play an important role. These societies (of amateur, improvement or learned character) were at the same time interested and disinterested. Their interest was restricted to the subject as such, and their disinterest meant that no personal, professional or political interests were involved or at least not conspicuously so.⁵⁴⁷ Moreover, in the case of competitions, entries had to be submitted anonymously and these entries were refereed by expert judges chosen by the society involved who (as part of the literary landscape of the time) were trusted to act without bias. As was showed above, even in the “three-decker”-case any obvious interest by Radermacher (which he didn’t hide anyway) was filtered out by the procedures in place. We may say that institutions such as these societies functioned as centres of calculation, administration and distribution of new knowledge, both theoretical and practical.⁵⁴⁸ Because the essays and appendices on the new ship design were published in the *Transactions* of the Zeeland society, they could be interpreted as politically disinterested, neutral and as transcending local interests. By providing access to the experiences of users, the essays acted as instruments of closure, whereas the earlier *Supplement* compiled by Radermacher had failed to do so. The *Supplement* came directly from a director of the Zeeland chamber, and therefore it could hardly be seen as anything else than trying to force a decision that was in the (political) interests of the Zeeland chamber; advice presented by the other chambers displayed of course a similar bias towards the interests of these chambers. By offering content, similar to that of the *Supplement*, as part of a discourse in the *Transactions* of the *Zeeuwsch Genootschap*, the message had been effectively depoliticized. Now, with the boundary between Zeeland and the other chambers coming down, it became possible for the three-decker to (metaphorically) sail safely across the local shallows that lay between the

⁵⁴⁷ For instance, the Rotterdam society was established explicitly (among other reasons) to advocate the adoption of steam technology in the Dutch Republic.

⁵⁴⁸ Porter (1995) p. 224 also mentions the Latour’s concept of centres of calculation, albeit in a more modern context.

Zeeland yard and the other yards⁵⁴⁹. Although a metaphorical voyage to Amsterdam still seemed to be out of bounds, three-deckers must literally have made their way into Amsterdam on a number of occasions, as was noticed in the previous chapter when we saw that the Zeeland built three-decker *Rijnsburg* took a distillation machine produced in Batavia to Amsterdam and again in the first section of this chapter.

As demonstrated by the complex decision making involved in the case of the Zeeland three-deckers, the relation between decisions and knowledge was not straightforward or one-directional in the sense that decisions were simply informed and guided by knowledge that was available and that as a result the decisions were acceptable to those involved. Instead, one sees a more complicated process. Knowledge connected with policy decisions was used in a somewhat detached way (detached in both senses of the word: detached from the sites where decisions were taken and detached as a (quasi)-objective attempt to argue for a solution). This was already partially shown by the Rotterdam and Zeeland essays written in the wake of the health problems on the ships of the VOC in the early 1770s. Just over a decade later, another set of essays published in the *Transactions* of a society turned out to be powerful enough to act as decisive arguments when policy decisions have to be revised, as became apparent in the role the later Zeeland essays played when the *Heeren XVII* finally reached a decision on three-deckers. The factions within the *Heeren XVII* were able to depoliticize their differences by agreeing on the outcome of experiential insights that crossed the border between the different factions, because they were interpreted as neutral and trustworthy, filtered through the socially and culturally sanctioned procedures of a society (such as their “literary technology”), and thereby seen as removed from personal (and therefore possibly contentious) claims. Now these objectified insights forcefully asserted that three-deckers were powerful in their disciplining of humans, in their mastering of nature and in their pursuit of profitable trade, and that they therefore contributed to increased health, safety and profitability for the VOC. In addition to the role that was played by (what could be seen as non-biased or disinterested) publications in governing the decisions of the *Heeren XVII*, we should not overlook the important role that was played by the three-decker itself. When the design had been materialized for a number of years between 1764 and 1773, it showed that it embodied the promised advantages: it could accommodate more crewmembers in healthier conditions, it was able to withstand the forces of nature better, and it contributed to a more profitable trade, experiential proof

⁵⁴⁹ One might see a parallel with the transregional membership of the Zeeland society (and of other societies). The production, assessment and distribution of knowledge was taken beyond local and regional borders.

that eventually had found its way into the *Transactions* of the *Zeeuwsch Genootschap*.

The 1780 decision of the *Heeren XVII* was not the last word in the development of the ship designs of the VOC. In 1784, the Amsterdam chamber embarked on an experiment of its own. It suggested building a larger charter of *retourschepen* [160 ft x 42½ ft x 19½ ft] together with special camels. Although the Zeeland chamber had not been given permission to build its longer ships, the Amsterdam chamber was allowed to build an even longer design. This ship (the *Admiraal de Suffren*) was still of the classic *kuilschip* design, meaning that it had the usual deep waist. On 17 November 1786, it left for its maiden voyage to Batavia and from there it sailed on to China.⁵⁵⁰ On 1 March 1788, it sailed from Canton on its first homebound voyage but it was wrecked when it hit an uncharted island in the South China Sea. Almost everybody was saved, but crews of Chinese junks stole most of the cargo which had a purchase value of over one million guilders.⁵⁵¹ The consequences this wrecking had for the charts that were provided by the VOC to its ships will be extensively discussed in the next chapter. Concerning what has been argued in this chapter on ship design, the fact that the *Admiraal de Suffren* was used on the direct China route gives the impression that – a few years after the *Heeren XVII* had not explicitly considered that matter in their decision-making – the tea-trade was considered important enough to dispatch the largest ship of the VOC on the route to China. One might even interpret the building of this ship as a vindication of the suggestions by the Zeeland chamber to enlarge the first charter, and certainly Radermacher did so when he wrote a number of considerations regarding shipbuilding for an extraordinary meeting of the *Heeren XVII* on 6 March 1788 at The Hague.⁵⁵² In this meeting, a memorandum for redress concerning the VOC (*Memorie van Redres*) was to be discussed which contained plans to improve the lossmaking activities of the VOC at that time. Radermacher lamented the fact that up till then no definite decision had

⁵⁵⁰ It is interesting to note that the Amsterdam (and the earlier Zeeland) experiment regarding ship design took place at the time when the VOC – according to received wisdom – was at death's door. There still seemed to be room for innovative experiments.

⁵⁵¹ The ship was called *Admiraal De Suffren*, after the French admiral that had prevented the English from taking the Cape of Good Hope during the fourth Anglo-Dutch war (De Jonge (1858-1862) Deel IV, p. 469); on the wrecking of the vessel: Loeve (2001), p. 70, quoting NA 1.04.02/199 and 4438 and Bruijn e.a. (1979-1987) Part 1, pp. 49-50; also <http://resources.huylens.knaw.nl/das/detailVoyage/95581> and <http://resources.huylens.knaw.nl/das/detailVoyage/99038>. The events surrounding the wrecking of the vessel, the subsequent investigation by a court-martial and its consequences for the provision of charts to ships of the VOC will be discussed in the next chapter.

⁵⁵² NA 1.10.69/95. These considerations show that Radermacher was still concerned with the overall introduction of three-deckers, in contrast to what Loeve states (Loeve (2001), p.66).

been taken to introduce three-deckers across the whole of the VOC. He also mentioned that the experimental vessel *Europa*, a three-decker of 155 ft. in length, had proven to be able to carry a significant larger payload than the standard 150 ft. vessel; he referred to the seventh volume of the *Transactions* of the Zeeland society to make this point. By doing so, he re-introduced the commercial aspect of the assumed advantages of the (larger) three-deckers that seemed to have escaped the attention of the *Heeren XVII* during their discussion in 1780. Applauding the fact that the Amsterdam chamber had built the 160 ft. *Admiraal De Suffren*, which – although not a three-decker – was an even larger vessel than the Zeeland built *Europa*, he went on to argue for a renewed inventory of experiential evidence regarding the advantages of three-deckers. The building of larger ships in the form of three-deckers would lead to the “most complete perfection of the art of shipbuilding”⁵⁵³ and was of the utmost importance for a commercial company. As a thought-experiment, he calculated the extra cargo that could be shipped to the Republic when eight ships of 155 ft. would be despatched to China. That extra cargo would amount to a value of nearly one million guilders. Better still, when three-deckers of 160 ft. were to be employed the extra profit would amount to 2.4 million guilders in the China traffic alone, not calculating the extra profit that would be realized when such large ships were also used in the East Indian traffic. The upshot of this would be that in twenty-five years’ time the current deficit of the company (which at the time amounted to 100 million guilders) could be turned into a surplus of more than 33 million guilders; however, continued use of ships of 140 and 150 ft. would still leave a deficit of 27 million guilders. In a final remark, Radermacher pointed to the fact that in the first half of the seventeenth century a number of ships of 185 ft. had been built, as well as ships of between 160 and 170 ft., and that therefore there seemed to be no technical objections regarding large ships.

As we will see in the next chapter, in 1788 the chief and the *supercargas* in Canton asked the *Heeren XVII* (through the China Committee) for copper-bottomed three-deckers on the voyages to and from Canton and for leaving the choice which route to sail to the skippers.⁵⁵⁴ In requesting three-deckers, the Cantonese staff can be seen to echo the remarks made by Lombard almost a decade earlier. In fact – as mentioned before – from 1764 onwards the Zeeland chamber of the VOC had been sending on average one

⁵⁵³ NA 1.10.69/95 (unpaginated, second page) “*de volkomenste perfectie van den scheepsbouwkunst*”

⁵⁵⁴ The points raised by the staff from Canton were preliminary discussed on 4 Dec 1788 (cf. NA 1.04.02/85 and NA 1.04.02/198 both dd. 4.12.1788). The Cantonese memorandum itself is in NA 1.04.02/85; see also Jörg (1978/1982), p. 42 and notes 142-146, quoting NA 1.04.02/4435, 4438 and 4442; Loeve (2001), pp. 66-67, quoting NA 1.04.02/198.

three-decker in each flotilla of four ships that usually travelled to China.⁵⁵⁵ The staff in Canton also noted that one of the fastest English ships used in the Canton tea trade was the *Vrouwe Catharina Wilhelmina*, a Rotterdam built *retourschip* of the second charter that had been taken by the English in January 1781, had been coppered since then and which turned out to be one of their fastest ships.⁵⁵⁶ The fact that this ship turned out to be so fast is even more remarkable as it was probably built to the same “coarse and square” specifications that had been commented upon by Udemans. On the one hand, this showed that coppering was very effective in increasing the speed of ships, and on the other hand, that the basic design of the VOC *retourschepen* (which dated back to 1742) was apparently still up-to-date.⁵⁵⁷ The proposal of Radermacher to build larger (three-decker) ships was not implemented, nor was – for the time being – the proposal effectuated to “copper” ships as a general rule; however, it was decided that by way of experiment chambers could build a “coppered” ship which then should be preferably used in the China trade.⁵⁵⁸ As far as the building of three-deckers was concerned, continued experiences with an increased number of these vessels (as allowed by the decision of 1780) finally helped to produce a definitive solution on 28 December 1793, when the *Heeren XVII* concluded that there was sufficient evidence that three-deckers were superior to the classic design of *retourschepen*; they decided that henceforth it became compulsory that only three-deckers should be built. Existing ships with a waist were to be refitted as three-deckers, which seemed to re-establish the centrally controlled standardization process that had effectively begun in 1697, almost a century earlier.⁵⁵⁹ However, not all was well by that time; three years earlier the dire financial situation the VOC found itself in had forced the company to look into either the building of ships that were cheaper to operate (such as the *pinkschip* or barque), buying ships from private yards or renting ships from private ship-owners. In the ensuing discussion Willem Udemans Jr showed convincingly that building, equipping and operating three *pinkschepen* was cheaper than that of two large *retourschepen*, whereas the amount of cargo that could be carried was the same.⁵⁶⁰ We noticed in this chapter that Willem Udemans Jr (just like his father) tried to improve ship designs when he saw the need to do so. It shouldn’t therefore come as a surprise that he suggested an improved design for a *pinkschip* which was to be compared with a different

⁵⁵⁵ Calculated on the basis of <http://resources.huygens.knaw.nl/das/search>

⁵⁵⁶ Dillo (1992), pp. 17-18 and 183

⁵⁵⁷ Jörg (1978/1982), chapter 1, note 142; for Udemans’s comments see section 3.2

⁵⁵⁸ NA 1.04.02/86 and NA 1.04.02/199, both dd. 3.11.1789

⁵⁵⁹ NA 1.04.02/94 dd. 28.12.1793; also Bruijn e.a. (1979-1987) Part 1, pp. 49

⁵⁶⁰ Dillo (1992), chapter 8; for Udemans’s calculations see Ibid., Bijlage 9 and also this chapter note 132.

improvement of the *pinkschip*, designed at the Amsterdam yard. This time the discussion was much shorter than in the case of the three-decker (partly because this time Zeeland and Amsterdam agreed on most issues) and it seemed that by the summer of 1794 an adapted design of the *pinkschip* would become the successor to the 1742 design of its *retourschepen*. That tried and tested design had been used for more than half a century. Its long timespan had been made possible because of the flexibility regarding adaptation, improvement and renewal, which had been built into the original mutable mobile of its design, as we saw in the first chapter.⁵⁶¹ However, as we also saw in that chapter, by May 1795 the VOC suspended all shipbuilding activities on its yards, partly because of the (metaphorically spoken) uncharted event of a French invasion of the Republic. The new *pinkschip* therefore never got the chance to really prove its expected advantages in practice.

Related to the aspect of route finding (as remarked upon by the Canton staff in 1788) we will see that uncharted events (in the literal sense of the word) had quite an impact on the safe passage of ships, especially in the China trade. This was caused by the unreliability of the charts that were centrally provided by the VOC. Then we will again notice tensions between centralized and local approaches which in this case meant that charts and sailing instructions were only provided through the chartmakers offices in Amsterdam or in Batavia and that local initiatives seem to have been ignored. We will also see reluctance by the VOC to look beyond its own borders when it came to updating and improving hydrographical, geographical and astronomical knowledge. This reluctance can be noticed even when such knowledge had been produced at sites controlled by the VOC, had come about through the involvement of individual skippers or through that of a society, this time the society that had become established in Batavia.

⁵⁶¹ Dillo (1992), pp. 180-182

Ezechiël Lombard (or Lombaard) (1745-1796) was born in Middelburg on 10 March 1745, as the son of Jacob Lombard and Bastiana Karmeloo. He trained as surgeon and was for a considerable time employed as *oppermeester* (i.e. chief surgeon) by the Zeeland chamber of the VOC.⁵⁶² In Radermacher's *Supplement voor eene Memorie* (1777), there is an extensive essay by Lombard on the advantages of using three-deckers, based on his experiences as a ships' surgeon employed by the VOC. Lombard mentioned that (at the time of writing) he had sixteen years' experience in sailing on ships, both on *kuilschepen* and on three-deckers and that he had completed four journeys as *oppermeester*. According to this, he must have started his sailing career in 1761. For that year we find an Ezechiël Lombaert mentioned as *bosschieter* on the Zeeland vessel *Borssele*, leaving on 9 January 1761 and returning on the Zeeland vessel *Zuid-Beveland* on 24 June 1762. Such a quick return was rather unusual as most common sailors had to serve a multi-year contract. A year later, on 20 June 1763, Ezechiël Lombaert left as *ondermeester* (second surgeon) on the *Duinenburg* for Ceylon, returning with the Rotterdam vessel *Zilveren Leeuw* on 24 May 1767. His first voyage as *oppermeester* took place between 17 December 1768 and 8 May 1770 on the *Barbara Theodora*.⁵⁶³ His second voyage as *oppermeester* was on the *Blijdorp*, leaving in August 1770 for

Batavia, returning on the *Jonge Thomas* in June 1772. He left again in October 1772 on the *Europa* (on its maiden trip), returning on that same vessel in August 1774.⁵⁶⁴

Fig. 3.9 Silhouette of Ezechiël Lombard
(Zeeuws Archief, Zeeuws Genootschap, *Zelandia Illustrata*, deel IV, nr 604)

In 1776, the *Zeeuwsch Genootschap* mentioned that he had written an essay on the problems of *rotkoorts* on the ships of the VOC, but although it received an honourable mention, it was not

published.⁵⁶⁵ This essay could well have been inspired by his experiences on board the *Europa*, as during the first part of its outward journey the *rotkoorts* had wreaked havoc on the crew. Out of 353 crewmembers, 150 had died before the ship reached the Cape of Good Hope. However, on the journey

⁵⁶² Nagtglas DI. 2 (1893), p. 93

⁵⁶³ Details on the voyages Ezechiël Lombaert/Lombaert/Lombaard made were retrieved through the VOC opvarenden website <http://vocopvarenden.nationaalarchief.nl/default.aspx> (accessed 05.11.2015). For the hierarchy of ships' surgeons, see Bruijn (2009), p. 60

⁵⁶⁴ <http://vocopvarenden.nationaalarchief.nl/detail.aspx?ID=351972&gerepatriceerdmetchip=true> and <http://vocopvarenden.nationaalarchief.nl/detail.aspx?ID=376938&gerepatriceerdmetchip=true>

⁵⁶⁵ *Verhandelingen Zeeuwsch Genootschap, Vijfde Deel* (1776), pp. xxxvi-xxxviii

between the Cape and Batavia, nobody died. Both his essay in the *Supplement voor eene memorie* and his essay on *rotkoorts* were written before Lombard embarked on another voyage. In his later (prize-winning) essay on the advantages of three-deckers, he mentioned this voyage as his fourth as *oppermeester* and his second on the *Europa*.⁵⁶⁶ The *Europa* left Rammekens for Canton on 2 (or 5) November 1774, arrived in Batavia on 2 July 1775 and sailed on to Canton where it arrived on 19 September 1775. Extensive details on the amount of cargo that the *Europa* loaded in Canton (as mentioned in his essay) suggest that Lombard was on board when the vessel left Canton (on 10 January 1776) for the Republic again, arriving at Rammekens on 1 September 1776.⁵⁶⁷ The competition regarding Radermacher's question was made public in August 1777.

According to Udemans, by the time he was writing his essay, Lombard had already left again bound for China on the vessel *Zeeuw*, which sailed from the roadstead at Rammekens on 19 October 1777. Therefore, Lombard's prize-winning essay must have been written in the two months between the announcement of the conquest and his return to the East Indies. The skipper on that journey was Jan Siereveld, who had been quoted extensively by Lombard in his essay. The *Zeeuw* was a ship of classic design with a waist; it had been built in 1774 at the time when the building of three-deckers was suspended on the orders of the *Heeren XVII*.

Lombard was for a time member of the Zeeland department of the *Oeconomische Tak* (economic branch) of the *Hollandsche Maatschappij van Wetenschappen* in Haarlem. In August 1779, when the *Zeeuwsch Genootschap* awarded him a gold medal for his essay he had taken up a position as *oppermeester* (chief surgeon) at the VOC *comptoir* at Cheribon on the island of Java.⁵⁶⁸ While in Cheribon, he wrote an essay *Verhandeling over de ontstaane grasseerende ziekte te Cheribon* ("Treatise on the emerged raging disease at Cheribon").⁵⁶⁹

On 1 April 1780, he joined the *Bataviaasch Genootschap der Kunsten en Wetenschappen* in Batavia.⁵⁷⁰ By 1781, he had moved from Cheribon to Batavia, where he was *oppermeester* (chief surgeon) in the *Ambagts*

⁵⁶⁶ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), p. 272

⁵⁶⁷ *Ibid.*, pp. 295-296. Information on this voyage of the *Europa* can be found at <http://resources.huylens.knaw.nl/das/detailVoyage/95272> and at <http://resources.huylens.knaw.nl/das/detailVoyage/98776>

⁵⁶⁸ *Verhandelingen Zeeuwsch Genootschap, Zevende Deel* (1780), p. xiii-xiv

⁵⁶⁹ A manuscript copy of this treatise is at the Zeeuwse Bibliotheek in Middelburg (KLUIIS Handschrift 4319)

⁵⁷⁰ *Verhandelingen Bataviaasch Genootschap Tweede Deel* (1780), p. 52 and *Verhandelingen Bataviaasch Genootschap Vijfde Deel* (1790), p. 43

Quartier.⁵⁷¹ Around that time he wrote an essay *Verklaring over de oorzaak van het bederff 't welk de thee (etc.)* (“Explanation of the causes of the deterioration of the tea (etc.)”) in which he gave details on experiments that he had undertaken in the years 1774 and 1776 to establish the causes for the deterioration of tea when it was transported from China to the Republic.⁵⁷² In 1792 he retired from his post as town surgeon in Batavia (a post he had held since at least 1790⁵⁷³) and returned to Veere in Zeeland.⁵⁷⁴ On 15 May 1795, after the French had overthrown the Dutch *ancient regime*, he joined the *Provisionele Representanten van het Volk van Zeeland* (the provisional representatives of the people of Zeeland) for the town of Veere.⁵⁷⁵ He was also a member of the town council of Veere. On 1 October 1795, he married Lolkje Steensma. He died on 2 August 1796, after a short illness.

Fig. 3.10 Sash as worn by the “*Representanten van het Volk*”. Photo taken by the author at the Rijksmuseum Amsterdam on 5.10.2013

⁵⁷¹ *Verhandelingen Bataviaasch Genootschap Derde Deel* (1781), p. 34

⁵⁷² This essay is mentioned by Blussé, L. (2013)

⁵⁷³ *Verhandelingen Bataviaasch Genootschap Vijfde Deel* (1790), p. 43

⁵⁷⁴ *Verhandelingen Bataviaasch Genootschap Zesde Deel* (1792), p. 23

⁵⁷⁵ Brood (1993), p. 557 and

<http://resources.huygens.knaw.nl/repertoriumambtsdragersambtenaren/1428-1861/app/personen/12047>

4

NAVIGATING THROUGH CHARTS

NAVIGATING THROUGH CHARTS: CONSTRUCTION, OBSERVATIONS AND RELIABILITY

For almost two centuries, the *retourschepen* of the Dutch East India Company VOC navigated from the Republic to the East Indies and back again, within Asia and beyond, as far as Japan and China. Their chances of doing so successfully depended on the design, construction and re-design of these ships (as we saw in the first and third chapter), their ability to withstand the forces of nature (as we noticed in the third chapter) and on the health of their crews (as we discussed in the second chapter). Other essential conditions for a safe outward bound and homebound voyage consisted of a substantial knowledge of oceans, wind- and weather-patterns, currents, coasts and harbours and great expertise in route finding. It is to these aspects of navigation that we will turn in this chapter. From the outset, the VOC considered it important to have reliable and usable charts and sailing instructions available for its crews.⁵⁷⁶ Terms such as “accurate” (*nauwkeurig*) and “improved” (*verbeterd*) were frequently used at the time by skippers, officers, VOC officials, writers and commentators; in this chapter these words are placed between quotation marks to indicate that I refer to the usability and reliability of charts and instructions as perceived, experienced, claimed and interpreted by contemporaries, without passing retrospective judgement.⁵⁷⁷ Using the words accurate and improved without quotation marks might give the impression that – instead of following the actors – I wish anachronistically to assess eighteenth century charts by means of some present-day standard of “objective” representation (assuming that such standards do exist anyway). The need to understand claims of “accuracy” and “improvement” in their contemporary context is underscored by the fact (as will be discussed in this chapter) that opinions on reliability and usability as held by officials of the VOC were not always compatible with those held by its skippers. Moreover, such terms were often used as rhetoric tools to persuade others of the existence of problems or to coerce them into action, as we will notice below. This rhetoric aspect of historical evidence is important for its understanding.

⁵⁷⁶ In this chapter the term “chart” will be used for representations of seas or coasts on paper or vellum, and the term “map” will refer to representations of areas of predominantly land. In doing so, I follow the sailors’ convention of speaking about charts and the landlubbers convention of using the term maps. In Dutch the general word for “map” is “kaart” whereby (if a distinction has to be made) a “chart” is referred to as “zeekaart” and “map” as “landkaart”.

⁵⁷⁷ See for instance the comments by J.S. Stavorinus as quoted in section 4.3 under the heading “Stavorinus’s Comments”. The contemporary English translation has the words “with requisite accuracy” and the original Dutch text has “met alle nodige naauwkeurigheid”.

On the other hand, in the text of this chapter I sometimes need to point to the perceived and experienced unreliability of charts and sailing instructions on a more general level or without having a direct quote at hand. In such cases I use the words *unreliable* or *unreliability* (without quotation marks).

The need to incorporate on a regular basis new developments, experiences and discoveries into charts and instructions, combined with the fact that the directors of the VOC tried to keep the company's nautical knowledge secret, led to the production and updating of charts and sailing instructions being taken in hand by the company itself. That during the seventeenth century, the Dutch were apparently masters in the construction of maps and charts was therefore very convenient, to say the least.⁵⁷⁸ The charts used by the VOC were more than just material and symbolic representations of nature. They also had a complicated political identity in the sense that they (together with sailing instructions) prescribed the routes that had to be followed, marked the boundaries of the territories controlled (in one way or another) by the company and were perceived by skippers and other officers as instruments of surveillance. This last point bore a degree of irony since the charts and instructions that were used to see whether skippers, officers and merchants had navigated as prescribed, were continuously updated on the basis of their accumulated experience. Sailing instructions appeared in two different forms, as (printed) texts in the so-called *zeilagie orders* (sailing orders) and as inscriptions on charts. Not only have *zeilagie orders* survived the centuries, a number of inscriptions are still visible on surviving charts of the Atlantic Ocean; there a number of lines delineated the boundaries of the courses skippers had to follow to cross the equator safely, the so-called *wagenweg* (waggon way). However, the wisdom of following these and other strict navigational rules (contained in the charts and in the sailing instructions) was challenged over time, a challenge that was made more powerful through the fact that skippers and company officials sometimes perceived very serious shortcomings on the official charts of the VOC. These – reported – shortcomings make the historian wonder why the directors of the VOC persisted in using only charts and sailing instructions that were made by and for the company, especially given the availability of foreign expertise and technology. This is a point that we will come across in the first section of this chapter.

That first section is concerned with a number of issues. First, I consider the production of charts and sailing instructions for and by the VOC,

⁵⁷⁸ As we will notice in section 4.1, Petrus Plancius (who has been characterized as “the most important catrographer of the time (i.e the early 17th century)” by Schilder in Mil, van & Scharloo (19880, p. 19) became the first cartographer of the VOC. Three decades later, several generations of the famous Bleau family served the VOC in that role, cf. Zandvliet (1998), chapter 7.

and how the necessary geographical knowledge became available. Next, I discuss how to interpret the character of these charts. I connect this with how their users mattered regarding the actual use that was made of these charts and regarding how their experiences found their way into the charts; and also with the surveillance that was carried out through the charts. In the course of the eighteenth century a shift became visible from the production of charts as copied manuscripts to the printing of charts, at least as far as the charts issued from the Republic were concerned.⁵⁷⁹ Until 1753, the chart-makers offices of the VOC in the Republic only produced manuscript charts, either on vellum or on paper. The reason for this was the secrecy that the company tried to maintain regarding its navigational knowledge, although sailing instructions were printed at least as early as 1669. In 1753, the drawing of manuscript charts was replaced by the printing of charts (on paper) by the Van Keulen company, whose subsequent directors were – by contract – subject to the same secrecy as the VOC's own staff.⁵⁸⁰ In that year the sixth volume of Van Keulen's *Nieuwe Groote Ligtende Zeefakkel* (the "New Large Shining Sea-torch") appeared with charts of the seas to the East of the Cape of Good Hope. Whereas this volume signalled the end of the production of manuscript charts by the VOC in the Republic, the production of manuscript charts in Batavia continued, as becomes clear from the manuscript atlas *Ligtende Zeefakkel off de geheele Oost-Indische waterweerd* (the "Shining Sea-torch or the complete East-Indian water-world") that was compiled by Gerrit de Haan, head of VOC's chart department in Batavia.⁵⁸¹ This manuscript atlas was used in addition to Van Keulen's atlas on those ships that sailed in the intra-Asian trade and on their way to China and Japan. It has been suggested that by the time the sixth volume of the Van Keulen atlas was introduced, the secrecy surrounding the (East Indian) charts of the VOC came to an end; however, this seems doubtful considering remarks that are to be found in decrees that were issued in Batavia as late as 20 August 1789 and 9 November 1792.⁵⁸² On the other hand, looking at some of the late editions of the fifth volume of Van Keulen's *Zeefakkel*, one gets the impression that already before 1753 a number of charts, covering areas that were under the control of the VOC, had

⁵⁷⁹ In that respect there may have been a difference between what occurred in the Republic and what was the case at the Batavian chart-making offices.

⁵⁸⁰ NA 1.04.02/5028 contains the contract drawn up between the VOC and Gerard Hulst van Keulen, joint director of the Van Keulen company (1756 – 1778) and only director (1779 – 1801) which has this secrecy clause in point 5. The same contract had to be signed by his widow, director of the company from 1801 until 1810.

⁵⁸¹ As we will see in section 4.2, Gerrit de Haan became also involved in observing the 1761 transit of Venus, cf. Zuidervaart & Gent, van (2004), pp. 7-9

⁵⁸² De Meer (2007), pp. 28-29 & p. 57; also Vries, Dirk de e.a. (2005), pp. 210-211. The decrees are in Chijs, J.A. van der (1885-1900) *Deel XI*, p. 155 & p. 479

appeared in the public domain. The journals kept by the skippers containing remarks on route finding, winds, weather, currents and the earth's magnetism, and the charts on which they had plotted their course had to be handed in at the end of outward-bound and of homebound journeys, which usually meant Batavia or Amsterdam, the two main centres of accumulation and calculation for chart making.

As we will notice, for some time other centres existed: in the Republic the town of Middelburg (in the province of Zeeland) was a centre of chart making from about the middle of the seventeenth century until 1753, the Cape of Good Hope and Batavia emerged as centres of astronomical observation and calculation during the 1750s and 1760s and Canton in China became a centre of critical assessment of charts during the 1770s and 1780s. Whereas Middelburg was a regional competitor to Amsterdam, the Cape of Good Hope and Batavia were linked to an outward-looking, internationally orientated and organized programme of astronomical activities that had a significant relation with navigation, and Canton was concerned with problems specifically related to the East Indian chart production at Batavia.

In the second section I look into matters of observation, as performed by skippers at sea as well as by astronomers on land. Despite the interest the VOC had in improving its charts, the company was not directly involved in the expansion of astronomical knowledge. Sustained attempts to increase knowledge about the stars in the southern sky or to establish the exact longitude (and latitude) of the Cape of Good Hope, of significant sites on Java or elsewhere in Asia were not undertaken by the VOC itself. Even when such knowledge became available through other sources, quite often it did not find its way onto the charts and sailing instructions issued by the company. According to the maritime historian Mörzer Bruyns:

“(...) many Dutch sea-charts had no longitudinal graduation at all. This is even true for many charts in the eighteenth century. A number of these were drawn by the Isaak de Graaf, the official cartographer to the Dutch East India Company in the years 1705-1743.”⁵⁸³

The absence of longitudinal information also held true for most of the charts in Van Keulen's *Nieuwe Grote Lichtende Zee-Fackel*. The fifth volume of this atlas (originally printed and published by Van Keulen in 1683 and several times updated, expanded and reprinted) that had become standard issue on the ships of the VOC from the 1740s onwards, and even the sixth volume of this atlas from 1753 lacked longitudinal information on the majority of the

⁵⁸³ Mörzer Bruyns (1985), pp. 33; also Jonkers (2005), pp. 26-28

charts.⁵⁸⁴ This lack of longitudinal information made a correction of “dead reckoning” almost impossible, which – to put it mildly – didn’t make navigation any easier. Establishing the exact position of a ship while out on the ocean requires knowledge of both latitude and longitude. Establishing latitude was by the time the VOC started its shipping operations a rather straightforward affair. For the much more elusive prospect of establishing longitude the skippers of the VOC had two methods at their disposal during the second half of the eighteenth century, the magnetic declination method and the lunar distance method.⁵⁸⁵ Of these two methods, the magnetic declination was used for a number of years during the first half of the seventeenth century and it was re-introduced after the 1740s. The lunar distance method appeared in the 1750s through the work of the French astronomer De La Caille, and was then introduced by the British, mainly through the work of the Astronomer Royal Maskelyne whose first nautical almanac appeared in London in 1767. A similar Dutch almanac became available for the first time in 1787 and was introduced within the VOC in 1789.⁵⁸⁶

The emphasis in this second section will be on the occasions when observations of celestial and magnetic phenomena took place at important sites under the control of the VOC or on its ships. We will also look into whether the knowledge that became thus available (and that could be translated into navigational tools) made its way into the official body of navigational knowledge of the VOC or into the private knowledge of skippers. It will be shown that sometimes skippers navigated their way around the official route finding procedures by using new knowledge that had become privately available to them.

The high price of unreliable charts forms the subject of the third section. As time wore on – and especially during the late eighteenth century – a discrepancy had started to become visible between the need to establish and improve safe routes between the Republic and the East Indies and within the

⁵⁸⁴ Vries, Dirk de e.a. (2005), pp. 208- 212. This was confirmed when I studied these volumes (in the editions kept at the library of the University of Amsterdam, dept. “Bijzondere Collecties”) on 29 Jan 2013 and on 2 April 2015.

⁵⁸⁵ The establishing of latitude and longitude in the Dutch Republic is discussed in Davids (1986), ch. 7 & 8. Magnetic declination is the difference between the geographical North and the direction in which the needle of the compass points; through comparing the local declination at a given latitude with tables or charts for that latitude, longitude can be found. The lunar distance method involves measuring the distance between the moon and the sun or between the moon and a bright star. Comparing the time when a certain distance is observed with the time this distance occurs at (e.g.) the port of departure, the time difference and therefore the difference in longitude can be worked out. Both methods are discussed more extensively in section 4.2.

⁵⁸⁶ For more on this, see Davids (1986), especially chapter 8.

East Indies and the actual practice of doing so. It will be shown that complaints about the unreliability of the charts provided by the VOC emerged on a regular basis. When in 1771 a vessel was wrecked on apparently uncharted rocky shallows near Madura in the East Indies, officials in Batavia and skippers started to accuse each other for not timely alerting to “inaccuracies” on the current charts or for failing to respond to such alerts. In 1772, a *retourschip* in the China trade went down with almost all hands on its approach to Canton, partly caused by a chart that did not show safe anchorage in case of a storm. This wrecking led to attempts to salvage some of the cargo and (more importantly) to the publication of a detailed chart of the approaches to Canton by a member of the staff there, a chart that apparently did not make it into the official body of cartographic knowledge of the VOC. Some years later skippers complained again and also the *Bataviaasch Genootschap der Kunsten en Wetenschappen* (the “Batavia Society of Arts and Sciences”) became involved when it published two articles regarding “inaccuracies” on the current Dutch (i.e. VOC’s) charts. Again no reaction came forward until 1789, after the largest *retourschip* of the VOC foundered on its way home from Canton on an uncharted island, which caused the loss of the vessel and of all its cargo. A court martial in the Republic concluded that the officers concerned were not to blame and that the disaster was caused by “inaccurate” charts.

Only then (as will be shown in the fourth section) did the VOC react, almost twenty years after a first official recognition of “inaccuracies” on some charts of the company, and after many complaints by skippers, officials and outsiders. After what seems to have been a rather intense debate, the VOC conceded that in a number of cases foreign charts were to be preferred over its own charts. As a consequence it provided its ships in the China trade with foreign charts; in contrast to the original proposal all other ships had still to rely on the company’s own charts. Although the decision that was taken can be seen as a watered-down version of the original proposal it nevertheless signalled a decrease of the power that the VOC wielded through its own charts. When they took this decision, the directors acknowledged that charts produced outside the VOC (and the knowledge and experience on which these charts were based) were more “accurate” than charts exclusively produced by and for the VOC. The decision that was taken also showed the limits of the centralizing tendencies within the VOC. On the one hand the company maintained its skippers’ obligation to follow the routes described in the sailing instructions instead of allowing them more freedom to do as they saw fit, thereby emphasizing a central approach, on the other hand those skippers that had to sail to China were finally allowed to use foreign charts and sailing instructions for (at least) that part of the voyage, thereby escaping the company’s central approach.

4.1 Charts: construction, character, and secrecy⁵⁸⁷

The production of charts for the VOC and its forerunners did not start from scratch. On the open market, by stealth, through bribes or even theft, the *voorcompagnieën* (the forerunners of the VOC) were able to lay their hands on charts and sailing instructions that the Portuguese had produced during the sixteenth century. The most famous (or notorious, depending on one's point of view) provider of these sailing instructions was Jan Huygen van Linschoten who – after having been employed by the Portuguese for ten years – published his *Reysgeschrift* and his *Itinerario* in 1595 and 1596 in the Republic. Based on twenty-five (secret) Portuguese manuscript charts that had probably been bought by the brothers De Houtman in Lisbon in the early 1590s, the cartographer Petrus Plancius was able to produce charts and instructions for the first fleets that sailed to the East Indies from the Republic.⁵⁸⁸ According to Pieter van Dam, on 20 April 1602 Plancius was appointed by the VOC as its first chief chart-maker and he was specifically asked to make a “*pertinente aantekening (...) van alle de plaatsen in Oost-Indiën, daar men eenigen handel soude mogen soecken*” (to produce a relevant memorandum of all the places in the East Indies where any trade could be found).⁵⁸⁹ The next chart-maker mentioned by Van Dam is Hessel Gerritsz, who – between 1617 and 1633 – “supplied the Company with all sailing charts both for the East Indies and for the outward bound ships, and who corrected and improved these charts based on experience”.⁵⁹⁰ It stands to reason that this refers to experiences of skippers and others, because when Gerritsz was succeeded by the first of three generations of the Blaeu family (who held the post of chief chart maker between 1633 and 1705), it was explicitly mentioned that journals and books

⁵⁸⁷ By concentrating on the production and use of charts we only recognize one tradition of navigation; completely different traditions (such as the navigation by Pacific people) are left out (cf. Turnbull (2000/2003), Ch. 4

⁵⁸⁸ Paesie (2010B), p. 23. Cornelis De Houtman (1565-1599) was the leader of the so-called *Eerste Schipvaart* (of 1595), the first Dutch fleet to reach the East Indies via the Portuguese route rounding the Cape of Good Hope. Cornelis was accompanied by his younger brother Frederik (1571-1627). In 1598 they sailed for a Zeeland consortium to the East Indies, during which voyage they were both taken prisoner in Atjeh. Cornelis was killed, but Frederik was released after two years. From 1603 until 1623 Frederik was employed by the VOC, cf. Van Wiechen (2002), pp. 146-147

⁵⁸⁹ Van Dam (1702/1927), Part I, p. 402 refers to a resolution of the *Heeren XVII* to that effect of 20 April 1602. Leupe (1867), p.14 mentions that Augustijn Robaert supplied charts to the VOC until his death in 1617. See also Schilder (1976) pp. 61-62, Schilder (1988), p. 19 and Zandvliet (1998), pp. 50-56

⁵⁹⁰ Van Dam (1702/1927), Part I, pp. 402-403 “*alle de paskaarten, soo voor Indien als voor de uytgaande schepen, aan de Compagnie leverde, deselve corrigeerde en verbeeterde na ondervindinge van zaken*”

by merchants, skippers and mates should be used to correct, improve and extend the charts in use. However, the chart-maker was only allowed to make changes after he had been given consent to do so by the directors of the company.⁵⁹¹ From 1705 until 1743 Isaak de Graaf was chief chart-maker, after he had already been employed by the VOC for the production of a collection of charts concerning the East Indies from 1691 onwards.⁵⁹² After his death the Van Keulen dynasty served the VOC as producers and printers of its charts (and as providers of navigational equipment) until the demise of the company.⁵⁹³

The production of charts

In the first two decades of the VOC's existence, its cartographic office in Amsterdam not only supplied the charts that were needed to sail to the East Indies but also the charts that had to be used within the East Indies. As early as 1614 that led to complaints by governor-general Coen about the inadequacy of these charts, which gave rise to the production of improved large-scale charts for the East Indian seas and to the decision (in 1618) that skippers should hand in these charts in Batavia (presumably with their comments) to the local *equipagemeester*.⁵⁹⁴ After more complaints had been lodged about the charts covering the East Indies, the *Heeren XVII* decided in 1664 that a "knowledgeable and experienced" person should be appointed to supervise the necessary revisions of charts in Batavia. As it turned out somebody seemed already to have been appointed in that role but the first definitive mention of a separate *kaartmakerswinkel* (chart-makers office) in Batavia dates from 1688.⁵⁹⁵ Whereas the chart-makers in Batavia were

⁵⁹¹ Ibid., p. 403. The complete text of this instruction is in Van Dam (1702/1927), pp. 414-415.

⁵⁹² Schilder (1988), p. 33

⁵⁹³ Schilder (1988), p. 38. In his inventory of the chart and map collection of the National Archives (NA 4.VEL) P.A. Leupe wrote (in 1867) that Isaak De Graaf was chart maker of the VOC until in his death in 1714. In the inventory of the supplement to this collection (NA/4.VELH) S.P. l'Honoré Naber suggested (pp. 10-11) that the fact that charts produced after 1714 (e.g. dating from 1728, 1735, 1736 and 1737) still bore Isaak De Graaf's name was connected to the fact that the VOC still had obligations to De Graaf, meanwhile suggesting that by then De Graaf had already been succeeded by members of the Van Keulen family. It is curious that on p. 10, l'Honoré Naber gives 1714 as the year that De Graaf died, whereas on p. 11 he gives the year as 1743.

⁵⁹⁴ Schilder (1976), p. 72. The role of the *equipagemeester* in Batavia was already mentioned in chapter 2.

⁵⁹⁵ Schilder (1988), pp. 30-32. However, Zandvliet (1998), pp. 102 states that from 1620 onwards the depot, set up in Batavia as the place where skippers had to return their charts, acted as a chart-making agency.

employees of the VOC, in Amsterdam the chart-makers were independent specialists who did not work exclusively for the VOC.⁵⁹⁶ Because of the huge numbers involved in producing, distributing and updating a great number of different charts, the chief chart-maker had a number of assistants. The basic template of a chart would be drawn by the chief chart-maker; based on this original, copies were produced by assistant chart-makers at the cartographic workshop.⁵⁹⁷ These charts were then distributed to the outward bound ships, together with sailing instructions and navigational instruments. Upon return, the *schipper*, *opperstuurman*, *onderstuurman* and *derde waak* (the skipper or captain, first, second and third mate) had to return their copies to the chart-makers office, at Amsterdam for the charts to and from the East Indies and at Batavia for the charts of the East Indies.⁵⁹⁸

Although the chambers of the VOC were not allowed to employ anybody else for the production of charts than the officially appointed Amsterdam-based chart-maker,⁵⁹⁹ it is certain that not all chambers followed that rule. Some chambers complained about the high prices asked by the Amsterdam chart-maker and this led to a decision by the Zeeland and Hoorn chambers to establish their own cartographic service.⁶⁰⁰ Although (in 1669) the *Haagsch Besogne* reiterated the decision that the production of charts should only be carried out in Amsterdam, it is clear that at least the Zeeland chamber persisted in producing its own charts. It did so until the mid-eighteenth century when the printed sixth volume of the Van Keulen atlas superseded the (Dutch) manuscript charts for the area east of the Cape of Good Hope (as we will see below). According to the maritime historian Paesie, there are strong indications that - apart from Zeeland and Hoorn - the chambers Delft and Enkhuizen also used local chart-makers; only Rotterdam relied solely on Amsterdam.⁶⁰¹ The cartographic historian Günter Schilder

⁵⁹⁶ Schilder (1988), *passim* and De Meer (2007), pp. 52-53

⁵⁹⁷ Zandvliet (1998), pp. 120-121 (esp. ill. 7.2), De Meer (2007), pp. 53-55, Schilder (1988), pp. 20 & 34 and Paesie (2010B), p. 35

⁵⁹⁸ According to Van Dam (1702/1927), p. 403 this procedure was officially put in place when Willem Jansz Blaeu was sworn in as chart-maker, which occurred on 22.03.1633. Probably it had been effective even before that date, because Van Dam mentions that this procedure also concerned journals and books by merchants, skippers and mates that were already in the possession of the company and those that would become available later (“*de journalen en boeken van de kooplieden, schippers en stuurlieden, die doenmaels in handen waren en die men vervolgens zoude krygen*”). This is confirmed by Zandvliet (1998), pp. 87-88 who mentions a number of regulations to that effect dating back to 1616.

⁵⁹⁹ Van Dam (1702/1927), p. 403, referring to a resolution of the *Heeren XVII* of 11.07.1628

⁶⁰⁰ Paesie (2010B), p. 27, quoting NA 1.04.02/4456 dd. 04.06.1669

⁶⁰¹ Paesie (2010B), p. 27 as before; however Schilder (1988), p. 34 claims that only Zeeland did not rely on Amsterdam for navigational material such as charts and instruments.

estimates that in the first century that the VOC existed, the chart-maker's office in Amsterdam produced about 20.000 charts, most of them drawn by hand on vellum.⁶⁰² To get an impression of the total number of charts, the production of the other chart-makers offices should be added. Unfortunately, no figures seem to have survived of the number of charts produced in Hoorn, Enkhuizen and Delft. Nevertheless, based on archival research, Paesie has made an estimate of the number of manuscript charts that was produced for the VOC during the seventeenth and the eighteenth century until 1753 when the production of manuscript charts in the Republic came to an end. This leads him to assume that at least 70,000 manuscript charts were produced on vellum; this number includes the production of the main cartographic centres in Amsterdam and Batavia, and the smaller centres in Middelburg, Enkhuizen, Hoorn and Delft.⁶⁰³ There exists a "snapshot" of what was going on in the *kaartmakerswinkel* in Batavia: Schilder mentions an inventory of that office (dating from 1715) that gives a total of 3636 manuscript charts on vellum.⁶⁰⁴ This reinforces the impression that thousands of Asian manuscript charts must have been produced in Batavia; in fact Batavia continued to produce manuscript charts until the demise of the VOC.

The mid-eighteenth century saw a gradual phasing out of manuscript charts, at least as far as the production within the Republic was concerned. When, in 1746, the *Heeren XVII* decided that a revision was needed of the 1731 list of charts and instruments supplied to the *retourschepen* of the VOC, this task was delegated to the Amsterdam chamber which in turn asked the examiners of its officers (Jan de Marre and Martinus Martens) to see into the matter.⁶⁰⁵ The two examiners were rather critical about the state of affairs they came across. De Marre wrote in his opening sentence that on inspection of the 1731 list of charts and equipment ("*de lyste van de kaarten en stuurmansgereedschappen*") he had discovered many unnecessary and faulty goods ("*veele onnodige en defecte goederen*") that ought to be taken off the list and be urgently replaced by "more needed and more accurate instruments and charts".⁶⁰⁶ He then proceeded with a list of twenty-nine detailed

⁶⁰² Schilder (1988), p. 23

⁶⁰³ Paesie (2010A), *passim* and Paesie (2010B) p. 46

⁶⁰⁴ Schilder (1988), p. 41 (referring to NA 1.04.02/11183) and Paesie (2010A), p. 5

⁶⁰⁵ Schilder (1988), p. 38. Martinus Martens was the examiner for theory between 30.12.1743 and his death in 1762, Jan de Marre was the examiner for practice between 10.05.1745 and his death in 1763 (Davids (1986), p. 399). Schilder only mentions Jan de Marre; however NA 1.04.02/5020 also contains an extensive letter by Martens which makes it clear that both examiners were involved in the revision process.

⁶⁰⁶ NA 1.04.02/5020 Letter by Jan de Marre "*Aan de Edele Achtbare Heren Bewindhebberen*" first page: "*noodiger en accurater instrumenten en kaarten*"

suggestions, the first nine of which were concerned with instruments such as compasses, octants and nautical telescopes. Concerning charts and sailing instructions, he rejected the current two linear ("*gelijkgradige*") charts of the Indian Ocean as useless and outright dangerous and suggested to produce an "accurate" chart in the Mercator projection ("*wassende graadkaart*") containing the correct latitude and longitude of all islands, shoals and reefs, and coasts.⁶⁰⁷ That chart should be produced through printing ("*in koper gebracht*") to prevent "inaccuracies" caused by continuous copying.⁶⁰⁸ A chart in linear projection, stretching from Texel to the Cape should be discarded, as linear projection caused serious problems in navigation when the chart was used.⁶⁰⁹ De Marre pointed to the fact that charts of Sumatra, Java, the Sunda Straits and Batavia were not based on the most up-to-date originals that were available to the Company.⁶¹⁰ On a more practical note, De Marre suggested to formally introduce the fifth volume of Van Keulen's *Nieuwe Groote Lichtende Zeefackel*, containing charts of the Atlantic Ocean from Portugal in the North to the Cape of Good Hope in the South, and from the coast of Guinea in the East to Brazil in the West; according to him, this atlas was in fact already effectively in use. When we look at the 1731 list of charts, we see several printed Van Keulen charts of the South Atlantic mentioned that must also have been contained in that atlas.⁶¹¹ From the same list it also becomes clear that the second volume of Van Keulen's atlas ("*t Westers Zeeboek*" i.e. the Western atlas, describing for instance the English Channel and English ports) meanwhile had become standard issue on the ships of the VOC.⁶¹² In addition, De Marre proposed that a printed atlas of the East Indian seas should be made.

⁶⁰⁷ The linear projection (also known as "equi-rectangular", "equidistant cylindrical" or "rectangular" projection) turns meridians and latitude circles into straight lines. The distance between a certain number of degrees (either longitudinal or latitudinal) remains constant over the whole area represented on the chart. This projection was known in the Republic as "*gelijkgradig*". The Mercator projection also converts meridians and latitude circles into straight lines, but whereas the distance between meridians remains constant, the distance between latitudinal lines increases towards the poles, which has the disadvantage that landmasses (and also seas) in high latitudes are shown much larger than they actually are. The huge advantage of this projection is that lines representing a constant course (so called rhumb lines or loxodromes) are straight lines, therefore these charts are eminently suited to navigational purposes. In the Republic, charts based on this projection were known as "*wassende gradige kaarten*."

⁶⁰⁸ Ibid., points 17, 18, 19 & 20

⁶⁰⁹ Ibid., point 21

⁶¹⁰ Ibid., points 22 & 23

⁶¹¹ For the (Zeeland) list of 1731, see the illustration in Mörzer Bruyns (1988) on page 53 and the same illustration at the top of page 72 in Paesie (2010B).

⁶¹² NA 1.04.02/5020 Letter by Jan de Marre "*Aan de Edele Achtbare Heren Bewindhebbers*", point 15

That would prevent separate charts of these waters ending up in the hands of foreign nations or at public auctions.⁶¹³ On the topic of the current sailing instructions he wrote an extensive, page by page commentary that was in places highly critical of these instructions.⁶¹⁴

Martens made a number of critical remarks regarding the fact that the current tables of magnetic declination were out of date and he suggested replacing these with more up-to-date tables.⁶¹⁵ He thereby referred to the Leiden professors 's Gravesande and Musschenbroek who agreed with him on that subject, which - as he wrote - was known to the VOC director Hasselaar. Just like De Marre, Martens argued that an octant was far superior to the *graadboog* that was in use at the time.⁶¹⁶ He agreed with De Marre on the deficiency of the current two charts covering the seas between the Cape and Java; he explicitly suggested to rely on recent French and English charts and on recent astronomical observations, a number of which had found their way "with great precision and with great expense" onto a French chart that had been published a few years earlier; Martens added: "*D'Edele Agtbare Heer Hasselaar weet welke kaart ik bedoel en hoe hoog men dezelve te schatten heeft*" ("The honourable gentleman Mr Hasselaar knows which chart I refer to and how high it should be valued").⁶¹⁷ In the light of complaints and suggestions that we will come across later, it is interesting to note that already in 1746 highly trained and experienced professionals of the Amsterdam chamber were critical regarding the quality of the charts produced by the VOC and suggested to take a close look at foreign charts.

The comments by De Marre and Martens led to a decision of the *Heeren XVII* to make the change (as far as the Republic was concerned) from hand-drawn manuscript charts to printed atlases and charts. As we saw, for the routes between the Republic and the Cape, the printed Van Keulen atlases already had become the standard information source, either officially as was the case with volume two, or somewhat less officially with volume five – at first through separate printed charts taken from this volume and then

⁶¹³ Ibid., point 29

⁶¹⁴ NA 1.04.02/5036. The edition on which De Marre commented does not display a year of publication. It stands to reason that De Marre used the latest edition available, which presumably dated back to 1731 that being the most recent year that the list of charts and equipment had been updated. This is confirmed by the fact that the printer was *Adraan Wor, en de Erve G. Onder de Linden* who acted as printers between 1728 and 1750: cf. <http://drukkers.library.uu.nl/node/52078>. The edition must therefore have been printed between 1728 and 1746, that being the year that De Marre and Martens produced their comments.

⁶¹⁵ See the next section for the use magnetic declination to establish longitude at sea.

⁶¹⁶ NA 1.04.20/5020 Letter by Martinus Martens "*Aan d'Edele Agtbare Heeren Bewindhebberen der Oostindische Com.*", point 2 & 3

⁶¹⁷ Ibid., point 10

(possibly already before an official decision had been taken) by the introduction of the complete volume. One gets the impression that the publishing house Van Keulen may have been anticipating a decision by the VOC to use its atlases, because as early as in 1728 it had added a number of charts to volume five covering the Southern Atlantic Ocean as far as the Cape of Good Hope and even a number of charts of the Western and Southern Indian Ocean covering the routes to the Malabar and Coromandel coasts of India, the island of Ceylon, Sunda Strait, Java and Batavia.⁶¹⁸ Then, from 1747 onwards, following the suggestion by De Marre and the subsequent decision of the *Heeren XVII* (taken on 13 March 1747) to follow his suggestions (although apparently not Martens's suggestion to introduce foreign charts), the current knowledge of the seas from the Cape towards in the East Indies and even partially beyond the East Indies was contained in the sixth volume of the printed *Nieuwe Grote Lichtende Zee-Fakkel* published in 1753. From then, chart production had become a really centralized affair, the sites of production being either Amsterdam or Batavia.⁶¹⁹

The character of charts

The charts of the VOC represented seas, landmasses, coasts, bays, inlets and harbours, either drawn by hand on vellum or paper or printed on paper. Whether this happened in an "accurate" or "inaccurate" way was – as we saw above and as we will notice below – a matter of continuing debate. These charts were constructed using either a linear projection or the Mercator projection, whereas sightings of land and landmarks were drawn as they would be visible from the deck of a ship. They had an explicit political identity because they were visible representations of the areas controlled by the company and of the routes along which its skippers had to navigate; these routes were sometimes drawn (or printed) on the charts themselves. How to use charts was not a self-evident process; users needed knowledge and expertise that was acquired thorough attending classes and courses, through studying books and through experience at sea. Through the hands and minds of competent users charts could display the power they possessed to guide ships across the oceans. On the other hand, without reliable charts these users

⁶¹⁸ Inspection of the 1782 (?) edition of the fifth volume of the *Zee-fakkel* at the library of Leiden University (Special Collections, catalogue number COLLBN Atlas 72: 9-10) on 02.06.2015 suggests that after volume six was introduced which covered the seas East of the Cape of Good Hope, the charts of those eastern seas were taken out of volume five where they had earlier been inserted in increasing numbers from 1728 onwards (Vries, Dirk de e.a. (2005), pp. 210-211).

⁶¹⁹ NA 1.04.02/169 dd. 13.03.1747; volume five of the *Zee-fakkel* was then revised and updated as well.

would literally be lost on the oceans. This is highlighted by the geographers Kitchin and Dodge when they explain how knowledge and experience of users effectively turned printed paper or drawn vellum into effective charts

(...) maps are practices – they are always *mappings*; spatial practices enacted to solve relational problems (e.g. (...) how to get between A and B, and so on) (...) Without these practices, a spatial representation is simply coloured ink on a page. (...) Practices based on learned knowledge and skills (re)make the ink into a map and this occurs *every time* they are engaged with – the set of points, lines and areas is recognized as a map; it is interpreted, translated and made to do work (...) ⁶²⁰

Although one may question whether the distinction they make between “learned knowledge” and “skills” is appropriate, the important point here is that the practice of users is essential when using charts.⁶²¹ Their point of view implies that whenever a map/chart is (literally) opened or unrolled and put into use, it emerges as different from what it was earlier. It may be in different location, it certainly is at a different point in time. And perhaps most importantly, the user has moved on as well through space, time and experience. Because of this emphasis on practices, they seem to agree with Bruno Latour concerning the fact that “*the fate of what we say and make is in later users’ hands*”.⁶²² Charts only emerge as charts when users take them in their hands, compare them with the observations they make at sea (either with the naked eye or with the help of instruments), link the actual (either observed or dead reckoned) position of the vessel to the chart, and plot its position onto it. Even when the underlying “set of points, lines and areas” is identical in the case of printed charts (or almost identical in the case of hand drawn charts), every enacted chart is different from any other edition of the same chart, because no ship will sail exactly the same course for any significant length of time, due to weather conditions, the sailing characteristics of the ship and the evolving expertise of the crew.

When we consider the continuous updating of charts (and sailing instructions) through the input of its users we may return to Latour’s concept of the “immutable mobile” which I used in the first chapter to shed some light on the design and building processes at the shipyards of the VOC from the 1740s onwards. In his introduction of the concept, Latour actually used the

⁶²⁰ Ibid., p. 335, italics in original

⁶²¹ The relation between knowledge and practice/skill/experience has already been discussed in chapter 1, section 1.1 *Know-how and design*.

⁶²² Latour (1987), p. 29, italics in original. Latour later rephrases this as his first principle: “The fate of facts and machines is in later users’ hands; their qualities are thus a consequence, not a cause, of a collective action” (ibid., p. 259)

example of the making of a sketch map of the island of Sakhalin.⁶²³ He described the purpose of this map (once it had safely arrived in France) as “...to determine (...) whether Sakhalin was an island, who will own this and that part of the world, and along which routes the next ships should sail”. A map of Sakhalin that would have stayed on Sakhalin would not have been worth the journey that was undertaken to provide that map – the map had to travel from Sakhalin to Paris where use of it could be made. To this aspect of mobility (the map could travel while the contents remained the same (i.e. immutable) Latour added a second aspect that consisted of “dozens of innovations in inscription, in (map) projection, in writing, archiving and computing”.⁶²⁴ This means that the usability of a map or chart not only depends on what was originally represented on it but also on the continuous updating of content, context, system of representation and – I would like to add – on how to relate a chart in practice to that what it is supposed to represent, be it the representation of seas, landmasses, coasts, bays, inlets and harbours, the ownership of parts of the world or the best routes along which to arrive there and come back again. To paraphrase Latour: “commercial interests, proto-capitalist spirit, imperialism, thirst for knowledge, are empty terms as long as one does not take into account Mercator’s projection, means to establish latitude and longitude at sea, copper engraving of maps and charts, rutters, the keeping of log books, and the extensive re-editing of sailing instructions that were supplied to the skippers of the VOC.”⁶²⁵

We may characterize charts as powerful actants within a network that they co-constitute with other actants such as the *Heeren XVII*, commercial interests, skippers, *retourschepen*, navigational techniques, wind and current patterns, heavenly bodies, the earth’s magnetism and so on. The interaction and negotiations within this network (based on input by users of the charts) led to adaptations or changes in the actants that took part in the exchange. This then implies a flexibility of charts that is similar to what we encountered in the first and third chapter concerning the design of *retourschepen*; this flexibility means that (just as was the case in ship design) the immutability of

⁶²³ Latour (1986), pp. 5-6 & Latour (1987), pp. 215-219. Kitchin and Dodge agreed that maps, charts and atlases have a mobile character (as becomes clear from the fact that charts can be taken along on a sea voyage), but they questioned the idea of its immutability, suggesting that each a map/chart is used it is mutated. Instead I would argue that what happens to a map/chart when it is used is part of the negotiations going on in the network. Cf. Kitchin & Dodge (2007), pp. 334-335 & 338-339 & 342.

⁶²⁴ Latour (1986), p. 6

⁶²⁵ Latour’s original sentence reads: “... *Commercial interests, capitalist spirit, imperialism, thirst for knowledge, are empty terms as long as one does not take into account Mercator’s projection, marine clocks and their markers, copper engraving of maps, rutters, the keeping of “log books”, and the many printed editions of Cook’s voyages that La Pérouse carries with him*” in Latour (1986), p. 6

charts was not absolute. An example of this flexibility is the fact that – following the comments by De Marre and Martens - the chart showing the route between the West coast of Africa and Brazil was changed from “*gelijkgradig*” into “*wassende gradig*”. Even when the ocean itself did not change, the way it was represented was changed in an attempt to make the chart more usable: a straight course through the water is shown as a curved line on a “*gelijkgradige*” chart whereas it is a conveniently straight line on a “*wassende gradige*” chart.

As we already noticed, the VOC itself recognized the importance of the users of its charts. This becomes clear through the resolutions that stipulated that charts and journals had to be returned to the (hydrographic) offices of the company, a policy which dated back to 1633 and probably even to 1616. The information drawn from users’ experiences was used in updating charts, sailing instructions and (as we will see in the next section) magnetic declination. Thus an expanding body of experiential navigational knowledge became accessible to skippers and officers of the company through their own and their colleagues’ accumulated knowledge and experiences. This then enabled skippers and officers in asserting a measure of control over the environment they passed through on their voyages. The returned charts also enabled the directors of the VOC to assert some control over their skippers. When the chart was read in the hydrographic office of the company, it showed (in hindsight) the route that had been followed, it confirmed existing points of view or it revealed new insights; the chart then also revealed another layer, that of a surveillance tool which showed whether skippers had followed routes and rules. A skipper could try to hide the fact that he had not followed the prescribed routes, but he would have to do so in agreement with his fellow officers (who had to return their charts as well) and probably with the merchant on board as well. He would have to insert plots on the chart corresponding to the official route while steering a different course, but as the day-to-day plotting of positions on the charts formed an essential tool for a safe navigation the insertion of invented plots could lead ships into difficulties later on. Successfully bending the rules would be even more complicated when ships sailed in smaller or larger groups together for any length of time, although (as we will see in section 4.3) in at least one documented case five skippers managed to do so without being found out. The navigational power that charts offered their users emerged through the combination of what was drawn (or printed) on the chart and the expertise of its users. The navigational power of the charts came hand in glove with the power of surveillance that they offered to the directors of the VOC.

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The routes to and from the East Indies as prescribed by the VOC were partly dependent on the time of departure and on the direction of travel. For instance, the instructions on how to sail from the Netherlands to Java when leaving in the spring ("*Instructie Om in May-tijd Uyt Nederland na Java te Zeylen*") differed from those on how to do so in the autumn ("*Instructie Om in de Herst-tyd Uyt Nederland na Java te Zeijlen*"). In 1669 an order was issued that during the spring sailings skippers should stay between a number of lines that had been drawn on the *paskaart*, to the North of the equator between the coast of Brazil to the West and the Gulf of Guinea to the East. This route was devised to prevent the *retourschepen* falling foul of two problems. First, it would prevent them from ending up near the Brazilian coast North of Cape Augustyn where (between June and October) northerly currents and southerly winds would make it impossible for the ships to turn south again, until the winds and currents had abated. Secondly, it would prevent ships from being forced by strong currents into the Bight of Guinea where southerly and south westerly winds prevailed which would lengthen the voyage considerably and which moreover would lead to an increased number of sick crewmembers because of the unhealthiness of the air.⁶²⁶ Originally, these lines were only mentioned in the case of May sailings and not in the sailing directions for ships leaving in the autumn. In his comments on the 1731 instructions, Jan de Marre not only gave the coordinates of a number of extra points (marking an extra line) which had apparently already been introduced on some charts, he also suggested that ships leaving in the autumn should steer a course in between these lines. When looking at the 1748/1758 instructions (and also those of 1768 and of 1783/1790), the number of lines had indeed increased and skippers were ordered to follow the routes between these lines in both seasons. Meanwhile the system had been given the name *Wagenspoor* or *Waagenweg* (Waggon Trail or Waggon Way), and as already was noticed by De Marre, the lines had found their way onto the charts of the company, not only on the manuscript charts (as shown in fig. 4.1) but also on the printed charts in the fifth volume of the *Zee-Fakkel*, there the name *Waagenweg* is actually printed on the chart.⁶²⁷ This chart (fig. 4.2 shows the relevant part of it) appeared for the first time in the 1728 edition of this volume and it

⁶²⁶ *Verbeeterde Instructie van de Eygenschap der Winden* (1748), pp. 3-13; Voorbeijtel Cannenburgh (1953), *passim*

⁶²⁷ Contrary to what Bruijn suggests in Bruijn (1986), pp. 18-19, Bruijn (2008), p. 226 and Bruijn (2011), p. 292 the *Wagenweg* or *Wagenspoor* is still mentioned in the 1783 sailing instructions (very detailed in the instruction on how to sail from the Netherlands to Java in the spring (*May-tyd*) and more succinct in the autumn instruction) cf. NA 1.04.02/191 dd. 24.11.1783 which contains the printed 1783 sailing instructions.

Fig. 4.1 Manuscript overview chart (in *gelijkgradige* or linear projection) of the Northern and Southern Atlantic Ocean with the “*wagenweg*” (the lines drawn between Africa and Brazil). This chart was drawn by the Zeeland chart maker Abraham Anias sometime after 1748. Note the insert in the top right hand corner showing the European coast from the Republic through the English Channel and the Bay of Biscay towards Portugal (Kaartcollectie Buitenland Leupe NA 4.VEL/100

Fig. 4.2 The “Waagen Weg” as shown on the printed *Nieuwe Wassende Graadige Pas-kaart van de Kust van Guinea en Brasilia, strekkende van Cap Verde tot de Cap de Bon-esperance en Verders van Rio de Berbice tot Rio de la Plata* in Van Keulen’s “*Nieuwe Groote Ligende Zeefakkel*” (volume 5). Photo taken by the author at the library of Leiden University (Special Collections) on 2 June 2015.⁶²⁸

⁶²⁸ According to Koeman (1970), p. 303, this edition of the fifth volume of Van Keulen’s atlas was published between 1783 and 1788; it contains existing and new charts. It actually has two different charts showing the *Waagen Weg*. The one pictured here is the older of the two as it was already published in the 1728 edition. The other chart cannot have been made before 1749 as it shows a depth sounding near the Cape that bears the year 1749. At the point of the sounding the name *Duinhof* is also mentioned. This ship arrived at the Cape on 18.05.1748 and was broken up there. The cargo was taken over by another vessel (the *Kasteel van Tilburg*). Possibly the sounding was taken by the *Duinhof* before it arrived at the Cape, and the results must then have arrived in the Republic with its skipper who sailed home as skipper on the *Huis ter Duine*, leaving the Cape on 21.08.1748 and arriving at Texel on 13.12.1748.

reappeared in all later editions. The *Voorreden aan den Leezer* (Preface to the Reader) in the fifth volume is directed to “gentlemen, merchants, skippers, mates, pilots, art lovers and lovers of shipping” and succinctly describes which types of produce, minerals and precious metals are to be found on the African and the Brazilian side of the Atlantic. It is therefore obvious that this volume of the *Zee-Fakkel* was meant for and could be purchased by anybody who was interested. This implies that the secrecy surrounding what the VOC considered the most appropriate route to cross the equator was effectively lifted as early as 1728. The charts, read in connection with the *Zeylaas Orders* (the sailing instructions), opened the way to the East Indies and beyond. This must have been an important reason for the secrecy that the VOC attached to its charts and instructions; it was of course well aware of what might happen when competing companies got hold of this material, the company itself having acted in a similar way *vis-à-vis* the Portuguese in its first years. The secrecy (whether effective or not) that the VOC exercised regarding its charts and sailing instructions was apparently one of the reasons why the company persisted in producing only manuscript charts until 1753, although sailing instructions had become available in printed form as early as the mid-seventeenth century.

It has been suggested that when the sixth volume of Van Keulen’s “*Nieuwe Groote Ligende Zeefakkel*” appeared in print with charts of the seas east of the Cape of Good Hope, the secrecy surrounding the (East Indian) charts of the VOC came to an end, but the situation was somewhat more complicated. As we saw above, the fifth volume of the *Zeefakkel* (which was published by the Van Keulens before they were employed by the VOC) not only contained charts of the Atlantic Ocean but also (from 1728 onwards) a chart showing the *Waagenweg* and charts of the seas between the Cape and the East Indies and even of the of the South China Seas. This means that on the one hand already a quarter of a century before 1753 the secrecy was in practice partly abolished. However, this secrecy was (at least officially) only lifted as far as the “general” charts were concerned which meant the general chart of the Indian Sea, of the Cape or the Southern part of Africa, of the Malabar, of the Coromandel, of Ceylon and the Maldives, of the Bight of Bengal, of Sumatra and of Java. All other charts (either existing or yet to be made) were considered to be special charts for the VOC and should not be sold to anybody outside the company; the same *proviso* applied to the special charts of harbours, bays or roadsteads belonging to the territory of the company and the descriptions thereof.⁶²⁹ Moreover, when these general charts were sold, it

The 1790 reprint of these sailing orders similarly mentions the *Wagenweg* or *Wagenspoor*.

⁶²⁹ *Instructies en Conditien voor Gerard Hulst van Keulen als Ordinaris en Gezwooren Kaartmaaker van de Oost-Indische Compagnie ter kamer van Amsterdam* (Instructions and Conditions for Gerard Hulst van Keulen as ordinary and sworn in chart maker of the East

was on the explicit condition that they shouldn't have been "corrected, extended or improved" with information provided by employees of the company. A similar *proviso* was applied to the sailing atlas for the East Indies; because it had partly been based on information from outside the VOC, it could still be sold but again without any corrections or additions by or on behalf of the company. One also gets the definite impression that the secrecy surrounding the manuscript charts and atlases of the VOC produced in Batavia was never lifted, which becomes clear when one considers several *plakaten* (decrees) that were issued in Batavia.⁶³⁰

The Batavian decrees must in particular have been related to hydrographic knowledge that was produced in Batavia, such as the manuscript atlas *Ligtende Zeefakkel off de geheele Oost-Indische waterweerdtd*, compiled by Gerrit de Haan, head of VOC's chart department in Batavia. This atlas contained detailed charts of the seas surrounding the East Indies; the volume *Noord en Oost* (North and East) was published in 1760, the volume *West* in 1761. However, already as early as 16 March 1703, the High Government in Batavia had issued a *plakaat* through which it became obligatory to mark in the inventory of each ship which charts had been "successively" supplied, the reason for this being that apparently many of the charts that had originally been supplied to the skippers and officers had been "lost". The underlying assumption was apparently that skippers or officers were either very careless or sold these charts to foreigners.⁶³¹ On 21 August 1753, a decree was issued that forbade to sell (without any exception) at a public auction charts, compasses, and all other navigational equipment, journals and other writings, records of roadsteads, streams, harbours, capes or anything that was related to seafaring that had been produced, written or acquired during the voyage.⁶³² Less than a year later (18 June 1754) it was explicitly said that a notice by the *baas-kaartenmaker* (the chief hydrographer) regarding shallows and other dangerous situations in the seas to the West of Batavia had to be secretly printed.⁶³³ On 15 December 1758, the *baas-kaartenmaker* was instructed to thoroughly check on each *retourschip*

India Company at the Amsterdam chamber), *Art. 6, 7 & 8* (NA 1.04.02/5028). See also Kok, M. (1980B), p. 51. Gerard Hulst van Keulen was chart maker for the VOC from 1756 onwards. He succeeded his father Johannes van Keulen who had died in 1755. From 1756 until 1778 he held this post together with his younger brother Cornelis Buys van Keulen. After his brother's death in 1778 he continued on his own until his own death in 1801. (cf. Bom, G.D. (1885), pp. 13-22).

⁶³⁰ An overview of these decrees is in Chijs, J.A. van der *Nederlandsch-Indisch Plakaatboek, 1602-1811 Deel I – XVII* (1885-1900), hereafter referred to as Chijs I – Chijs XVII

⁶³¹ Chijs III, p. 529

⁶³² Chijs VI, p. 520

⁶³³ Chijs VI, p. 679

that was about to leave whether the number of navigational instruments and charts was according to what was needed and prescribed, and to supply any of these materials that were still missing. In case such materials could not be provided, notice should be given to the Governor-General and the ships' officers should be provided with a certificate to that effect so that could exonerate themselves upon arrival in the Netherlands.⁶³⁴ This suggests that both the authorities in the East Indies and in the Republic were still very much concerned that charts and instruments could fall into foreign hands. If any more proof of the continued secrecy regarding charts should be needed, one finds in the list of decisions taken by the High Government of the East Indies on 25 August 1761 that it was forbidden (punishable by corporal punishment) to sell, hand over or give any of the company's charts to a foreign nation.⁶³⁵ This was repeated by a decree of 20 August 1789, which stated that it was absolutely forbidden to sell charts to foreigners; on 9 November 1792 it was explicitly forbidden to the *baas-kaartenmaker* to lend any chart of the company to anyone.⁶³⁶ The fact that the VOC was concerned that its charts might fall into the hands of foreign competitors was in all likelihood because the company still wanted to maintain some grip on the trade in a number of spices, even though its monopoly had already effectively come to an end. It also suggests that it considered its charts as superior to charts that were being produced by or for these competitors. That experts in the service of the company were of a different opinion had already become clear when Martens and De Marre produced their comments on the charts and instructions of the VOC in the late 1740s. Although the VOC implemented a great number of their suggestions, it did not introduce up-to-date foreign charts. Although in the Van Keulen atlases some charts are present produced by foreign chart-makers, these charts are certainly not the most up-to-date that were available at the time.

In 1769, Pybo Steenstra (who had succeeded Martens as examiner for theory at the Amsterdam chamber of the VOC and as lecturer at the *Athenaeum Illustre* in mathematics, astronomy and nautical science) translated the French description by D'Après de Mannevillette of the routes to and from the East Indies.⁶³⁷ In his preface, Steenstra mentioned the excellent charts that had been published by D'Après de Mannevillette in the *Neptune Orientale*, which (as Steenstra wrote) were to be updated in the near future. In between the lines, one can detect some criticism on the current state of affairs:

⁶³⁴ Chijs VII, pp. 285-286

⁶³⁵ Bataviaasch Genootschap van Kunsten en Wetenschappen (1882-1886) *Realia*, p. 381

⁶³⁶ Chijs XI, p. 155 resp. p. 479

⁶³⁷ D'Après de Mannevillette was captain in the French *Compagnie des Indes* and became a famous hydrographer. See Haudrère (1993), pp. 85-87

The wish (to translate this treatise) grew even stronger when I, on further reading, came across various issues, that are contested by our elder sailors, although present-day experiences, mentioned in the journals of our seafarers, all sufficiently and unanimously confirm their truth.⁶³⁸

Maybe it was no coincidence that the translation, although published by Van Keulen, the official chart supplier of the VOC, carried no dedication to the directors of the VOC – on the issue of charts and sailing instructions Steenstra probably was of a different opinion than his VOC employers. Although Steenstra added a number of footnotes to his translation, he seems not to have felt the need to add a footnote to oppose the opinion of D'Après de Manneville that the Dutch charts by Pieter Goos and by Van Keulen were so “inaccurate” that there was no point in commenting on these charts as he did regarding new French charts.⁶³⁹ These new charts – despite some shortcomings – were much better and could therefore benefit from criticism. More than twenty years after his predecessor Martens had argued for the superiority of French and English charts, again an examiner of the VOC (this time more or less in between the lines) sang the praises of foreign charts. However, the VOC continued to use its own charts; it would take another twenty years before the directors of the VOC conceded that foreign charts might be more reliable than the company's own charts, but then only after it had suffered the high cost of its own unreliable charts and of its reluctance to engage with locally produced cartographic knowledge.

4.2 Centres of observation: ships, the Cape of Good Hope and Batavia

Being equipped with reliable and up-to-date charts and sailing instructions was a necessary condition to sail safely from the Republic to the East Indies and beyond, within Asia and to return to the Republic. A second necessary condition was that skippers and officers should be able to translate their actual position at sea (consisting of latitude and longitude) onto these charts. Whereas finding latitude was a problem that had already been solved by the time the VOC started its shipping operations,⁶⁴⁰ establishing one's longitude was a much more elusive affair. Throughout the seventeenth and eighteenth

⁶³⁸ Steenstra (1769), p. viii (“Dit verlangen wierd by my nog sterker, toen ik, verder voortleezende, verscheide zaaken ontmoette, die van zommigen onzer oude Zeelieden bestreeden worden, schoon de hedendaagsche bevindingen, in de Journaalen onzer Zeevaarenden vermeld, genoegzaam alle eenpaariglyk derzelver waarheid bevsetigen.”)

⁶³⁹ Ibid., p. 31. See also Haudrère (1993), *passim*

⁶⁴⁰ Davids (1986), pp. 65-67

century several schemes, systems and mechanical solutions had been proposed but – until the middle of the eighteenth century – no useful and reliable solution had become available, apart from a method based on magnetic declination to which we will come back. In the second half of the eighteenth century it became possible to determine longitude at sea reliably using two different systems. One of these was the method of comparing the local time on board ship with the time at the port of departure using a marine chronometer that could keep time within very narrow boundaries, even on a moving ship. Although such timekeepers (produced by clockmakers as Harrison in Great Britain and Berthoud in Switzerland/France) appeared on the nautical scene from 1762 onwards, it was not until the nineteenth century that these instruments started to be used on Dutch oceangoing ships.⁶⁴¹ The other method was the “lunar distance method”, developed by astronomers such as Mayer, De La Caille, De Borda and Maskelyne. This method (which involved measuring at sea the distance between the moon and a certain bright star) relied on the availability of pre-calculated “lunar distance” tables in almanacs (called “*Nautical Almanacs*” in England and “*Connaissance des Temps*” in France) and on a simplified way to perform the necessary calculations. To that end, De La Caille devised a calculation system in the 1750s, while the British astronomer royal Maskelyne came up with a similar scheme that became available in 1767.⁶⁴² This “lunar distance method” made some inroads in Dutch (intercontinental) shipping but in the case of the VOC officially only after 1789, although the method devised by De La Caille had been privately used by a skipper of the VOC almost fifteen years earlier. Concerning the lunar distance method, it was not until 1787 that a nautical almanac was published in the Republic that contained the necessary tables. The *Almanac ten Dienste der Zeelieden voor het jaar 1788* (Almanac on Behalf of the Sailors for the year 1788) was prepared by the “longitude-committee” of the Amsterdam Admiralty.⁶⁴³ In their meeting of 28 April 1789, the *Heeren XVII* decided that each *retourschip* should be provided with three copies of the second printing of this almanac (i.e. the Almanac for 1789) and for the following years with the next editions. All officers (and future officers, educated by the *Kweekschool voor de Zeevaart*, the Naval Training College in Amsterdam) should acquaint themselves with this method of establishing

⁶⁴¹ On the emergence of this method, see Cotter (1976), pp. 334-337. During the late 18th century only a few experiments with marine timekeepers were undertaken in the Republic and then only on naval ships, cf. Davids (1986), pp. 183-186.

⁶⁴² Glass (2013), pp. 128-129

⁶⁴³ For an overview of the longitude/latitude question, see Jonkers (2003), pp. 131-146, Schilder & Mörzer Bruyns (1977 B), pp. 215-216 and Mörzer Bruyns (1985), pp. 33-34. The successors to the Dutch almanac (its longitude calculations based on the meridian of Tenerife) were published well into the nineteenth century.

longitude.⁶⁴⁴ Within the VOC, until 1789 the only officially available method for establishing longitude was based on magnetic declination. Although the “lunar distance” method had much earlier been translated into Dutch (and was known to Pybo Steenstra, the examiner for theory at the Amsterdam chamber, as became clear from his public lessons in the early 1770s), it never made into the official sailing instructions.

In this section we will see that to keep the system of magnetic declination up to date, the VOC was dependent on observations made by hundreds of skippers *en route*: (future) colleagues were dependent on their (former) colleagues when reliable figures were needed for the next few years. To that end the company used standardized printed tabulated forms that had to be filled in on route. The combined results from these forms found their way into the sailing instructions, but it is rather curious to note that a different method (the “lunar distance method”) developed abroad and astronomic observations related to it never made it into the official body of knowledge available to skippers. This was even the case when such observations had been made on territories governed by the VOC, by foreign or even Dutch astronomers. This was even the case when figures were made available regarding latitude and longitude of important landmarks. Apparently the VOC concentrated on updating its existing methods and to observations carried out by its own officers and did not care much about other observations, even when this might have led to more reliable information on its charts.

Magnetic declination and magnetic observation

As Davids and Jonkers have shown, before lunar almanacs and chronometers became available, magnetic declination (the difference between the magnetic North as shown by the compass and the true geographical North) was used as a method in Dutch intercontinental shipping to establish longitude at sea.⁶⁴⁵ On the ships of the VOC this was the case during the first decades of the seventeenth century and again from 1742 onwards.⁶⁴⁶ The method was based on the fact that the compass is subject to a different measure of magnetic declination depending on its position on the globe. There usually is a

⁶⁴⁴ NA 1.04.02/85 dd. 28.04.1789

⁶⁴⁵ Sometimes the term *variation* was also used. Throughout this chapter I follow the nomenclature as used by Jonkers (2003).

⁶⁴⁶ Although the printed sailing instructions by the VOC (*Instructie van de Eygenschap der Winden etc.*) contained information on magnetic declination (again) from 1748 onwards (cf. Davids (1990) *passim*, Jonkers (1996A), *passim* and Jonkers (1996B), *passim*). A written update of the sailing instructions of 28 Aug 1742 (NA 1.04.02/168 dd. 28.08.1742) already contained information on magnetic declination near the equator (cf. Davids (1986) pp. 195-196).

difference between the Northerly direction in which a compass needle points as compared to the North represented on charts. This is caused by the fact that the needle of the compass aligns itself with the earth's magnetic field (or points to what is popularly known as the magnetic North Pole) whereas the North on a chart is the geographical North (i.e. the North Pole).⁶⁴⁷ To complicate matters, the earth's magnetic field changes over time in a way that is on the one hand quite noticeable over the timespan of a decade but on the other hand is not reliably predictable in the long term. The direction in which a compass needle points is also influenced by other magnets nearby or by iron parts contained in a ship. This last effect was for example noted in VOC's sailing instructions of 1669, when it said "*Ook moet men toesien, datter geen Yser ofte Stael te digt by het Compas is: dat ook het eene Compas niet al te na het ander Compas gezet word.*" ("One should see to it that no iron or steel is placed too close to the compass; nor should one compass be positioned too close to the other compass").⁶⁴⁸ To be able to follow one's course, one had to compensate for the declination of the compass. That meant that the declination had to be observed on a day-to-day basis and that the compass was adjusted accordingly; this was on the ships of the VOC usually achieved by turning the rose of the compass.⁶⁴⁹ The readers of the 1669 sailing instructions were referred to book by Blaeu or a book by Lastman on how exactly to go about this. In the sailing instructions it also said: "*Als de Naaldwysing vlytig gade geslagen, ende aangeteykend word, zal een yder in toekomende tyd mogen bemerken, hoe ver 't Oost ofte West, dat hy op die breete is, daar de Naaldwysing ras verandert.*"⁶⁵⁰ ("When the pointing of the (compass)needle is diligently observed, and recorded, then in future everybody will know how far to the East or West one is at that latitude, where the pointing of the needle changes rapidly"). Although research by Davids seems to indicate that the using magnetic declination to find longitude was discarded on the ships of the VOC after 1635 (although magnetic declination had to be observed in order to compensate for it on a daily basis), the quote from the 1669 sailing instructions nevertheless suggests that information on declination was still being collected with a view on (future) use for longitude finding.⁶⁵¹

⁶⁴⁷ In fact, the earth's magnetic field is too complicated to be described with the simple dipole model that is suggested by using the terms magnetic North pole and magnetic South Pole. See Jonkers (2003), chapter 1.

⁶⁴⁸ *Instructie van de Eygenschap der Winden etc.* (1669), p. 24 (*Instructie van de Naalden parallel leggende onder de Roos van 't Compas*)

⁶⁴⁹ Jonkers (1996A), pp. 124-125

⁶⁵⁰ *Ibid.*, p. 24

⁶⁵¹ Davids (1986), p. 192 and Davids (1990), p. 285

Combining the observed declination with the knowledge of one's latitude and with information on declination across the globe, made a reliable estimate possible of one's longitude. Information on the magnetic declination was contained in so-called isogonic charts, in tabulated form and it was noted in VOC's sailing instructions.⁶⁵² Although (as we will notice in this chapter) the VOC was reluctant to introduce foreign charts it did sometimes supply its ships with such specialist items as isogonic charts, for instance when the latest English charts that contained information on the magnetic declination of the compass were supplied to outward bound ships.⁶⁵³ In 1783, the "*Ordre wegens het houden en schryven der Dagregisters etc.*" ("the order regarding how to keep and write the daily logs") stipulated – as had in fact been the case for several decades – that each day the skipper and mates had to make notes of their observations of the sun to find the true north (*Poolshoogte*) and of the pointing of the compass (*Naaldwyzing*).⁶⁵⁴ These outcomes should then be used to establish the declination of the compass.⁶⁵⁵ Just like over a century before, the amount and direction of declination was immediately important in order to compensate the compass and it would later be used to keep the sailing instructions up-to-date. Compasses had to be continually adjusted, which had to be recorded in the log (the penalty for not doing so was to forfeit three months' wages). The logs (written on printed tabulated forms as shown in fig. 4.4) had to be handed in immediately upon arrival (either at the Cape, Batavia or another port in the East Indies, or Amsterdam) on a penalty of forfeiting again three (or even six) months' wages. This whole set of regulations shows that the VOC considered these observations as very important. This is not surprising, as knowledge of the amount of magnetic declination was essential for keeping the right course and (both from an experiential and from a theoretical point of view) magnetic declination was considered to be the most appropriate method of establishing one's longitude at sea. Seen from a user's point of view the importance of magnetic declination

⁶⁵² The first isogonic map was produced by the astronomer Halley in 1701. Isogones are lines of constant magnetic declination. In 1738, Nicolaas Cruquius, examiner of the ships' officers at the Delft VOC chamber produced a booklet containing extensive tables on magnetic declination.

⁶⁵³ The decision to use English charts containing information of magnetic declination can be found in NA 1.04.02/82 dd. 03.01.1788; see also Davids (1986), p. 196.

⁶⁵⁴ This *Ordre* was inserted after the minutes of the *Heeren XVII* meeting of 24 November 1783, although parts of this order date back to a resolution of 5 September 1747.

⁶⁵⁵ In the margin of the text of the printed *Ordre wegens het houden en schryven der Dagregisters etc.* (NA 1.04.02/191 dd. 24.11 1783) it says explicitly: "*De Poolshoogte en de miswyzing der Compassen in Zee aan te tekenen*".

(or variation as he called it) was emphasized by the Zeeland skipper Johan Splinter Stavorinus in the journal of his first voyage from 1768 until 1771:⁶⁵⁶

The variation of the compass is the easiest, and almost the surest, rule that is observed by our navigators, to arrive at the Cape, and to determine the longitude they are in; for neither solar nor lunar eclipses occur frequently enough for that purpose, and it is scarcely possible to take an observation by the satellites of Jupiter from on board a ship, on account of its continual motion. If the instrument be correct, and the observation accurate, the variation of the compass may be depended upon (...)⁶⁵⁷

A somewhat more theoretical perspective (although not exclusively so) was offered by Pybo Steenstra in a number of public lectures on the finding of longitude at sea, which he gave at the *Athenaeum Illustre* in Amsterdam in 1770 and which he subsequently published. In his translation of D'Après de Manneville of 1769, Steenstra had already been at pains to explain that experience and (what he called: mathematical) knowledge were both essential and intertwined aspects of what made a good navigator.

One may only expect an increase in the art of navigation through seafarers that have a sufficient knowledge of the underlying mathematics, or through mathematicians that have experientially engaged themselves with the practical aspects of navigation: the contemplative knowledge of the art of navigation has to be combined with a long and attentive experience. The great advantages in the art of navigation that have been achieved through the voyages of Halley, De La Caille and other famous astronomers bear indisputable testimony to that.⁶⁵⁸

⁶⁵⁶ In his career with the Zeeland chamber of the VOC, skipper Johan Splinter Stavorinus kept extensive and sometimes quite frank journals that were posthumously published. The account of his voyage between 1768 and 1771 was published in 1793, and that of his travels between 1774 and 1778 appeared in 1797/98; both volumes were translated into English, French, German and Swedish. For some more details on J.S. Stavorinus, see chapter 3, section 3.1

⁶⁵⁷ Stavorinus (1798) Vol I, pp. 26-27. The quote is taken from the English translations of 1798 (as will be the case with all following quotes from Stavorinus's journals). In this fragment Stavorinus refers to some other methods of finding longitude, either solar/lunar eclipses or the occultations of Jupiter's moons (as suggested by Galileo).

⁶⁵⁸ Steenstra (1769), pp. v-vi ("Het is daarom dat, dat de Stuurmanskonst geen aanwas te wagten heeft, dan van Zeevaarenden, die een genoegzaame kennis van de vereischte Grondbeginselen der Wiskunde hebben; of van Wiskunstenaars, die zig tot de daadelyke oeffening der Zeevaart begeeven; en dus de beschouwende kennis van de Konst der Zeevaart, met eene langduurige en oplettende ondervinding kunnen doen gepaart gaan. De groote vorderingen, die de Stuurmanskonst door de beroemde reizen van HALLEI, DE LA CAILLE en andere voornaame Sterrekundigen bekoomen heeft, is hier een ontegenzeggelyk bewys van.")

In the first of his six lectures, he again emphasized that the art of navigation could only flourish when experienced seafarers (and especially navigators) did not ignore the theoretical aspects of their art. However, he continued, one should also realize that there was little point in pretending that the theory of navigation had to include a complete knowledge of geography and astronomy, of Euclidian mathematics, algebra and other parts of pure mathematics. The result of that would be that future navigators never got around to learning those aspects that were needed at sea.⁶⁵⁹ Just as in the first and third chapter of this book, we see again the necessary und unavoidable intertwining of practical experience and formal knowledge.

In his second lecture, Steenstra discussed ways of improving dead reckoning and finding longitude by using knowledge of latitude, the average speed of the ship (either measured or estimated) and the knowledge of currents. In the third lecture he turned to the topic of finding longitude through magnetic declination. He told his audience

(...) finding the declination has immediately become a main navigational topic: because without it one can only know very inaccurately which course one keeps. But the use of this declination to find one's longitude has not (so to say) become common practice with seafarers, although it has been highly praised by Halley, the Abbot de la Caille and others. (...) To use the declination to establish the longitude, one not only needs to establish by observation the declination on every location one actually finds oneself, but also how much the declination is at every longitude and latitude on earth or should be (...) ⁶⁶⁰

He mentioned the chart made by the astronomer Halley in 1700 which contained the declination of the compass over a large area of the globe, and said that it would be of great advantage for navigation if it were possible to establish the laws governing the declination. But even the excellent mathematician Euler had in 1757 not succeeded in calculating the declination for different places on earth, so one had to be content with experientially observing the phenomenon. Such observations had to be carried out as

⁶⁵⁹ Steenstra (1770), pp. 1-27 *Eerste Les* (first lecture), passim

⁶⁶⁰ Ibid., pp. 40-41 *Derde Les* (third lecture): "(...) is het vinden van deeze miswyzyng terstont een hoofdzaakelyk werk voor de Zeevaart geworden: om dat men zonder die niet, dan zeer onnauwkeurig, de gehouden koers kan weten. Dog het gebruik deezer miswyzyng tot vinding der Lengten, kan men niet zeggen, dat nog by de Zeevaardenden algemeen in gebruik geraakt is, of werkstellig gemaakt wort; schoon het van Halley, de Abt de la Caille en anderen, grootelyks is aangepreezen. (...) Om uit de miswyzyng der Kompassen de Lengten te bepaalen, is het niet alleen noodig op alle plaatsen, daar men zig daadelyk bevint, de miswyzyng door waarneming te kunnen vinden; maar men behoort ook nog buiten dien te weten, hoedaaning op elke Lengte en Breedte van de Aarde de miswyzyng is, of behoort te zyn."

frequently and as “accurately” as possible; the best of these currently available (according to Steenstra) were the notes and the chart produced by Mountaine and Dodson in 1756 (published in the Philosophical Transactions of the Royal Society in 1757). Steenstra added a table (shown as fig. 4.3) that he had constructed by using their notes. Comparing the declination and the latitude as observed from a ship with this table would give the longitude.⁶⁶¹ He concluded that the declination method was until then the best and most expedient way to find the true longitude at sea, at least in those latitudes where a significant change in declination could be observed for every degree of longitude – which was the case near and south of the equator. The only remaining problem was the change that occurred in declination over time, but this could be solved by updating the tables every three or four years.⁶⁶² This process of updating had of course already been going on for a number of decades as is shown by a remark by Steenstra, that

(... he) was daily in the opportunity to check these (i.e. Mountaine and Dodson's) notes against the observations of our Seafarers, especially regarding the declination in the Indian Sea, near the reef of Anguilhas, near the Cape of Good Hope, south of the Line, during the passage of the *Wagenweg* and along the coast of Brazil⁶⁶³

This meant that the oceans had been turned into sites of observation on magnetic declination that had to be performed by the actual users of the method. The observations involved establishing the guessed and true latitude, the guessed longitude and the magnetic declination, and they were carried out by hundreds of skippers and mates on a day-to-day basis with different instruments, such as octant, sextant, bearing compass (*peilkompas*) and azimuth compass, as shown in fig. 4.4. As already noticed, the results of these observations were used immediately to adjust the compass on board and were later handed in at intermediate (i.e. the Cape of Good Hope) and at final destinations (such as Batavia, Bengal, Ceylon, Amsterdam or Middelburg) to

⁶⁶¹ Ibid., pp. 41-45. The table is inserted after p. 46. Steenstra made no mention of the tables that had been constructed in 1738 by Nicolaas Cruquius, the examiner of the Delft chamber of the VOC. Because of the symmetry occurring in Cruquius tables and the static nature of it, Jonkers (1996), p. 193 assumes that his figures were based on a mathematical model instead of actual observations.

⁶⁶² Ibid., pp. 45-46

⁶⁶³ Ibid., p. 43: “(Ik) heb dagelyks gelegenheit deeze aantekeningen met de waarneemingen onzer Zeevaarders te toetzen, inzonderheid omtrent de miswyzyngs in de Indische Zee, op het Rif van Anguilhas, by de Kaap de Goede Hoop, onder de Linie, in het passeeren van den Wagenweg en langs de Kust van Brasil.”

be accumulated, compared and checked, and were then added to the experiential body of knowledge of the VOC.⁶⁶⁴

Stellar observations and lunar distance

In the next three lectures Steenstra mentioned a number of alternatives to the magnetic declination method, which all essentially involved answering two questions. The first of these was “How to find the true time on board” and the second was “How – at the same moment – find the time at a place of which one knows the longitude”.⁶⁶⁵ He explained that eclipses of the moon or the sun occurred too infrequently to be of any use, and the occultations of the moons of Jupiter (as suggested by Galilei) could not be observed with sufficient accuracy from a moving vessel, although these methods did have their use on land. Using a chronometer that was set upon departure at the time of the homeport seemed a straightforward solution, were it not that currently such timepieces did not reliably keep time on board of a moving ship. (“And although the timepiece of Mr. Harrison seems to be getting very close to the requirements, I doubt whether a timepiece will ever achieve that goal”).⁶⁶⁶ This left as the only practical alternative solution to use the positions of heavenly bodies to establish the time at the port of departure. Of the great number of possibilities, Steenstra considered only two as being sufficiently workable on board of a ship. The first was a method originally suggested by Kepler, later by Halley and improved by De La Caille, which entailed measuring the distance between the sunlit edge of the moon and a certain fixed star, the second consisted of measuring the height of the moon over the horizon. Such measurements had to be compared with extensive pre-calculated tables showing the time at which the same outcome would occur at (e.g.) the port of departure. Although this comparison involved a number of calculations that had to be made on board, these calculations had (in the case of the first method) been made less complicated by De La Caille through pre-calculating a number of steps, as Steenstra mentioned.⁶⁶⁷ Both methods emphasized the importance of increasing the knowledge of the heavens; but in

⁶⁶⁴ The skippers of the VOC were not the only ones to note the declination of the compass. For instance, Lieut. James Cook on his 1768-1771 voyage around the world in the Endeavour, took extensive notes of magnetic declination, which were published in the *Philosophical Transactions* (1771) Vol. 61, pp. 422-432.

⁶⁶⁵ Steenstra (1770) pp. 76 *Zesde Les* (sixth lecture): “*Om den waaren tyt te vinden hoe laat het aan boord is, daar men zig bevint*” and “*Om op datzelfde oogenblik den waaren tyt te vinden, hoe laat het op een plaats is, daar men de Lengte van weet.*”

⁶⁶⁶ Ibid., p. 78: “*(...) En of schoon het Uurwerk van Harrison vry na by schynt te komen, om aan de vereischens te kunnen voldoen, twyffel ik echter, of men wel ooit dit gewenschte oogmerk naar genoegen door een Uurwerk zal komen te bereiken (...)*”

⁶⁶⁷ Ibid., pp. 79-96

contrast to the observations on magnetic declination that were collected by skippers and officers of the VOC, the expansion of astronomical knowledge relied for the greatest part on observations by foreign astronomers, although sometimes carried out at sites under the control of the VOC. But even when such observations became available, the VOC seems to have been rather reluctant to add these to the body of knowledge that was made available to its skippers and officers.

A case in point are the astronomical observations that were carried out in 1751/1752 at the Cape of Good Hope by the French astronomer (and member of the *Académie Royale des Sciences* in Paris) Nicolas-Louis Abbé De La Caille. On 19 April 1751 he and his technical assistant Mr. Poitevin arrived at the Cape on *Le Glorieux*, a ship belonging to the French *Compagnie des Indes* commanded by Jean-Baptiste D'Après de Manneville. According to De La Caille in the *Relation Abrégée* which he read upon his return to the *Académie Royale des Sciences* in Paris, he intended to establish the exact position of the fixed stars in the Southern hemisphere (in addition to his work on the fixed stars in the Northern hemisphere), to determine the parallax of the moon and the planets, to find the length of a simple pendulum to measure the time of one second and to establish the longitude and latitude of several important landmarks with an eye on improving the knowledge of geography and improving charts. For the observations on the fixed stars he used the same instruments that he had used to find the exact positions of the stars in the Northern hemisphere.⁶⁶⁸ De La Caille carried a number of introductory letters,

⁶⁶⁸ The name De La Caille is also spelled as De Lacaille or Lacaille. I follow the spelling as given in Glass (2013). Glass (2013), p. 1 gives the name of De La Caille's assistant as Poitevin, whereas he is called Rétail by Armitage (1956), p. 175. Evans (1967), p. 269 just mentions "possibly one assistant". De La Caille referred to him as "*un ouvrier, élève de M. Langlois*" (i.e. a workman, pupil of Mr. Langlois). He did so in his *Relation Abrégée*, the short account that he read at the *Académie Royale* on 15.11.1754 but which is contained in the *Histoire de l'Académie Royale des Sciences* 1751, published in 1755. The referral is on p. 526. The *Relation Abrégée* was translated as *Kort Berigt* in *Uitgezogte Verhandelingen Eerste Deel*, (pp. 333-364); in this contemporary translation in Dutch, the assistant is referred to as *werkmeeester, eene leerling van Mr. Langlois* (p. 346). De La Caille's mentioned his plans on p. 520 of the *Relation Abrégée*; in the *Kort Berigt* these are on pp. 335-336. The historian Glass (Glass (2013), p. 29) gives a slightly different overview, based on De La Caille's original proposal: (1) To determine the true position of the Cape (...); (2) To determine by concerted observations, the parallax of the Moon (...); (3) To observe the parallax [distance] of the Sun (...); (4) To complete the catalogue of the principal fixed stars, by the same method and with the same instruments with which he has already established the exact positions of the northern ones. A copy of this proposal is in MacLear Vol. 1 (1866), Appendix 3, pp. 56-58. The Cape of Good Hope was eminently suited for De La Caille's observations because it was situated at the greatest distance from Paris in the same half of the world and on the meridian that passed through the centre of Europe, and the air was cleaner and healthier than anywhere else south of the equator.

among which was one that had been written by Willem IV, the stadholder of the Dutch Republic and principal director of the VOC. In this letter every possible assistance was asked from those in charge of the VOC settlement at the Cape of Good Hope to facilitate De La Caille's astronomical observations at the Cape.⁶⁶⁹ When he arrived, governor Rijk Tulbagh granted him permission to stay and to build an observatory in the grounds of the house owned by the *freeburgher* Bestbier.⁶⁷⁰ The observatory was constructed with materials, manpower and assistance provided by the government of the Cape.⁶⁷¹ De La Caille used observations of nearly 10,000 stars to produce a comprehensive catalogue of some 1900 stars visible in the southern hemisphere, which was a huge improvement on the existing catalogues that had been established (as far as Europeans were concerned) by Amerigo Vespucci and Andreas Corsali in the early sixteenth century, Pieter Keyser, Frederick de Houtman and Petrus Plancius in the early seventeenth century and by Edmond Halley in the late seventeenth century.⁶⁷²

Fig. 4.5 The planisphere of the Southern heavens as measured and drawn by De La Caille

⁶⁶⁹ The whole set of letters is published in MacLear Vol. 1 (1866), Appendix 4-14, pp. 58-64

⁶⁷⁰ Freeburghers were not employed by the VOC (although they usually had been employed by the company earlier) and who lived as (more or less) independent citizens in towns like Capetown or Batavia. On Bestbier, see De La Caille (1757), p. 339, 346, 352-353, Schirach (1952), pp. 32-33 and Glass (2013), pp. 41-45 & 73-80.

⁶⁷¹ De La Caille (1757), p. 339, Armitage (1956), p. 176, Glass (2013), pp. 43-45

⁶⁷² Armitage (1956), p. 177, Kanas (2003), pp. 117-123

De La Caille established the longitude of the Cape to which end he used “eclipses of the Moon, of Jupiter’s Satellites and of Stars by the Moon”.⁶⁷³ Whereas De La Caille explicitly mentioned the improvement of charts as one of his objectives (which is also borne out by his experiments with establishing longitude while at sea), there is no evidence that the VOC adapted its charts by using his values for the geographical coordinates of the Cape. This is even more remarkable as the VOC was offered De La Caille’s stellar observations on a plate so to say: as a token of gratitude for the cooperation given by local officials of the VOC, De La Caille presented a handwritten copy of his observations to governor Rijk Tulbagh; this volume was transferred by him to the University of Leiden.⁶⁷⁴ The longitude and latitude were published in the *Histoire de l’Académie* in 1755 in Paris, and the longitude was published in 1757 in the Republic in *Uitgezogte Verhandelingen*, so even without having recourse to De La Caille’s stellar observations as such they were available in a Dutch translation.

Looking at the use that could be made of recent astronomical observations, the policies of the VOC showed a marked contrast to those of the French *Compagnie des Indes* as is borne out by the events when De La Caille was about to return to France in 1753. De La Caille was ordered by the *Compagnie* to travel first to Île de France and Île de Bourbon (as Mauritius and Réunion were known at the time) to establish the coordinates of these islands.⁶⁷⁵ In fact, De La Caille saw little point in going to these islands, as – according to his own words – he already knew that D’Après de Manneville had made the necessary observations which he had checked when he had called at the Cape on his way home and which (in De La Caille’s words) couldn’t be bettered.⁶⁷⁶ What this episode shows is that the French *Compagnie des Indes* (in contrast to the VOC) attached great importance to establishing the longitude and latitude of its important ports of call. On his way to these islands (just as on his way to the Cape and later on his return to France), De La

⁶⁷³ De La Caille (1757), p. 348 (“*de verduisteringen der Maan, die van de Omloopers van Jupiter, en die der Sterren door de Maan*”). The longitude of Cape Town was according to his measurements 16° 10’ east of Paris (which equals 18° 30’ east of Greenwich); its latitude was 33° 55’ 15” South. The latitude is in *Histoire de l’Académie* (1751/1755), p. 412; the longitude is given on p. 527. De La Caille doesn’t make clear how he exactly came by the latitude, other than remarking that one had to take refraction into account. In the *Kort Berigt* one only finds the longitude of the Cape (p. 348). According to Mackenzie (Mackenzie (1952), p. 45 & 49) this is the longitude of the Cape itself, but Armitage (1956), p. 176 interprets this as the longitude of De La Caille’s observatory, which is also suggested by Glass (2013), pp. 63-64.

⁶⁷⁴ Zuidervart (1999), p. 268 (and *Afbeelding* 62 on p. 252). This manuscript is still at the library of Leiden University (Special Collections).

⁶⁷⁵ De La Caille (1757), pp. 354- 355 & 361-363

⁶⁷⁶ *Ibid.*, p. 355

Caille experimented with establishing longitude while at sea using the “lunar distance” method, trying to reduce the necessary calculations to a minimum.⁶⁷⁷ Although De La Caille did not mention this explicitly in his original proposal, it becomes clear from his actions at sea (and through his report) that he attached great importance to testing his method for finding longitude in practice and see to it that it could be used by seafarers without requiring any more cumbersome calculations than was absolutely necessary:

I made some of these calculations in advance, to have this new method tested by some officers of our ship (i.e. the ship that took him from the Cape to Île de France), and already the first time those that wished to follow my methods conceded that it would be very easy to do so given pre-calculations: I made different ones for them for the remainder of their voyage, with a written instruction to use these calculations and the gentlemen used these without any trouble⁶⁷⁸

In 1755, De La Caille published his method in the “1755 *Ephemerides des Mouvements Célestes*” which became available in a Dutch translation in 1759.⁶⁷⁹ It would take another thirty years (i.e. twenty years after the lectures given by Steenstra) until the VOC introduced in 1789 the Dutch almanac that contained the essential tables with which the “lunar distance” method could be implemented.

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Stavorinus's experiments

That the VOC formally introduced the “lunar distance” method in 1789 did not mean that it was not used several years earlier by at least one of its skippers. In the journal concerning his second voyage (from 1774 to 1778), Stavorinus wrote:

On the 5th (September 1774) we saw a good deal of seaweed, which made us conclude that we had passed the islands of Amsterdam and St. Paul, or were to the eastward of them; the more so, as the variations of the compass, and

⁶⁷⁷ Ibid., pp. 359-361

⁶⁷⁸ Ibid., p. 360 (“Ik maakte by voorraad sommigen van die Rekeningen, om een Proef van deze nieuwe Manier te laten nemen door sommigen der Officieren van ons Schip, en in de eerste keer zelve bekenden die genen, welke myn Werkingen wilden volgen, dat het hun zeer ligt zou vallen dergelyken te maken met behulp van vooraf gegane Rekeningen: Ik maakte nog anderen voor hun tot het overige van de Reis, met eene geschreven Onderrigting om gebruik van deze Uitrekeningen te maken, en die Heeren bedienden'er zig van zonder moeite”)

⁶⁷⁹ De La Caille (1759), pp. 495-539. Later De La Caille devised a graphical method to avoid the need for most of the calculations; this was published in *Connaissance des Temps pour l'Année 1761* (1759), pp. 174-193 and Planche I & II (after p. 240)

two lunar observations, which I had made, according to the manner of M. DE LA CAILLE, corroborated the conjecture.⁶⁸⁰

This fragment shows the three different ways in which skippers could establish their longitudinal position. The first was paying attention to natural phenomena (in this case the occurrence of seaweed), the second consisted in observing magnetic declination and the third one was observing and calculating the lunar distance, which Stavorinus implemented fifteen years before the official introduction by the VOC. The two first ways were explicitly mentioned in the sailing instructions of 1768:

(...) observing the declination, which is to the west, out of sight of these islands, nowadays from 19 to 18 degrees, and at the islands themselves between 18 and 17 degrees Northwestering. But in case one could not observe these (islands), one has to look out for the greenery, which can sometimes be found just to the west but always to the east of the islands (...)⁶⁸¹

There is no evidence that De La Caille's tables had been translated into Dutch at the time (although, as we saw, the method as such had been translated in 1759) so we must assume that being able to use this method must have mattered enough for Stavorinus to go to the trouble of acquainting himself with this method and to purchase the necessary almanac with the tables to perform it from Paris. In October 1775, while on a voyage to Surat, Stavorinus mentioned:

The seeing of all these signs of land, made us suspect that we were much more to the westward than we reckoned; and some observations of the longitude, taken according to the manner of M. DE LA CAILLE, confirmed this supposition⁶⁸²

Then we find that on his return voyage to the Republic in 1777/1778, he used an eclipse of the sun (which took place on 24 June 1778) to establish his position by comparing the time the eclipse ended "according to several observations" with the time it ended in Paris "according to the *Connaissance des Temps*". The outcome (which showed that his current position was far more to the West than had been presumed) was in accordance with a number

⁶⁸⁰ Stavorinus, Part II, p. 106 (Capitals in original)

⁶⁸¹ *Verbeeterde Instructie* (1768), p. 11 (" (...) *het observeeren der miswyzing, die bewesten buyten het gezigt van deze Eilanden thans van 19 tot 18 graden, en by dezelve 18 a 17 graden, Noordwestering bevonden is. Dog indien men dezelve niet konde observeeren, diend men uyt te zien na de groente, die somtyds even bewesten, dog altyd beoosten dezelve gevonden word (...)*")

⁶⁸² Stavorinus, Part II, pp. 438-439 (Capitals in original)

of observations he had made four days earlier “of the distances of the sun and moon.”⁶⁸³ It would take more than a decade after Stavorinus’s return before this method was introduced as a standard procedure by the VOC. Why the method of De La Caille, tried and tested as it was on the ships of the French *Compagnie des Indes*, translated into Dutch and positively commented upon by Steenstra in his public lectures in 1770 failed to be accepted by the VOC remains unclear. What is clear though is that other observations made by the company’s own skippers (as was the case with magnetic declination) found their way into the body of knowledge on which revisions of the sailing instructions were based. This gives the impression that for the VOC, observations made by its own users related to existing policies of the company mattered far more than observations (even by a company skipper) connected with other methods.

The transits of Venus

The predicted occurrence of the transit of Venus across the face of the sun of 1761 and 1769 – an astronomical event that occurs only twice every 130 years - caused a lot of excitement amongst astronomers in the eighteenth century.⁶⁸⁴ Despite the fact that the Seven Years Anglo-French War (1756-1763) was still raging at the time, an international effort saw a great number of astronomers of different nationalities travelling to far-flung places to make observations.⁶⁸⁵ Although some Dutch astronomers observed the transit from different places in the Republic, there was no concerted Dutch effort to use the territories controlled by the VOC for making observations further afield.

The Royal Society in London had appointed the astronomers Mason and Dixon to observe the 1761 transit of Venus from Bencoolen on the Southwest coast of Sumatra, where the British East India Company had

⁶⁸³ Stavorinus, Part III, p. 471. Here Stavorinus explicitly referred to the “*Connaissance des Temps*” which contained the lunar tables.

⁶⁸⁴ Johannes Kepler was the first astronomer to predict these very rare transits when the planet Venus moves across the face of the sun, and he had calculated that a transit of Venus would occur in 1631, which was not visible in Europe because it occurred during the night. Only two astronomers, Horrocks and Crabtree, observed the next transit in 1639, which was not predicted by Kepler, but of which the astronomer Horrocks had calculated that it would occur. Horrocks suggested that the observation of Venus’s transit might be used to calculate the distance between the earth and the sun. In a paper for the Royal Society in 1716, the astronomer Halley outlined a method to be used to that end, and he pointed to the next pair of transits (those in June 1761 and 1769) as the only chance during the eighteenth century to make the necessary observations. Cf. Woolf (1953), pp. 182-183 and Hudon (2004), p. 7

⁶⁸⁵ Woolf (1953), pp. 184-187 and Hudon (2004), pp. 7-10

established a pepper-trading centre and a garrison in 1685.⁶⁸⁶ Due to a skirmish at sea between their vessel and a French naval vessel they were severely delayed and when they reached the Cape of Good Hope and got word that the French had captured Bencoolen, they decided to stay at the Cape. There they were given permission by the Dutch governor Rijk Tulbagh to set up an observatory to watch the transit of Venus.⁶⁸⁷ Apparently, the observatory used by De La Caille had meanwhile been dismantled because Mason and Dixon built a new observatory on a different site. Just as De La Caille had done before them, they established the longitude and the latitude of Cape Town and of Cape Point.⁶⁸⁸ The French *Académie Royale des Sciences* asked the Republic to assist them in setting up an observatory in Batavia for the 1761 transit, but the only help that was offered was that the VOC was willing to provide passage on a ship to Batavia for a representative of the *Académie*. There was apparently no interest in the Republic for sending Dutch astronomers to Batavia. In the end, it was agreed to ask a VOC official, capable of using astronomical instruments, to observe the transit in Batavia. An added advantage would be that the astronomical coordinates for Batavia could be reliably established. Gerrit de Haan, head of the Batavian chart-makers office and Pieter Jan Soele, a skipper employed by the VOC made the observations from the seaside residence of Johan Mohr, (retired) rector of the Portuguese church in Batavia and an amateur astronomer.⁶⁸⁹ They succeeded in observing the complete transition; however, the results that were sent by De Haan and Soele to the Republic appear to have been lost. They had given a copy of their measurements to Mohr, who – using their observations - wrote his own version of events, in which he accused De Haan and Soele of producing a “*lomp en ongeschikt*” (stupid and unsuitable) and “*defect en vitieus*” (defective and worthless) report. In 1763, Mohr’s report was published in the *Transactions* of

⁶⁸⁶ Bencoolen was the name given by the British at the time to what is now known as Bengkulu.

⁶⁸⁷ Resolutions of the Council of Policy of Cape of Good Hope, Ref. code C. 139, pp. 197-208 & pp. 523-526. These resolutions are in edited form available through <http://databases.tanap.net/cgh/>

⁶⁸⁸ Their outcome was that the longitude of Cape Town was 18° 23’ 15’’ (East of Greenwich), cf. Mackenzie (1951), p. 102

⁶⁸⁹ Zuidervaar & Gent, van (2004), pp. 4-9. It turns out impossible to find a Pieter Jan Soele as being in the service of the VOC as skipper around 1761 (neither through <http://resources.huygens.knaw.nl/das> nor through <http://vocopvarenden.nationaalarchief.nl/default.aspx>). There is however (in both databases) mention of a skipper Pieter Joele who had arrived in Batavia on 17 May 1760 and who left again on 2 November 1761. This could well be the skipper in question, which suggests that some way or another a misspelling has occurred.

the *Hollandsche Maatschappij der Wetenschappen*.⁶⁹⁰ Other astronomers expressed doubts on the quality of Mohr's report and eventually, the Batavian observations were not included in the recognized list of the 1761-observations.⁶⁹¹ Mohr also established the longitude of Batavia around the time of the Venus transit of 1761, as becomes clear from a letter Mohr wrote (on 2 November 1768) to Thomas Hope, one of the directors of the Amsterdam chamber of the VOC. In this letter Mohr argued that astronomy had been and still was particularly important for the improvement of charts and maps, but that the true longitude of Batavia had never been established until he had done so during the Venus transit of 1761. He offered to establish the longitude and latitude of several other locations on Java, its eastern and western extremities, its north and south coasts, and inland as well, because at the moment every map or chart showed different longitudes and even latitudes for the same spot. He suggested that a small letter of recommendation for his work, directed to the government of the East Indies would be sufficient as remuneration, especially considering the lack of interest in pursuing the natural sciences in Batavia or even the downright sabotage of it.⁶⁹²

In the years between the two transits of Venus, Mohr had a large house constructed in Batavia, with a private astronomical observatory on the sixth floor. The observatory was equipped with astronomical and meteorological instruments purchased on his behalf by Johan Lulofs, professor of astronomy

⁶⁹⁰ *Verhandelingen van de Hollandsche Maatschappij van Wetenschappen deel VII* (1763), pp. 380-391

⁶⁹¹ Van der Bilt (1940), p. 58 and Woolf (1959), pp. 135-140

⁶⁹² Leupe, P.A. (1864), pp. 165-166 has Mohr's letter verbatim ("*De land- en zeekaarten inzonderheid zijn door haar (i.e. sterrekunde) grootelijks verbeterd, en ondergaan zulks nog jaarlijks (...) dat alhier op deze Hoofdplaats van Neêrlands-Indiën, ter bepaling van desselvs ware lengte, nog nooit vóór het jaar 1761 gedaan zijn, wanneer ik de bekende passage van Venus over de zonneschijf heb waargenomen*" and "(...) zoodanige waarnemingen om (...) op andere plaatsen van dit eiland aan zijnen oostelijken of westelijken uithoek, langs zijne stranden ten noorden of ten zuiden, dan wel landwaarts in, moesten gedaan om de ware situatie van Java in zijne lengte en breedte (...) nader en naauwkeuriger te bepalen (...) waarvan men zeggen mag, zoo veel kaarten, zo veele verschillen in lengte en somtijds ook in breedte. (...) Ik offereere ten dien einde mijne geringe vermogens om dezelve te emploijeren" and "(...) een lettertje van recommandatie na herwaards aan deze regering mag afgaan, om mij in deze functie, waarmede ik mij zelve ter liefde van de weetenschappen en van 't algemeen welzijn vrijwillig gechargeerd hebbe, door Haar voorbeeld en gezag behoorlijk aan te moedigen en te maintaineren tegen den haat en de veragting van zulke lieden, die het zoo min aan malitie als vermogen ontbreekt, om de beste inzigten en onderneemingen van anderen, die niet van hunnen smaak en goedkeuring zijn, te dwarsboomen en hatelijk te maken." See also Bilt, J. van der (1940), pp. 70-71, Mörzer Bruyns (1985), pp. 37-38, Zuidervaart (1999), pp. 317-318 & Zuidervaart & Gent, van (2004), p. 19

at the University of Leiden.⁶⁹³ The 1769 transit was observed by even more observers worldwide than the 1761 transit. On the day itself, no observations could be performed within the Dutch Republic because of clouded skies. However, in Batavia Mohr was able to observe most of the transit from his observatory. He could not view the ingress of Venus due to overcast skies, but he was able to observe the egress, as is borne out by his report in the *Verhandelingen van de Hollandsche Maatschappij der Wetenschappen deel XXII (Berichten)*.⁶⁹⁴ Mohr also presented James Cook (who had arrived in Batavia to have repairs carried out on his ship⁶⁹⁵) with a report (in Latin) that contained his observations of the transit of Venus and of the later transit of Mercury; this report was published in the *Philosophical Transactions of the Royal Society* 1771.⁶⁹⁶ This time the observations from Batavia were in due course officially recognized as reliable and accepted into the official list of 1769-observations.⁶⁹⁷

However, just as the VOC had not used the figures obtained by De La Caille, neither did the company use the results of astronomical observations that had been carried out by other astronomers from territories under the control of the VOC, be it “professionals” such as Mason and Dixon at the Cape of Good Hope or “amateurs” such as Mohr, De Haan and Soele in Batavia, even when such “amateurs” were closely connected to or even employed by the company.⁶⁹⁸ The only observations that made it into the accumulated navigational knowledge of the company were the observations made by the skippers and officers on board of the company’s ships, in other words the

⁶⁹³ Bilt, van der (1940), p. 61, Bilt, van der (1942), p. 71, Zuidervaat (1999), p. 317 and Zuidervaat & Gent, van (2004), pp 11 and 15. Lulofs had also played a role in the appointment of Mohr as a member of the *Hollandsche Maatschappij van Wetenschappen* because of his observations of the transit of Venus in 1761, cf. Bilt, van der (1942), pp. 71-72 and Zuidervaat & Gent, van (2004), p. 11.

⁶⁹⁴ *Verhandelingen van de Hollandsche Maatschappij van Wetenschappen deel XXII Berichten* (1770), pp. 123-130

⁶⁹⁵ Apparently, the shipwrights at Onrust had a reputation that went beyond the VOC. That they were able to carry out these repairs on a foreign vessel can be seen as testimony to their embodied, practical and experiential knowledge.

⁶⁹⁶ *Philosophical Transactions of the Royal Society* Vol. 61(1771), pp. 433-436

⁶⁹⁷ Woolf (1959), pp. 182-187

⁶⁹⁸ Cf. l’Honoré Naber (1914), p. 14 (“*Nergens blijkt echter dat de Nederlanders getracht hebben hunne “overzeilers” aanstonds te verbeteren door het bepalen van de lengteverschillen der voornaamste punten. De lengte van de Kaap was door Lacaille in 1751 bepaald op 18 graden en 30 minuten ...*”). After 1761, Mohr also established the latitude and longitude of his newly built observatory; the values obtained by him were reviewed after more than seventy years when the longitude of Batavia was officially established in 1839; there was only a small difference between Mohr’s results and these measurements. See Bilt, van der (1940), pp. 67-70.

users of its charts and sailing instructions. Looking at subsequent editions of the sailing instructions, it is certain that these were updated using new information on magnetic declination. As far as the updating of charts was concerned, one gets the impression that the VOC left any updating of the sixth volume of the Van Keulen atlas entirely to the publishing firm of Van Keulen. However, no traces can be found of any updated reprint of the sixth volume of this atlas after an early update that was published in 1757.⁶⁹⁹ Likewise, whether the charts produced in Batavia were kept up to date seems at least debatable as we will see in the following section. The fact that the directors in Amsterdam did not act upon the possibility of adapting the charts of the company is remarkable as the criticism regarding the “accuracy” of its charts increased during the second half of the eighteenth century. That these “inaccuracies” could prove very costly was shown by a number of events between 1770 and 1790.

4.3 The high price of unreliable charts

On 22 November 1771 (and again on 10 December of that year), the High Government in Batavia issued a decree in which it mentioned that the *retourschip Scholtenburg* had been wrecked on a “*klippige droogte*” (rocky shallows) near the coast of Madura; a hazard that was said not to have been marked on the charts of the company.⁷⁰⁰ That was almost certainly the case because the skipper on the *Scholtenburg* was still employed as skipper after these events – and the VOC was not known for its leniency when officers were to blame for mistakes.⁷⁰¹ However, part of the blame for unreliable charting

⁶⁹⁹ According to Koeman (1970), Vol. IV (pp. 364-366) “(...) two editions (of 1753) with different settings are known. (...) Immediately after 1753, Joh. Van Keulen started revision of the work. He added new charts and a final edition with a register and numbered plates appeared after his death, ca. 1757. But no edition is known with a date other than 1753 on the title-page (...)” Under the heading Keu 135 C Koeman says: “This (i.e. the 1757 edition) is the final edition on the sixth part of the *Zee-Fakkel*. It has more charts than any of the older variants and the plates have engraved plate numbers 1-66. The date of publication is after 1755, because one of the charts (...) shows this date in a legend.” Also Vries, de e.a. (2005) give only 1753 as the date of the sixth volume of the *Zee-Fakkel*.

⁶⁹⁹ NA 3.02.33/24 letter of 12.03.1795

⁷⁰⁰ Chijs VIII, pp. 718-719

⁷⁰¹ According to <http://resources.huygens.knaw.nl/das/detailVoyage/95115> the *Scholtenburg* was wrecked on 09.01.1772 while sailing from Batavia to Ceylon – it is most likely that the date should be 09.01.1771, because the stranding must certainly have happened before the decree was published in December 1771. Probably the skipper was Jan Ide, see

http://resources.huygens.knaw.nl/das/voyages?clear=1&field_voymaster=Ide,%20Jan

was shifted towards skippers in general when it was suggested in the decree that skippers had been rather negligent in reporting issues with unreliable charts. Skippers were again instructed to report immediately any shortcomings they had noticed on the official charts, be it features missing or misplaced. On the other hand, as we will notice later in this section, skippers complained that their remarks were not seriously considered by the chart-makers of the VOC. The *baas-kaartenmaker* in Batavia was ordered to send reports containing details of “new or improved discoveries” to the government and to do so every three months. Whoever was to blame, one gets the impression that there was in any case a discrepancy between the need to establish and improve safe routes between the Republic and the East Indies and within the East Indies and the actual practice of doing so. In this section, it will become clear from a number of critical comments on the charts of the VOC that these charts did not reflect in sufficient measure the experiences of its users, neither had they incorporated observations made by astronomers nor had advantage been taken of foreign expertise. This state of affairs contributed in a number of cases to the wrecking of ships with the loss of human life and/or valuable cargo. What happened in 1771 was not the first instance of problems with either skippers who presumably did not report “inaccuracies” on charts or with chart-makers who did not respond to such reports by skippers. This becomes clear from several decrees that had been issued earlier, most of which were directed to officials in Batavia and beyond.

On 15 January 1753 (almost twenty years before the stranding), the High Government in Batavia appointed the naval lieutenant Pieter Ohdem, lector in mathematics and navigation at the Batavian “*Académie de Marine*” as examiner of charts.⁷⁰² He had to see to it that the copies of (manuscript) charts provided to the ships were based on the originals that had been approved by the government. On 6 March of that year, the *baas-kaartenmaker* received orders to painstakingly keep note of all discoveries contained in ships’ journals and of all improvements and changes that had been made as ordered by the government or the Governor-General. In addition he had to see to it that ships were only provided with those charts that had been approved by the examiner. “Improved” copies of charts were to be sent to all outposts to be locally checked. When these charts had been returned, the charts of Java and the West of India (that being the areas of which foreign nations had reasonably correct charts) should be sent to the Netherlands to be printed.

⁷⁰² Chijns VI, p. 320 dd. 15.01.1753. The “*Académie de Marine*” was a nautical academy, established in Batavia by Governor-General Van Imhoff in 1743. Its purpose was to increase the number of well-educated ships’ officers. To that end, boys, aged between 12 and 14 years old, were (theoretically and practically) schooled to become officers. However, the academy existed for only twelve years, as it was closed in 1755. See Haan (1894), Heuven, Van (1953), Merens (1953) and Dekker (1969), *passim*.

However, it was also stipulated that locally produced charts of the East and the North should never be handed over to private persons or foreigners.⁷⁰³ The conclusion must be that (as far as the government in the East Indies was concerned) only those charts could be printed in the Republic that were in the public domain anyway and that charts of other areas (specifically those of the seas between the East Indies and China/Japan and the seas in the Eastern part of the Indonesian archipelago) should be kept secret. No mention is made of the fact that foreign charts of these areas might be used to advantage by ships sailing to the North or to the East. As a follow-up on this order, the chiefs of the outposts were instructed to carry out improvements on charts covering their area and to send these to Batavia.⁷⁰⁴ In 1756, this order was repeated and extended, to the effect that local *equipagemeesters* and nautical experts should send reports to the government on anything that could lead to the improvement of knowledge of local wind patterns, currents and charts.⁷⁰⁵ The fact that in the 1750s the officials involved in chart making in Batavia were several times instructed to make use of remarks by skippers lends some weight to complaints by skippers that their reports did not get the attention they deserved.

A dangerous trade

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As noticed in the previous chapter, the direct tea trade with China can be considered to have been advantageous for the VOC (just as its extensive and intricate intra-Asian trade), but particularly the voyage to and from Canton was not without some severe risks.⁷⁰⁶ These risks consisted first and foremost in the seasonal occurrence of typhoons in the South China seas, but they were made worse by fact that the VOC's charts of that area quite often lacked sufficient and/or reliable information on the longitude and latitude of important landmarks. Moreover, the complete absence on the charts of existing islands, the presence of non-existent islands and the lack of reliable and up-to-date information on sheltered inlets and soundings was at least very inconvenient, if not outright dangerous to the safe passage of ships. The first time that this state of affairs became obvious was when the Zeeland built three-decker *Rijnsburg* (sailing on behalf of the Amsterdam chamber at the time) went down on 17 July 1772 with almost all hands on its approach to Canton.⁷⁰⁷ That it happened was – at least in part – caused by the fact that its

⁷⁰³ Chijs VI, p. 326 dd. 6.03.1753

⁷⁰⁴ Chijs VI, p. 346 dd. 6.04.1753

⁷⁰⁵ Chijs VII, p. 194-195 dd. 17.09.1756

⁷⁰⁶ Cf. chapter 3, section 3.3

⁷⁰⁷ *Verhandelingen Zeeuwisch Genootschap, Zevende Deel* (1780), p. 224 (footnote f); also Mulder (1944), *passim*

gunports had not been secured while battling a typhoon, and while riding out the next typhoon behind its anchors near Canton. Apart from this alleged recklessness of the skipper, insufficient knowledge of the South China Seas (specifically on where to find a sheltered place for anchoring) contributed to the wrecking of the ship. The problems of insufficient knowledge were apparently aggravated by the fact that the skipper stubbornly refused to follow the advice of a local pilot.⁷⁰⁸ Only eleven people survived the disaster. The first mate, three seamen and the Chinese pilot were the first to arrive in Canton. They had clung to wreckage for thirty hours before they reached land, after which they had to walk for twelve days before they finally reached Canton. A number of days later, six more crewmembers of the *Rijnsburg* arrived in Canton, five seamen (one of whom died some weeks later) and a slave belonging to the second mate.⁷⁰⁹ In the *Eerbiedig Rapport* (the Respectful Report) concerning the year 1772 that the VOC officials in Canton sent to the directors of the *Chinasche Commissie*⁷¹⁰ (the China Committee, i.e. the committee for the direct shipping and trade with China) they wrote extensively about what had happened to the *Rijnsburg*. They explained that they had purchased a replacement vessel from the Portuguese governor at Macao in order to have the cargo designated for the *Rijnsburg* transported to the Republic. This vessel (originally named *S. Simão*, and renamed *Herstelder* after a local refit) had been launched in Bombay in the autumn of 1770; the rather high price that had been paid for it might be offset – they wrote – by the long life expectancy (sixty years, they assumed) of the ship.⁷¹¹ It remained in the service of the VOC and it made a number of return voyages until it was wrecked in the East Indies in 1783, which meant that its lifespan was much shorter than what the Canton staff had expected.

The staff in Canton added that they had tried to salvage the bullion, coins and/or the tin on board and that they had decided that the rest of the cargo could not be of any use anymore as it would have been ruined by seawater. However, not only was the ship too deep down, but eight divers (diving off two Chinese fishing vessels) who had tried to make a profit by salvaging goods from the wreck had never resurfaced, possibly devoured by the great number of sharks on that coast. The effect of this had been that no diver had been prepared to risk his life anymore. It seemed that the *Rijnsburg* had gone to the bottom of the sea more or less in one piece, because at low

⁷⁰⁸ Mulder (1944), pp. 624-625

⁷⁰⁹ Mulder (1944), p. 623 & 626

⁷¹⁰ NA 1.04.20/234 *Eerbiedig Rapport*, pp. 20-27; see also chapter 3, section 3.3

⁷¹¹ NA 1.04.20/234 *Eerbiedig Rapport*, pp. 24-27; also Mulder (1944), pp. 621-630, Dyke, Paul A. van (2005/2007), p. 145 and Liu (2007), p. 101-111, <http://resources.huygens.knaw.nl/das/search> (“name of ship”= “herstelder” - results after 1772).

tide in October 1772 the tops of its three masts were still visible.⁷¹² The Canton staff continued to pursue the possibility to salvage some of the valuable and non-perishable goods on board of the wreck, which can be seen from a number of entries in the *Repertorium op zaken in de missiven van China naar de Republiek*.⁷¹³ As the result of an agreement reached in the course of 1772, two parties left for the wreck in 1773. One returned without success but the other salvaged all six cases with ingots of silver, of which the company got 30%, i.e. 188 ingots. The leader of the divers had been shown around a *retourschip* that was in Canton at the time, to make him acquainted with the entries and exits to the decks to ease the operations. The divers could not get to the tin as the pepper on board had swollen because of being immersed in seawater and therefore formed a hard crust over the rest of the cargo. The wreck was full of fish and covered in oysters, although the many sharks around had not caused any harm.⁷¹⁴ By the end of 1774 no progress had been made but after the Chinese New Year the divers would try again. By the end of 1775 it was feared that no tin could be salvaged until the ship had broken into pieces. Finally, in 1778 there seemed to be no hope that any of the tin from the *Rijnsburg* could be recovered.⁷¹⁵

In the *Rapport (...) over het seizoen van 1772 aan (...) Gouverneur Generaal (...) in Batavia* (Report (...) on the season 1772 to (...) Governor General (...) in Batavia) the staff in Canton mentioned that “the (current) chart of the Chinese coast exonerated the skipper Schott (of the *Rijnsburg*) from not seeking shelter behind the island of Sanciam because his chart did not show safe anchorage there”, and moreover, the position of the islands was “inaccurately” marked on it.⁷¹⁶ The purpose of the new chart was to provide “accurate information on the area between the island called Mandarin’s Cap and the island group of the Ladrones, thereby covering the South Westerly approach to Macao and Canton; it was based on observations Van Braam

⁷¹² NA 1.04.20/234 *Eerbiedig Rapport*, p.21, also in NA 1.04.02/4556 *Lading* (in margin 28 Nov 1772) & *Schepen* (in margin *GR als boven fo. 13 & Res. 7 Aug 1772*)

⁷¹³ This *Repertorium* (NA 1.04.02/4556) is more than just a register of letters and reports. It contains (sometimes rather extensive) summaries of the contents of these letters and reports. It covers the period from 1757 until 1779.

⁷¹⁴ NA 1.04.02/4556 *Scheepen* (in margin *GR 20 Dec 1773*) and *Rapp. aan de H.R. 21 Dec 1773*. Apparently the agreement with the divers meant that the VOC in Canton would get 30% of any finds in case of success and that the rest would go to the salvage team; in modern terms the salvage operation was apparently carried out on a “no cure no pay” basis. See also Dyke, Paul A. van (2005/2007), pp. 87-88.

⁷¹⁵ NA 1.04.02/4556 *Scheepen* (in margin *Rapp. aan de H.R. in dato 24 Dec 1774* and *GR 31 Dec 1775 folio 125* and *GR. 31 Jan 1778*)

⁷¹⁶ NA 1.04.02/4556 under the heading “*Kaarten*” (in margin “*Rapp. Aan de H.R. in dato 28 Nov. 1772*”): “*De kaart van de Chin. Kust plijt echter in het voordeel van gem. Schott, alzo uit dezelve niet te zien is, dat men agter het Eijland Sanciam zeer vijlig ligt*”

Fig. 4.6 (Top) Chart of the approaches to Canton drawn by A.E. Van Braam Houckgeest based on his observations in 1762 (Kaart-collectie Buitenland Leupe NA 4.VEL/278A). The route on the chart was taken by the *Admiraal de Ruyter* on which ship Van Braam Houckgeest sailed in 1762.

(Left) The smaller picture shows a detail of the bottom left hand side of the chart (near the island of Nampang) where it says “*Hier*

omtrent is de Reijnsburgh gezonken” (“Hereabouts the Reijnsburgh went down”).

Houckgeest had made in 1762 whilst on board of the *Admiraal de Ruyter*.⁷¹⁷ In this report Van Braam Houckgeest wrote: “Since then it had been checked

⁷¹⁷ NA 1.04.20/282A, folio 108 & 109. Andreas Everardus van Braam Houckgeest (1739-1801) started his career as lieutenant in the Dutch navy but in 1758 he took up employment with the VOC as third *carga* (merchant) at the Canton factory. Apart from two periods of leave (the last involving a stay in the Republic between 1763 and 1765), he worked in Canton until 1772, by which time he had risen to the position of *supercarga*. He then lived in the Republic until 1783 when he moved to the United States of America where he became a merchant and owner of a rice plantation in South Carolina. After personal and financial problems he returned in 1789 to Canton as director of the VOC factory. He was part of the delegation that paid a visit to the emperor of China in 1794 on behalf of the VOC. In 1795 he left for the United States again and stayed there until 1798. Via London

against the most careful observations by nautical experts (and it had) been judged as very accurate by the skippers Pietersz and F. Papegaaij.”⁷¹⁸ It was mentioned in the *Eerbiedig Rapport* that the High Government in Batavia had been informed about Van Braam’s comments on the current charts.⁷¹⁹ Before Van Braam Houckgeest travelled home to the Republic on board of the *Herstelder* in 1772 (which he had helped to purchase), he presented his chart and a set of sailing instructions in the meeting of the commercial council in Canton; copies were added to reports that were sent to the Republic and to Batavia.⁷²⁰ On 2 July 1773, the High Government responded that “they wished that the chart by Van Braam had earlier become available to the High Government, so that a copy could have been handed over to all ships leaving for China.”⁷²¹ Whereas Mulder says that “there is no evidence that in one way or another advantage has been taken of the information contained in chart and instructions”⁷²², the response by the High Government suggests that the new locally produced chart may in due course have been supplied in Batavia to ships bound for Canton to improve on the current centrally produced detailed charts of the approach to Canton, such as the (printed) *Pas-Kaart van het in- en opkomen van de rivier van Quantong* in the sixth volume of Van

and Germany he returned to Amsterdam in 1801 where he died a few months after his arrival. Cf. Hullu, J. de (1920), pp. 284-285, Mulder (1944), pp. 618-619 and Braam Houckgeest, J. P. W. A. van (1987), *passim*.

⁷¹⁸ NA 1.04.02/4556 under the heading *Scheepen* (in margin *Rapp. aan de H.R. 28. Nov 1772*): “*Zij is zeedert door de secuurste observatien van zeekundigen nagegaan ook door de schippers Pietersz en F. Papegaaij zeer accuraat bevonden*”. These skippers must have been Kornelis Pietersen (as his name is spelled on the DAS website) and F. Papegaaij. Pietersen sailed three times to and from Canton, Papegaaij two times. On one occasion they left Canton on the same day. It seems reasonable to assume that on that occasion they were provided with Van Braam’s chart – they may have reported back the next time they arrived in Canton, which was for Pietersen in 1772 (the year that the *Rijnsburg* perished) and for Papegaaij in 1771. This would imply that Braam had produced his chart between 1762 and 1769.

⁷¹⁹ NA 1.04.20/234 *Eerbiedig Rapport*, p.21

⁷²⁰ The meeting is mentioned by Mulder (1944), pp. 630-631. Van Braam’s charts are in the National Archives as NA 4.VEL/278A & 278B, the (printed) sailing instructions as NA 1.04.02/11485. The charts in the National Archives contain a remark on where the *Rijnsburg* perished; we may therefore assume that these charts arrived in the Republic after the disaster, either directly from Canton (possibly taken by Van Braam on the *Herstelder*) or via the High Government in Batavia.

⁷²¹ NA 1.04.02/4556 under the heading “*Kaarten*” (in margin “*Miss. Van H.R. aan de C.Bed 2 July 1773*”): “*Het ware te wenschen geweest, dat de gezondene kaart van de S(uper) C(arga) Van Braam, eerder de H(oge) R(egering) ter hand gekomen ware, teneinde dezelve aan alle de na China vrttrekkende scheepen in copie te hebben kunnen afgeven.*”

⁷²² Mulder (1944), p. 631: “*Uit niets blijkt dat op een of andere manier profijt is getrokken van de gegevens die kaart en zeilaanwijzing bevatten*”

Keulen's *Zee-Fakkel* or the (manuscript) chart *Ladronische Eylanden en Rev(ier) van Canton (Guangzhou)* in De Haan's atlas. Mulder seems to have been right as far as the Amsterdam cartographic offices were concerned. Nevertheless, it would not be the last time that the staff in Canton in general or Van Braam Houckgeest in particular became involved with the improvement of charts, as we will see later.

At the time when in Canton the *Herstelder* was being prepared to sail for the Republic, the *Heeren XVII* discussed (on 13 Oct 1772) a number of charts of the China coast and of sea routes in that area produced by the British cartographer Alexander Dalrymple.⁷²³ These charts had been presented by Dalrymple to Johan Gideon Loten, former VOC governor of Ceylon; in turn these charts were given to the *Heeren XVII* by the company's advocate Van der Hoop on behalf of Loten.⁷²⁴ The seventeen gentlemen thanked Loten and Dalrymple profusely and asked the presiding chamber (which was the Amsterdam chamber at the time) to see whether the charts could be of any use for the company.⁷²⁵ The Amsterdam chamber acknowledged the receipt of the request and the charts on 16 October 1772, and on 22 March 1773 it received an advice that had been drawn up on 12 February by its examiner for practice Jan de Boer and the skippers Jan Och and Wopke Popta (both had

⁷²³ Alexander Dalrymple (1737-1808) was employed as writer by the British East India Company from 1752. His first posting was in Madras; later he also travelled to Canton. In 1765 he returned to London, where (from 1767 onwards) he published nautical charts. In 1779, he was appointed examiner of ships' journals and chart publisher for the East India Company and in 1795 he became hydrographer to the Admiralty. He was elected fellow of the Royal Society in 1771.

⁷²⁴ Joan Gideon Loten (1710-1789) was employed by the VOC between 1728 and 1758. He started his career as clerk in Amsterdam and rose through the ranks to become governor of Ceylon from 1752 until 1757. He commissioned a great number of watercolours of Ceylonese and Indian birds, which he took with him when he returned to the Republic in 1758. He then moved to London where he lived from 1759 until 1781. He was elected fellow of the Royal Society in 1760 and he became friends with Alexander Dalrymple. An extensive biography of Loten was published in 2010 by Alexander J.P. Raat. Raat mentions that "In London Loten loaned his charts and topographical drawings to his friend Alexander Dalrymple." (Raat (2010), p. v). According to P. J. B. C. Robidé van der Aa (1881) p. 53 this happened in 1775. "*Ook getuigt het meer voor zijn wetenschappelijken zin dan voor zijn trouw aan de Compagnie, dat hij in 1775 met den beroemden Engelschen hydrograaf Dalrymple in briefwisseling was en dien onder anderen kaarten van Celebes bezorgde*" ("It says more for his scientific mind than for his loyalty to the Company that he corresponded in 1775 with the famous English hydrographer Dalrymple and supplied to him charts of Celebes").

⁷²⁵ NA 1.04.02/181 dd. 13.10.1772

Fig. 4.7 Chart of the South China Seas by Dalrymple, possibly similar to the one that was rejected by the VOC on 29 March 1773. The island *Lincoln* is at $4^{\circ}15' \text{ W}/16^{\circ}40' \text{ N}$ according to the coordinates on the chart; the zero-meridian is running through the peak of Banguay island, just North of Borneo. The way compass lines are shown differs from the Dutch way of representing these. Picture retrieved through www.raremaps.com, accessed on 16.12.2012. According to the seller of this chart, it is to be dated between 1770 and 1775. The same chart is contained in the 1775 edition of *Le Neptune Oriental* by d'Après de Manneville to whom the chart was dedicated by Alexander Dalrymple. A copy of *Le Neptune Oriental* is at the library of Leiden University (Special Collections / COLBN Atlas 125).

sailed to Canton a number of times).⁷²⁶ Their verdict was that the charts were not adequate because they lacked compass lines, that the company should continue to use its own charts, and that there was no need to introduce new charts.⁷²⁷ The remark on the lack of compass lines showed that users mattered – compass lines were useful tools for plotting one's course and when such lines were missing (or different from the system currently in use) navigating would become more complicated. On 29 March 1773, the *Heeren XVII* followed this advice and decided not to use Dalrymple's charts.⁷²⁸ By doing so the VOC rejected a chart that in all likelihood showed the position of an island called "*Lincoln*" which was not marked on the company's own charts, a fact that would cost the company dearly in a number of years' time.⁷²⁹

Stavorinus's comments

From the journal that Stavorinus kept on his second voyage it becomes clear that according to him the VOC was not taking sufficient action to improve its charts. In October 1774, he wrote:

We here perceived that the south coast of Java, instead of being laid down, in the Company's charts, with requisite accuracy, is, on the contrary, placed very erroneously (...) (In the journal that skipper Halfman of the *Zuidbeveland* kept in 1772) I found the same occurrence noted down in it, at the same place. It is really to be lamented, that so powerful a body as the East-India Company, and whose prosperity so much depends upon the safe and prosperous voyages of their ships, should trouble themselves so little with the improvement of navigation in general, and the correction of their charts in particular. I could adduce many instances of their faultiness, both with respect to the Indies, and to the coast of Africa. Other nations pursue this object with indefatigable assiduity, especially the English, whose maps are, in general, infinitely preferable to our's.⁷³⁰

The problem of unreliable charts was not confined to the charts that were supplied for the routes between the Republic and the East Indies, but the

⁷²⁶ Jan de Boer was successor to Jan de Marre; he served from 6.08.1764 until his death in 1779. By the time of this advice, Jan Och and Wopke Popta had twice sailed together to and from Canton; they would sail another two times together to and from Canton.

⁷²⁷ NA 1.04.02/281 dd. 16.10.1772 resp. 22.3.1773

⁷²⁸ NA 1.04.02/181 dd. 29.03.1773

⁷²⁹ A contemporary account discussing the discovery of the island of Lincoln is in d'Après de Manneville (1775B), pp. 563-574 *Mémoire sur la Carte des Mers de la Chine, par M. Alexandre Dalrymple, Écuyer*

⁷³⁰ Stavorinus (1798) Vol II, pp. 111-112. The quote is taken from the English translation; however the year in which Halfman kept his journal (1772) is mentioned in the original Dutch text of *Tweede Reize, Deel I* (p. 89) but not in the English translation.

problem of unreliability also occurred on the charts that were produced in Batavia for voyages within the East Indies and beyond, as becomes clear from another complaint by Stavorinus about a voyage he made within the East Indies:

It would be well if the charts of these parts (i.e. East of Batavia), which the Company give to their vessels, were correct; it is this that makes the navigation so dangerous. None of the islands which I met with, except the group called the *Hen and Chickens*, are laid down in their true latitudes, as may be proved by my logbook, and those of other ships. This inaccuracy not only renders the charts useless, but likewise extremely dangerous; for instead of being, as they ought, the surest guide and dependence of the navigator, they mislead him and become his bane.⁷³¹

Stavorinus went on to say that the company cannot have been unaware of these “notorious faultiness”⁷³² because every skipper was obliged to hand over his journal to the master chart-maker in Batavia and any competent sailor would have noticed these mistakes, as was borne out by several journals he had seen or which he even had in his possession. He suggested that these mistakes were left deliberately on the charts (“It is an adopted opinion that it is better to expose a few ships to the danger of shipwreck, than to correct errors”⁷³³) to discourage ships from other nations to sail towards the Spice Islands. He explicitly referred to the decree of 10 December 1771 (which was mentioned at the beginning of this section) through which the officers of vessels large and small were ordered to report immediately any shortcomings in the charts to those in authority. The decree suggested that officers had been rather negligent in reporting shortcomings in charts. However, Stavorinus took issue with that remark and wrote that since the decree had come into force, charts hadn’t been altered more frequently than before;⁷³⁴ the unspoken suggestion being that the problems of unreliable charts was caused by negligence in Batavia rather than by negligent ships’ officers.

In 1778 on his return voyage to the Republic, he noticed on 26 April that the position of the island of Ascension (in the Atlantic Ocean) was “1⁰ 37’ too much to the eastward, in our maps, according to the observations of M. de la Caille made in the road; but the latitude agrees with observations made by us”. At the same time he observed that the compass showed a north-westerly declination of 11⁰, which was one degree more than on his voyage of ten years earlier.⁷³⁵ On the same day, the skippers of the small fleet of five ships of

⁷³¹ Ibid., p. 168; Stavorinus referred here to a voyage that he made in late January 1775.

⁷³² Ibid., p. 169

⁷³³ Ibid., p. 168

⁷³⁴ Ibid., pp. 169-170

⁷³⁵ Stavorinus (1798) Vol III, p. 465

which his ship was part, decided to disobey the instructions regarding the route they had to follow but to take a shorter route. This shorter route was – whenever possible – also taken by ships of other nations, and

(...) these, not being bound to follow any particular instruction or sailing-orders, with respect to their navigation, generally perform much shorter voyages, both to and from the East-Indies, than the ships of the Company.⁷³⁶

In order to avoid being fined (“and other difficulties, which would ensue to the ships’ officers and crew”) they decided to note the official course in their journals. When they rejoined the prescribed route (on 8 May) the true course was noted again.⁷³⁷ This scheme of falsifying their journals succeeded: they were not found out and therefore still received their premiums after they arrived in the Republic. Stavorinus argued that because of the strict navigational rules imposed on the skippers of the VOC

(...) the commanders of Dutch ships, impeded and fettered in their proceedings, cannot possibly make as much progress as others, in the improvement of navigation; and to this it may also, in my opinion, be greatly attributed that the English, the French, and others, so far outstrip us in the making of improvements, new discoveries, &c. although our East-India trade might reasonably be supposed to be an excellent nursery for seamen and a school for the greatest nautical improvements, on account of the number of ships and men it employs, and the distance and diversity of the voyages.⁷³⁸

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These two extracts from Stavorinus’s journal disclose tensions between his ideas about how skippers should be allowed to command their ships and the strict procedures that the VOC had in place. With these procedures the company tried to maintain a tight grip on the way its skippers navigated, procedures that were (as we have seen in the second chapter) similar in character to those that were used in controlling and disciplining the common crewmembers.

The Bataviaasch Genootschap

⁷³⁶ Ibid., p. 466

⁷³⁷ Ibid., pp. 465–467 (the quote is on p. 467). The skippers involved were Leendert van Koopstad on the *Bredenhof* for the Hoorn chamber (commander of this fleet), Johan Splinter Stavorinus on the *Ouwerkerk* for the Zeeland chamber, Wopke Popta on the *Ganges* for the Amsterdam chamber, Jan Och on the *Zeepaard* for the Amsterdam chamber and Olke Hendrik Andringa on the *Hoogkarspel* for the Enkhuizen chamber. Van Koopstad and Stavorinus had departed from Batavia, Popta and Och from Canton and Andringa from Bengal.

⁷³⁸ Ibid., p. 466

In 1779 the *Bataviaasch Genootschap* published the first volume of its *Transactions*. In this volume one finds “*Eenige waarnemingen over de nuttigheid van het verbeteren onzer Hollandsche zeekaarten, naar de Engelsche en Fransche*” (Some observations regarding the usefulness of the improvement of Dutch charts after the English and the French), written by the secretary of the society, Josua van Iperen.⁷³⁹ He began his article by promoting the choice of a single first meridian to avoid miscommunications between ships of different nations, and suggested to use as this first meridian the meridian running through *Isle de Palma* as the French had done. He then questioned the wisdom of the order to follow the *Wagenweg*, explaining that the (foreign) ships under the command of the famous James Cook and Furneaux had been forced into the bight of Guinea (just as had happened with the *Europa* on which Van Iperen made his voyage to the East Indies) and in all those cases this had not led to any difficulties. To illustrate his point he referred to wind patterns that were shown on a globe by George Adams and on a (French) chart by Bonne that had been added to Abbé Raynalt’s *Histoire Philosophique & Politique des Etablissements et du Commerce des Europeens*.⁷⁴⁰ He argued that such up-to-date information on shifting wind patterns near the equator was currently absent from Dutch charts but ought to be added. The publishing of this critique is remarkable considering that the society stipulated in that same volume that “(it) excludes completely from its research all communications that might in any way be related to the East India Company...”⁷⁴¹ This gives the impression that the unreliability of the charts in use must have been seen as a very serious matter by the society. Van Iperen illustrated his discourse with a personally experienced example of unreliable coordinates of landmarks on the charts provided by the VOC. Rather ironically, he wrote about his outward voyage on the *retourschip Europa* in late 1778:

(The dead reckoning had been improved based on the coordinates of the island *Tristan* according to the company’s map). However, on the 28th (of November 1778) we couldn’t understand why we hadn’t discovered any land because when we reckoned according to our improved position made near *Tristan*, we were now sailing straight across the (Cape’s) *Voorberge*, heading deep inland over the possessions of the Dutch, towards the border with the *Kaffers*. (Then the private English globe – made by Adams – of Van Iperen showed that *Tristan* was probably four degrees further to the West

⁷³⁹ *Verhandelingen Bataviaasch Genootschap Eerste Deel* (1779), pp. 263-272

⁷⁴⁰ Van Iperen referred here (ibid., p. 267) to an edition of Raynalt’s book that had been published in Maastricht.

⁷⁴¹ *Verhandelingen(...) Bataviaasch Genootschap(...), Eerste Deel* (1779), pp. 8-9. The original Dutch text reads “*Het Genootschap sluit geheel en al, buiten den kring zijner onderzoekingen, alle berichten, die de Oostindische Compagnie eenigszins zouden mogen aangaan; ...*”

than as shown on the company's maps). Apart from that we had the declination of the compass, at about 20 degrees Northwestering. And apart from this sign, which showed us that we were near the Cape, we could fortunately daily use the octant to ascertain that we were on the correct latitude; and so on the morning of the 29th we saw the roadstead of *Tafelbaay* and reached it that afternoon.⁷⁴²

Van Iperen not only commented upon the “misplacing” (*misstelling*) of the longitude of islands, he also remarked that the latest discoveries by navigators as Anson, Bougainville, Cook and others were not to be found on Dutch charts. In addition, coastal profiles added to the current atlas were “in no way accurate” (*gantsch niet naauwkeurig*) and he had been assured that that the coasts of Java were so inadequately represented that they caused serious problems when cross bearings were taken. It could be of advantage to our seafarers, he wrote, that these new discoveries would become available on their “improved” charts.⁷⁴³

A year later Mr. J.C.M. Radermacher, one of the presidents of this society, published in the second volume of the *Transactions* “*Waarnemingen over het verbeteren onzer Hollandsche zeekaarten naar de Engelsche en Fransche*” (Observations regarding the improvement of Dutch charts after the English and the French) in which again the “(in)accuracy” of Dutch charts was unfavourably compared with English and French charts and manuals.⁷⁴⁴ Radermacher wrote that the coordinates of several islands between the Cape of Good Hope and Java as shown in the new (1753) edition of the sixth volume of the *Groote Lichtende Zee-Fakkel* differed significantly from the positions that were shown on the Dutch *paskaart* of the Indian Ocean that was currently in use on the ships of the VOC and even more in comparison with the better

⁷⁴² Ibid., pp. 268-269 (“*Edoch, op den 28 daaraan volgenden, wist men onmogelyk te raaden, waar by het mogte toekomen, dat wy geen land ontwaarden; daar wy, volgens het verbeterd bestek, by Tristan gemaakt, thans reeds over het Voorbergegte, diep landwaards in, over de bezittingen onzer Nederlanders, naar de grenzen der Kaffers, henen zeilden (...) Behalven dat wy de Miswyzyng van de Compasnaald hadden, op omtrend 20 Graden Noordwestering. En behalven dit teeken, 't geen ons de nabyheid van de Kaap deed blyken, genooten wy dagelijks het geluk, van den octant te kunnen gebruiken: zynde wy dus verzekerd, dat wy op de behoorlyke breedte zeilden; gelyk wy ook, op de 29. 's morgens, het gezicht, en, na den middag, de rede van de Tafelbaay bereikten*”).

⁷⁴³ Ibid., pp. 271-272 (“*Alleentlyk zeg ik maar, dat het, onze Zeevarenden, 't eeniger tyd, kan te pas komen, om de nieuwe ontdekkingen der Zuid-Oostelyke, en andere onbekende, Eilanden, Kusten en Baayen, met zoo veel moeite, door de Franschen en Engelschen, gedaan, ook, op hunne verbeterde Zeekaarten, aan te treffen*.”)

⁷⁴⁴ Mr. J.C.M. Radermacher in *Verhandelingen Bataviaasch Genootschap Tweede Deel* (1780), pp. 327-331

Fig. 4.8 Detail of the chart of the South China Seas (by Dalrymple) in the 1775 edition of “*Le Neptune Oriental*” by D’Après de Manneville, showing the island of Lincoln, the island of Hainan and Quang tcheou-fou (Canton). The island “Le Lincoln” is to the east of Amphitrite and to the northwest of Macclesfield in the lower half of the chart. Picture taken by the author (on 4 Aug 2015) of the copy of *Le Neptune Oriental* at the library of Leiden University (Special Collections / COLLBN Atlas 125).

charts used by Captain Cook in 1769-1771 and 1771-1775. The conclusion of Radermacher (and of Van Iperen before him) was that it would be beneficial for the company to take a close look at French and British charts and sailing instructions to improve its own charts. There is no evidence that the VOC followed this suggestion or even reacted to it. However, it would not be the last time that the VOC, its employees or (relative) outsiders had reason to complain about the charts provided by the company. The culmination came when eight years later, a new disaster in the South China Seas finally spurred the directors of the VOC into action.

The (un)charted island of Lincoln

In the autumn of 1787 five *retourschepen* of the VOC arrived in Canton, the *Canton* for the Rotterdam chamber, the *Barbestein* for the Zeeland chamber and the *Nederlands Welvaren*, the *Voorschoten* and the *Admiraal de Suffren* for the Amsterdam chamber. As we have seen in the preceding chapter, the *Admiraal de Suffren* was an experimental *retourschip* built at the Amsterdam yard. It was of the classic “waisted” design (160 feet long, 42½ feet wide with a draught of 19½ feet), surpassing all existing *retourschepen* as far as length and width was concerned, even the (also experimental) three-decker *Europa* of the Zeeland chamber of 155 feet.⁷⁴⁵ By the end of January 1788, the *Canton* and the *Nederlands Welvaren* had left the roadsteads near Canton for the Republic, and on 1 March 1788 the other three vessels began to make their way towards the Republic. The total value of the cargo on the five ships (mostly consisting of tea, porcelain and silk) amounted to almost 4.8 million guilders of which the *Admiraal de Suffren* carried over one million guilders’ worth, which (again) shows the importance of the trade with China at the time.⁷⁴⁶

In the evening of 10 March, at sunset, the *Admiraal de Suffren* found itself two-and-a half to three miles (which is approximately twenty kilometres in modern terms⁷⁴⁷) to the leeward of the other two vessels, the *Barbestein* and the *Voorschoten*. Daniël Correch, the skipper of the *Admiraal de Suffren* fired seven warning shots (the last with live ammunition) to signal to the other two ships that they should slow down, but this had no effect, and the next morning the ships were out of sight.⁷⁴⁸ Then in the night between 13 and

⁷⁴⁵ Cf. chapter 3, section 3.4

⁷⁴⁶ For details on these sailings, see http://resources.huygens.knaw.nl/das_under_number_8211.1, 8212.1, 8217.2, 8218.1 and 8219.2

⁷⁴⁷ The Dutch or German mile in use with the VOC equals 7.407 kilometres (cf. *VOC Glossarium*)

⁷⁴⁸ On 18.11.1787, Gottlieb Mulder, the original skipper of the *Admiraal de Suffren* had died (NA 1.04.02/6748, 1.04.20/93 and 1.04.20/324). After an examination of two

14 March 1788, the *Admiraal de Suffren* ran aground near an island in the South China Sea; some details of what happened were given in a letter of 3 April 1788 to the *Commercie Raad* (the Commercial Council) at the Canton factory. Daniël Correch and first mate Daniël Kikkert wrote that on 13 March they had lost their vessel on some cliffs and rocks, after the ship had drifted very much to leeward because of strong currents in a Westerly direction.⁷⁴⁹ On the second day after the stranding, a number of crewmembers had managed to get through the heavy surf with rafts to a small island where they were saved by a number of Chinese fishermen. On the third day – the ship had meanwhile broken into two – the (Canton) bookkeeper Idemans also tried to leave the ship on a raft but he was swept off the raft by the surf and drowned in full view of everybody else. After five to six days on the wreck in indescribable circumstances, everybody (apart from four men) managed to get onto the island on rafts, planks and grids. The letter goes on to mention the dire situation of the crew on the island (at 16° 40' North) as there was only water to drink and wild birds to eat.

When the sea had become somewhat calmer, the crew managed to get some provisions off the wreck by using the *schuit* (the small boat) but as the wreck was full of water, only a small supply could be salvaged and that was of poor quality. They also managed to get some cases with Nanking silk from board and some chests containing tea. Three days before the letter was written, Chinese fishermen on the island had (under cover of darkness) stolen a great deal of the goods on board and had left with four small junks to an unknown destination, leaving behind two sacks with some salt. The letter ended by saying that help was urgently needed and that therefore the letter would be taken to Macao by the second mate Pieter Jansen who was to sail there with the *boot* (the longboat) that had been salvaged by breaking away part of the leeward side of the wreck. Despite the urgency that speaks from the letter (“Our crew is very weakened by this dreadful ordeal and the surgeon has a broken leg”) Jansen had obviously not left before 7 April as his signature is on a document dated 7 April 1788 in which the officers state that all decisions regarding the courses followed by the *Admiraal de Suffren* had

candidates (Simon Laurentius, first mate on the *Barbestein* and Daniël Correch, first mate on the *Voorschoten*) by the skippers Ary Kikkert of the *Neerlands Welvaren* and Cornelis de Wit of the *Canton*, Daniël Correch was appointed as skipper on the *Admiraal de Suffren* on 30 November 1787 (NA 1.04.20/93 and 1.04.20/324). On what happened on 10 and 11 March: NA 1.04.02/86 Report of the *Zeekrijgsraad* concerning the wrecking of the *Admiraal de Suffren* and NA 1.04.02/199 *ibid*. In the sworn statement of the crew of the *schuit* (see below) the date is given as 11 March.

⁷⁴⁹ The letter is in NA 1.04.20/372 and a copy is in NA 1.04.02/4438. The letter was signed by Daniël Correch (skipper/captain lieutenant) and Daniël Kikkert (first mate/captain lieutenant).

been taken unanimously.⁷⁵⁰ However, Jansen must have left before 17 April because his signature is not on a document of that date which gives details of the negotiations with Chinese fishers for the rescue of the crew. From this document it becomes clear that in return for transporting the crew to Macao on the mainland, the Chinese demanded 600 *Spaanse matten* in cash (if available) and also silk cloth to the value of 3000 *Spaanse matten*.⁷⁵¹ This meant that four cases of silk cloth had to be handed over, containing in total 200 rolls of silk, because the Chinese had valued each roll at 15 *Spaanse matten*. Seeing no alternative, the officers and three representatives of the crew (one of them was Thomas de Baar, whom we will come across later) agreed to the deal.⁷⁵²

In the afternoon of 10 May 1788, the *schuit* of the *Admiraal de Suffren* suddenly arrived in Macao, as was mentioned in the *Dagregister 1788* of the *VOC Factorij* in Canton (i.e. the journal kept by the *supercarga* of the factory).⁷⁵³ The *schuit* was manned by the boatswain's mate Thomas de Baar and eleven seamen; they were the first to bring the message that the *Admiraal de Suffren* had been wrecked almost two months earlier. According to them, the (larger) *boot*, carrying a letter for the *Commercie Raad* in Canton had left four weeks before them.⁷⁵⁴ The rest of the crew (apart from three seamen who had refused to leave the island) had been divided over two Chinese junks which could arrive any moment. On the day they arrived, the whole crew on board of the *schuit* made a sworn statement in front of Martinus Nolthenius,

⁷⁵⁰ NA 1.04.20/372; this letter was signed by Daniël Kikkert (first mate/captain lieutenant), Pieter Jansen (second mate/lieutenant), Pieter Jahn (third mate/souslieutenant) and Remko Woltgrass (third mate/cadet de marine).

⁷⁵¹ The *Spaanse mat* was the standard monetary unit in much of East Asia at the time. Its value (in Dutch currency) was 60 *stuiver*, i.e. three guilders (cf. *VOC Glossarium* under *reaal/reaal van achten*).

⁷⁵² NA 1.04.02/86 Report of the *Zeekrijgsraad* concerning the wrecking of the *Admiraal de Suffren* and NA 1.04.02/199 *ibid.*, this letter was signed by Daniël Correch, Daniël Kikkert, Pieter Jahn, Remko Woltgrass and (apparently as representatives for the ordinary crew members) Fredrik Haagenmeester (boatswain's mate/*schiemman*), Hendrik Brienings (boatswain's second mate/*schiemansmaat*) and (with a cross) by Thomas de Baar (boatswain's mate/*bootsmans- maat*)

⁷⁵³ NA 1.04.20/94, entry for 10.5.1788

⁷⁵⁴ Whether that means "before they left the island" or "before they arrived in Macao" is unclear. In Dutch it says "(...) *rapporteeren dat de Scheepsboot (...) vier weeken voor hun van 't Eyland vertrokken zijn*" "which seems to support the first interpretation, although looking at the dates the second interpretation is far more likely. Four weeks before the arrival of the *schuit* would mean a departure of the *boot* on about 12 April, which is in between the last letter signed by Jansen (7 April) and the next letter that was not signed by him (17 April). Four weeks before the departure of the *schuit* would mean a departure of the *boot* by the end of March, which would have made it impossible for Jansen to sign the letters of 3 and 7 April.

third time. As a result the main mast and the other masts went overboard and with it all the sails. Immediately there was five feet (i.e. about a metre and a half) water at the pumps. A number of those giving the statement were on deck when this happened and they had asked, while cutting loose the rigging, where the ship was, to which the captain had at one time answered “thirty miles from shore” and somewhat later “twenty miles from shore”, adding that the ship had hit an unknown cliff.

According to one of the witnesses (Willem Ellington), the first mate Kikkert had told the skipper Correch: “Didn’t I tell you so this afternoon, you were steering a course too much to leeward”.⁷⁵⁶ The boatswain’s mate Thomas de Baar had overheard Correch saying to Kikkert: “Let’s have a final drink while we are looking death in the eye” whereupon Kikkert had replied: “Sir, I die with a clear conscience, having not to answer for all those souls.”⁷⁵⁷ During the night the whole crew stayed on the *halfdek* and the *campagne*, because it was too dangerous to stay in the *kuil* (waist) where one might be swept overboard by the breaking waves or below-decks where loose crates and cases caused danger.⁷⁵⁸ The statement then described into quite some detail about how the crew managed to get off the wreck.⁷⁵⁹ After the crew had been saved, the *schuit* had sailed a few times to and from the wreck to get hold of supplies; thereafter a number of cases containing silk, some clothing and belongings of the officers had been salvaged. In the night between 24 and 25 March, the Chinese had sailed to the wreck and had stolen the remaining cases of silk and anything else they could lay their hands on, something which had

⁷⁵⁶ NA 1.04.20/372 “*Heb ik het Uw niet vanmiddag geseid, dat gij de coers veel te laag stelde*”

⁷⁵⁷ NA 1.04.20/372 “*Kom, laten wij nog eens drinken voor het laatst terwijl wij toch de Dood voor oogen sien*” “*Mijnheer, ik sterf met een gerust gemoed en hebbe geen een van al die zielen op mijn hals*”

⁷⁵⁸ The risk that the low lying *kuil* or waist constituted in stormy conditions was (as we have seen in the third chapter) one of the arguments against the classic design of *retourschip* and in favour of the three-decker.

⁷⁵⁹ The day after the stranding attempts to launch the *schuit* had been thwarted by the waves and the surf. The day after, the third mate Woltgrass plus four crewmembers had reached land on a raft, a second raft with the second mate Jansen, the boatswain’s mate and thirteen seamen had been driven out to sea for a mile and a half before they were rescued by Chinese fishermen. From a third raft with the bookkeeper Idemans and the sailor Ellington (one of those giving evidence), Idemans had been swept into the sea and drowned while Ellington had managed to get back onto the wreck. Nobody dared to step onto the fourth raft. After six days the skipper, the first mate and eight seamen managed to get on shore with the *schuit*. On the same day about the whole crew (apart from about twenty people) had reached land with rafts, taken out of the water by the *schuit*. The following day (21 March) the rest of the crew was saved, later the *schuit* had ferried a few times to and from the wreck to get some supplies.

been impossible to prevent. Later on, the *schuit* had been used from time to time to take some fine teas and provisions from the wreck and one had kept watch on the wreck as long as possible to prevent the looting by the Chinese. Nevertheless four Chinese junks had come alongside the wreck, stealing as much as they could and sailed to Haynam.⁷⁶⁰ Those giving evidence had left on 27 April on the *schuit* at the same time as two junks on which were the skipper, the first mate, the other officers and the rest of the crew (about 90 people in total). The *boot* had left four weeks earlier with the second mate, the *schiemman* and ten seamen to deliver a letter to the *Commercie Raad* in Macao.⁷⁶¹ The Chinese, meanwhile, had burned down the wreck to the waterline. In view of what we will come across later, the statement by the crew of the *schuit* is in factual detail almost identical to the letter that had been written by the officers on 3 April. A very important difference is the apparent disagreement between the skipper and the first mate about the course that had been followed as was overheard by the boatswain's mate, a disagreement that was not mentioned in the letter written by the officers on 7 April.

On 11 May the *boot* arrived at last in Macao, with the second mate (*lieutenant* Pieter Jansen), a *schiemman*, an assistant carpenter and nine seamen; they handed over the letter that had been written on the island on 3 April. Meanwhile the Canton staff had begun to organize accommodation, food, clothing and other essentials for the crew for the time when they would be staying in Macao. They also informed the officials in Canton about what had happened, requested permission ("*sjap*" as it was called) to transfer the Dutch crew to Canton without being taxed, and asked to have the mandarin on the island of Haijnan informed that the cargo that had been stolen from the wreck by Chinese junks from that island should be returned, for which the staff offered an unspecified *douceur* (reward) and to organize rescue for the seamen still on the island.⁷⁶² In the afternoon of 13 May, the two Chinese junks arrived in Macao with the rest of the officers and crew. These vessels had left the island on 27 April and carried what little of the cargo had been salvaged from the wreck, minus the four cases of silk cloth that had meanwhile been divided among the Chinese. The Chinese had taken all the cash that the crew

⁷⁶⁰ Or Hainan as it is spelled on the chart by D'Après de Manneville/Dalrymple (see fig 4.8).

⁷⁶¹ Again in Dutch it says "*dat de scheepsboot (...) vier weken voor hun het Eyland verlaaten hebben (...)*"

⁷⁶² One gets the impression that the Canton staff was worried about the possibility of troubles between the seamen from the *Admiraal de Suffren* and Portuguese and Chinese locals in Macao.

had with them and they still were owed 600 *Spaanse matten*, a sum that was to be paid upon safe arrival in Macao.⁷⁶³

It is testimony to an impressive feat of seamanship by the crew of the *schuit*, consisting of the boatswain's mate Thomas de Baar and eleven ordinary seamen that they were the first to arrive in Macao, one day ahead of the *boot* (which had left considerably earlier and which they apparently had not seen *en route*) and three days ahead of the junks. This suggests that these sailors knew about how to use a chart and compass, how to plot a course and how to manage a vessel. It is strange that there was no officer on board of the *schuit*: after Jansen had sailed with the *boot* there were still four officers left and it would therefore have been quite possible to have one officer on each vessel. An explanation could be that there may have been some discontent amongst the crew towards the officers, and that the officers deemed it not sensible to have one officer against forty-odd crewmembers on a Chinese junk, or on the small *schuit* against a dozen seamen. This explanation seems the more credible as on 15 May it came to a fracas in Macao whereby a seaman and an officer were involved in a scuffle.⁷⁶⁴

The crew stayed in Macao until the first VOC *retourschip* of the next season, the *Leiden*, arrived on 21 July. Meanwhile a number of seamen had deserted and one had been thrown in the Macao prison because of misbehaviour. On 22 and 23 July the crew was transferred to the *Leiden* which then moved upstream to the roadstead of Whampoa. On 18 August a Chinese merchant brought word that the three seamen that had stayed behind on the island of Lincoln had arrived in Macao. Eventually the crew of the *Admiraal de Suffren* was repatriated to the Republic, divided over the four VOC *retourschepen* that arrived in Canton for the trading season 1788/1789, left during January 1789 and arrived back in the Republic in July and August 1789.⁷⁶⁵ The financial aftermath will probably not have pleased the staff at Canton, nor the *Heeren XVII* in the Republic. The expenditure that had to be paid for the lodging, food, clothing and equipment of the saved crewmembers amounted to more than 2500 tael (i.e. approximately 10,000 guilders).⁷⁶⁶ The

⁷⁶³ As we saw from the sworn statement by the crew of the *schuit*, they had left on 27 April as well; this implies that the *boot* cannot have left four weeks before the *schuit* and the junks, as Jansen still had been able to sign a letter on 7 April; a departure two weeks before the junks and the *schuit* is therefore more likely. The salvaged cargo consisted of ten cases of silk cloth, eleven cases of raw silk and eight cases of painted papers (presumably wallpaper) and two more boxes of paper. The burning of the wreck presumably occurred to get hold of the metal that was contained in the ship.

⁷⁶⁴ NA 1.04.20/94 entry for 15.05.1788

⁷⁶⁵ These ships were the aforementioned *Leiden*, the *Goede Trouw*, the *Gouverneur-generaal Maatsuyker* and the *Blitterswijk*.

⁷⁶⁶ NA 1.04.20/372 *Onkost Reekening der Manschappen*; according to the VOC glossarium 1 Tael equalled 80 stuiver, i.e. 4 guilders.

goods that had been salvaged from the wreck amounted to eight cases and one packet of silk cloth, eleven cases of raw silk (most of these were in good order), and eight cases of “painted paper” (i.e. wallpaper). When we take the value that the Chinese sailors attached to a case of raw silk as a measure (as we saw 750 *Spaanse matten*, which was probably below its selling value in the Republic but which might be near the price that had been paid for it) then the amount of salvaged silk might have been worth about 15,000 *Spaanse matten* (i.e. approximately 45,000 guilders), a far cry from the more than one million guilders that had been paid for the total cargo. The *boot*, *schuit* and equipment that had come with these vessels were almost worthless.⁷⁶⁷ One gets the impression that despite several *demarches* towards the authorities in Canton and through these to the mandarins at Haijnan, nothing of the cargo that had been stolen from the wreck was ever recovered. It seems therefore safe to conclude that the wrecking of the *Admiraal de Suffren* was the highest financial price in a single incident on the China route that the VOC had to pay for the use of its own unreliable charts: not only the largest ship sailing for the company at the time was lost returning from its maiden voyage, but almost all of its cargo had disappeared as well.

4.4 Aftermath of a disaster

On 14 September 1789 (on 25 August, three of the China ships for the 1788/1789 season had arrived at Texel on 25 August, the fourth ship had already arrived at Rammekens on 17 July), the Amsterdam chamber of the VOC set up a sea court martial to investigate the wrecking of the *Admiraal de Suffren*. The court martial consisted of the examiners of five of the six chambers of the VOC (the examiner of the Zeeland chamber did not attend) and a number of retired skippers, some with personal experience of the China route.⁷⁶⁸ In a document attached to the papers of this court martial, the

⁷⁶⁷ NA 1.04.20/372 *Bevinding van zodaanige zijde stoffen, Nankinge ruwe zijde en geschilderde papiere Meublementen...*

⁷⁶⁸ According to the signatures under the report, the members were Cornelis Pietersz (examiner for practice at the Amsterdam chamber and former skipper on the China route, cf. Bruijn (2008), p.227 and Bruijn (2011), pp. 294-295), Abraham van Bemmelen (examiner at the Delft chamber), Willem Koelbier (examiner at the Rotterdam chamber), Bernhardus Hulleman (examiner at the Hoorn chamber), Hendrik Hilverduyn (examiner at the Enkhuizen chamber) and the retired skippers Johannes van Voorst (who had sailed three times to and from China), Gerrit Springer (who had sailed once to and from China), Hendrik N(ie)u(w)boer, Daniël Deune and Wopke Popta. Popta had sailed four times to and from China, had been involved with the assessment of Dalrymple’s chart in 1773 and he had sailed home in 1778 with the small fleet of five ships of which Stavorinus also had been part, during which voyage the skippers had agreed to falsify their journals.

Fig. 4.10 Chart of the island of Lincoln (latitude North $16^{\circ} 44'$) as drawn after the wrecking of the *Admiraal de Suffren*, in a document signed by Correch, Kikkert and Jansen (NA 1.04.02/ 86, dd. 19.11.1789, also in NA 1.04.02/199 dd. 19.11.1789). Picture taken by the author at the National Archives on 6 June 2014.

skipper Daniël Correch and two of his fellow officers explained that the unknown island on which they had lost their ship was known as “Lincoln” on a French chart by D’Après de Manneville and on a British chart by Robert Sayer of 1787. No mention is made of the date of the French chart, which (as we saw before) was published in 1775 and which had been produced by Alexander Dalrymple a few years earlier. On 12 October the court martial started its investigation into the causes of the wrecking of the *retourschip* *Admiraal de Suffren* in the South China Seas and the culpability of the officers involved. On 17 October they reached their verdict; in their report of the same date, they quoted their brief

An investigation (...) into the conduct of captain Daniël Correch and the other officers appointed on Yours Honours’ vessel the *Admiraal de Suffren* which supposedly came to grief in the night between 13 and 14 March 1788 in the Chinese Sea at latitude North $16^{\circ} 44'$ on an island, which was known on the French and on a number of English charts since the year 1787 under the name of Lincoln, but which was not

known on the company's charts produced in Batavia for these waters and there supplied to the company's vessels navigating to China.⁷⁶⁹

The wording of the text is interesting because it connects the year 1787 with English as well as with French charts, whereas Correch and his officers explicitly linked the year 1787 only with the English chart by Sayer. It can hardly have been unknown to the court martial of navigational experts that the chart by D'Après de Manneville (who was named by Correch and his colleagues) had appeared in print as early as 1775. However, by only mentioning the year 1787 the court martial conveniently glossed over any possible link with a previous decision of the VOC and its advisors regarding the rejection of foreign charts of the South China Sea. The report then goes on to quote extensively from and refer to the journals of the *Admiraal de Suffren* (and to a lesser degree from those of the *Barbestein* and the *Voorschoten*) and then it says

(...) the officers of the wrecked ship the *Admiraal de Suffren* have in every sense, both during and before the unfortunate occurrence of the stranding, done their utmost, as far as the circumstances allowed, to see to the wellbeing of the company's vessel and its crew (...) that they had according to the sailing orders (...) unanimously decided on the course they followed (...) as they had confirmed by their signature on 7 April 1788 while on the aforementioned island of Lincoln (...) and had maintained their commando and character as they should until the last moment.⁷⁷⁰

The court martial concluded therefore that the officers involved had shown good seamanship, had behaved as they should, were not to blame and could be employed by the VOC in future. It rejected the accusations contained in the

⁷⁶⁹ NA 1.04.02/86, dd. 19.11.1789, the Dutch text reads “*Een onderzoek (...) wegens het gedrag van den capitain ter zee Daniël Correch, en de overige officieren bescheiden geweest zijnde op UEdAchtb^s schip de Admiraal de Suffren; hetwelk 's nagts tussen 13 en 14 Maart 1788 in de Chinesche Zee op de Noorderbreedte van 16 gr en 44 Min op een Eiland in de Fransche en eenige Engelsche kaarten zedert den Jaare 1787 bekend onder de Naam van de Lincoln; doch in 's E. Comp^s zeekaarten welke op Batavia, van dat vaarwater worden vervaardigd en aldaar aan 's E Comp^s schepen op China navigerende worden verstrekt, niet bekend is zoude zijn verongelukt*”.

⁷⁷⁰ Ibid., the Dutch text reads: “*... de zee-officieren van het verongelukte schip de Admiraal de Suffren, alleszins, zowel onder als voor dat ongelukkig geval van stranding voor zo verre het die akelige omstandigheid toeliet, hun uiterste devoir hebben aangewend, welke tot welzijn van 's Comp^s schip en het volk dienen konde (...) dat ze hunne koersen (...) volgens Zeilagie order (...) volgens approbatie of goedkeuring van de gezamenlijke zee-officieren (gevolgd hadden) (...) welke zij alle op den 7^e April 1788, op het meergem. Eiland de Lincoln zijnde, door hunne handteekening hebben bekrachtigd (...) tot op het laatste oogenblik toe, hun Commando en Character na behooren hebben weten te maintaineren.*”

sworn statement that had been given in Canton by the boatswain's mate Thomas de Baar and eleven seamen in which they "accused captain Daniël Correch" ("*ten lasten van opgemelde capitain ter zee Daniël Correch*") because the statement was "replete with untruths and therefore not worth to be believed or getting the attention of your Honours" ("*ten enen maale met onwaarheden is opgevuld, en dus geen geloof, nog uE Achtbaarhedens attentie meriteert*"), although the court martial did not specify these untruths. Interestingly though, on reading the statement of the crew of the *schuit*, one notices not so much an accusation of captain/skipper Correch as such, but rather the outspoken suggestion of a disagreement between the first mate Kikkert and Correch about the course that the *Admiraal de Suffren* had followed before the stranding. The statement also implied that the skipper did not know exactly where the ship was at the moment when disaster struck. The further details in the text of the statement are very much in agreement with the letters written by the officers while being marooned on the island of Lincoln. The only untruth that can be detected by present-day researchers is the day on which the *boot* left the island, which as we saw may be interpreted in two different ways, depending on how one reads the text written by the secretary of the Broad Council at the Canton factory.⁷⁷¹

These goings-on remind us of what we saw in the second and third chapter where the matter of trustworthiness was discussed.⁷⁷² There we noticed that at the beginning of the eighteenth century, the assumption still held that trustworthiness was first and foremost connected to and coming from those circles to which one belonged, be it by birth, education, experience or profession. In the course of that century we saw a shift appear when institutions emerged that were able to claim that they produced unbiased ("disinterested") and therefore trustworthy facts, figures and numbers. That made it possible that (in the case of politicized debate taking place in meetings of the *Heeren XVII*) different factions were able to depoliticize their differences by agreeing on the outcome of experiential insights that crossed the border between these factions, thereby steering away from personal (and therefore possibly contentious) claims; these insights had been filtered through the socially and culturally sanctioned procedures of a society instead of emerging from protagonists who might have a personal interest in the matter. But when the court martial had to decide which interpretation to believe of what had happened and of underlying events, it can be seen to refer to the old maxim that trustworthiness belongs to one's own class of people; this prevented the inconvenience that what common crewmembers overheard at the time of the

⁷⁷¹ It is not inconceivable that the crew, having made this statement on the day they arrived after what must have been a quite uncomfortable journey of two weeks in a very small boat, did not quite fathom the intricacies of some details of the text.

⁷⁷² Chapter 2, section 2.1 and chapter 3, section 3.4

stranding might be nearer the truth than the contents of a letter written almost three weeks after the stranding. There is some irony in the fact that one of the members of the court martial, Wopke Popta, had in 1773 advised against introducing Dalrymple's chart (which was published in 1775 by D'Après de Manneville) that probably contained the island of Lincoln and that he knew from personal experience all too well that texts written by officers did not necessarily contain the truth – after all, he and four others had falsified their journals when it seemed convenient to do so.

In any case, the *Heeren XVII* agreed unanimously with the verdict of the court martial in their meeting of 19 November 1789; considering that - based on an adequate investigation of the journals and other relevant papers – the court martial had not seen evidence of misbehaviour or neglect of duty by the officers of the *Admiraal de Suffren*, but on the contrary that they had shown skill and good management in their behaviour and manoeuvres, these officers were declared free of all misbehaviour or neglect of duty and could be employed again by the company.⁷⁷³ That Daniël Correch, Daniël Kikkert and Remko Woltgrass were indeed employed again should therefore come as no surprise, but it is somewhat surprising that the common sailor Thomas de Baar, explicitly accused by the court martial of untrue statements, was again employed as sailor by the Zeeland chamber shortly after the verdict had been passed, even before the officers had been re-employed.⁷⁷⁴

⁷⁷³ The provisional minutes are in NA 1.04.02/86 dd. 19.11.1789 and the official minutes in NA 1.04.02/199 dd. 19.11.1789. Rather curiously, the minutes of the meeting of the *Heeren XVII* give 12 and 13 March as dates of the disaster, whereas the court martial mentions the (correct) dates of 13 and 14 March.

⁷⁷⁴ Daniël Correch was appointed skipper again on the *Voorland* which ship left Texel on 13.04.1790 for Batavia, arriving on 7.12.1790. He returned with the *Voorland* on 9.02.1794 in Goeree, having left Batavia on 30.01.1793 with intermediate stops at the Cape of Good Hope, Cork and Duins. On 26.12.1794 he sailed as skipper on the *Prins Frederik* from Texel but he did not get any further than Duins where he arrived on 29.12.1794. In December 1795 the vessel was confiscated by the English:

<http://resources.huygens.knaw.nl/das>, searching for “masterr” Correch. According to the website <http://vocopvarenden.nationaalarchief.nl/default.aspx>

Daniël Kikkert sailed again as first mate on the *Meerwijk*, leaving on 29.11.1790, arriving in Batavia on 14.09.1791, he returned with the *Eenparigheid*, leaving on 29.10.1791 and arriving on 26.04.1792. He then left as skipper on the *Christoffel Columbus*, leaving on 15.01.1793, arriving in Batavia on 16.08.1793. He died in Asia on 10.10.1793. Remko (Reinke) Woltgrass (Woltgraft) sailed again as third mate on the *Gouverneur Falck*, leaving on 25.05.1790 and arriving in Batavia on 27.12.1790. He went missing in Asia in 1794. No details could be found regarding Pieter Jansen and Pieter Jahn. On 18.01.1790, Thomas de Baar left as sailor on the *Goede Trouw* from Rammekens, arriving in Batavia on 09.08.1790. He remained in the company's service in Asia, until he died there on 13.12.1797 (cf. <http://vocopvarenden.nationaalarchief.nl/detail.aspx?ID=386955>)

It should not have come as a surprise to the *Heeren XVII* that the reliability of the company's charts (particularly those of the East Indies and beyond) left much to be desired, considering the number of complaints that had been voiced over the years. On 3 November 1789 (about two weeks before the outcome of the court martial was discussed), the *Heeren XVII* spent quite some time (if one looks at the provisional minutes of the meeting) deliberating a possible solution to this problem. Their deliberation was part of a more extensive one regarding a memorandum written by the *Cantonsche Bediendes* (i.e. the staff at the company's factory in Canton) on 18 January 1788, less than two months before the wrecking of the *Admiraal de Suffren*. On 4 December 1788, the *Heeren XVII* had preliminarily discussed this memorandum which contained a number of suggestions for innovations that might contribute to faster sailing times between the Republic and Canton and vice versa: three reasons were given for the fact that the ships of the English East India Company managed to realize must faster crossings to and from Canton than the ships of the VOC. First, the English ships had coppered bottoms; second, the skippers of these ships were given a free hand in which courses to follow; and third, the English used only three-deckers on the China route, ships that were much more able to withstand adverse conditions than the classic Dutch ships that were built with a *kuil* or waist.⁷⁷⁵ In December 1788, the six chambers were asked to give their opinions on all these points. As the introduction of the three-deckers has been discussed in the third chapter, I will concentrate here on the aspect of route finding, which implied that a decision was needed on whether skippers should be allowed more leeway in the courses they had to follow.⁷⁷⁶

Considering the advice of the six chambers, we see that something rather remarkable happened: in favour of allowing skippers more freedom of choice regarding route finding were the Amsterdam chamber, the Hoorn chamber and the Zeeland chamber, in favour of maintaining the current system of prescribed routes were the Enkhuizen chamber, the Rotterdam chamber and the Delft chamber. That meant that - translating this into votes at the actual *Heeren XVII* meeting - thirteen votes were in favour, three were against and

⁷⁷⁵ This argument had been put forward earlier, e.g. in the seventh volume of the *Transactions of the Zeeuwisch Genootschap*, see this volume chapter 3

⁷⁷⁶ NA 1.04.02/85 and NA 1.04.02/198, both dd. 4.12.1788; the memorandum is attached to NA 1.04.02/85. Added was a more general point about possible changes in the construction of ships, which turned out to be aspects like the widening of ships, the introduction of iron knees instead of wooden knees, the shortening of masts and constructing the figureheads at the stem of the ships as light as possible. Decisions were taken on 3.11.1789 (NA 1.04.02/86 and NA 1.04.02/199, both dd. 3.11.1789).

Fig. 4.11A Provisional minutes of the discussion and decision of the *Heeren XVII* regarding giving skippers a free hand in the routes they choose to follow and regarding the introduction of foreign charts (NA 1.04.02/86 dd. 3.11.1789). Picture taken at the National Archives by the author on 6 March 2015.

Fig. 4.11B Provisional minutes of the discussion and decision of the *Heeren XVII* regarding the introduction of foreign charts (NA 1.04.02/86 dd. 3.11 1789). Picture taken by the author at the National Archives on 6 March 2015.

the extra vote was probably also against, a clear majority therefore for allowing the skippers more choice of their own.⁷⁷⁷ However, the decision went the other way: the “*Commissarissen tot de Besognes*” (the committee that had read the comments of the chambers on the Cantonese suggestions and that had prepared the resolution) considered it too dangerous to grant skippers too much freedom of choice regarding routes, on the basis of which verdict the meeting decided to hold on to the current policy, the more so as there already existed a clause that – if circumstances dictated – it was possible to deviate from the instructions. Looking at the provisional minutes, one gets the impression that the discussion did not take up much time, as there was hardly any change made in these minutes.⁷⁷⁸ It may be worth remembering that the proposal to allow decentralized route finding, had been suggested by the Canton staff, which, although tightly but distantly controlled from the Republic, had shown again to be in favour of finding local solutions to local problems as opposed to a strictly enforced central approach. The fact that the directors ignored the advice of what can be seen as a qualified majority of the chambers (when we take into account the relative importance of these chambers) means that they held on to the notion that the company was a centralized institution, as already had emerged in the discussions regarding changes in ship design that we came across in the third chapter and the procedural measures that had been taken in the wake of the health problems as we saw in the second chapter.

Continuing their discussion, the *Heeren XVII* considered an advice of the same committee, which stated that the charts in use by some nations were more “accurate” (*nauwkeurig*) than those in use by the VOC; the committee explicitly used the wrecking of the *Admiraal de Suffren* as an example of the risk involved in using charts on which information was missing. The suggestion by the committee was that all ships bound for the East Indies should be provided with the *werk* (i.e. the volume) by D’Après de Manneville, which presumably meant the complete *Neptune Oriental* with charts and sailing instructions; in addition, a number of copies should be sent to the East Indies to be provided to the ships in the intra-Asian traffic. Looking at the large amount of crossings-out and inserts in the provisional minutes of the meeting (to the advantage of twenty-first century historians, these crossings-out still allow us an almost complete look at the original proposal) the decision seems to have been taken after extensive discussions. In the end, it was agreed to provide only the China ships (on an experimental basis) with the said volume. The reason for the reluctance to introduce the new charts

⁷⁷⁷ The opinions of the chambers are given as an attachment to NA 1.04.02/85 dd. 8.04.1789.

⁷⁷⁸ NA 1.04.02/86 dd. 3.11.1789

across the board was the high price of this volume and the fuss of the introduction (“*de kostbaarheid en omslag*”), coupled with the uncertainty whether the existing charts might not still be “improved” in due course. The presidential chamber (which was in this case Amsterdam) was asked to investigate whether more extensive use should be made of the work of D’Après de Manneville and “which new volumes are available that can be of some advantage” (*welke nieuwe werken er voorhanden zijn waarvan enig nut kan worden getrokken*).⁷⁷⁹ Here we see that the directors did not follow the proposal of the committee, but again favoured (as much as possible) centralized approach.

When we consider the refusal to grant skippers more freedom on the choice of routes and the refusal to provide all ships bound for the East Indies with the charts and manual by D’Après de Manneville, the conclusion must be that *Heeren XVII* wished to uphold as much of the amount of centralized control they had regarding route finding. This French manual contained opinions that significantly differed from the instructions contained in the sailing orders of the VOC, a fact that must have become clear through the translation made by Pybo Steenstra twenty years earlier. On the other hand, a complete rejection of this French manual which contained a chart on which the island Lincoln was shown was not attractive either. After all, the wrecking of the *Admiraal de Suffren* on its maiden voyage had meant the loss of the largest and most expensive vessel ever to sail for the VOC, and - adding insult to injury - after the stranding almost the complete cargo (to the value of more than one million guilders, as valued at the time) had been lost to Chinese sailors. The fact that the wrecking had taken place on an island that was not shown on the charts of the VOC had made it painfully clear that it could prove to be very costly when the company did not continually acquire, accumulate and circulate up-to-date geographical, nautical and navigational knowledge, even when it had to be provided through foreign expertise. A compromise which involved providing the China-bound ships with the French manual solved on the one hand the problem of the obviously “inaccurate” charting of the South China Seas while on the other hand all other skippers could still be supplied with the company’s own charts and instructions, thereby preventing them from following foreign advice.

The first (published) occasion to assess the suitability of “new volumes (...) that can be of some advantage” occurred when a memorandum arrived in the Republic (probably in late 1790 or early 1791) written by A. E. van Braam Houckgeest, by then appointed as director of VOC’s factory in Canton and – as we have seen - former *supercarga* at the factory there; this memorandum was

⁷⁷⁹ The provisional minutes are in NA 1.04.02/86 dd. 03.11.1789 and the official minutes in NA 1.04.02/199 dd. 03.11.1789

accompanied by a fragment of a letter by the High Government in Batavia.⁷⁸⁰ While sailing in the Southern Ocean on the *retourschip Doggersbank* in July 1789, Van Braam had drawn up a proposal that the VOC should use Dalrymple's chart of the South China Seas, because this chart was far more "accurate" than the charts that were issued by the VOC itself. At the time, he was of course not aware of the decision that the *Heeren XVII* would take a few months later regarding the work by D'Après de Manneville in which this chart was contained, although he may have been informed at the Cape about the disaster that had befallen the *Admiraal de Suffren*.⁷⁸¹ The memorandum consisted of a Dutch translation of D'Après de Manneville's *Mémoire sur la Carte des Mers de la Chine* concerning Dalrymple's chart, with a recalculation of the longitude figures based on the meridian of Greenwich to the one used by the VOC, which was running across Tenerife.⁷⁸² Van Braam added some notes made by D'Après de Manneville concerning the chart in question, "which chart was the most exact and perfect of all (charts) that have appeared until now".⁷⁸³ Cornelis Pietersz⁷⁸⁴, examiner for practice of the chamber Amsterdam of the VOC, produced a comment on Van Braam's paper in which he wrote that the chart that had been added by Van Braam (although slightly "improved" compared to the original by D'Après de Manneville, which in

⁷⁸⁰ NA 1.04.02/4580 *Memorie omtrent de Kaart van de Ind. Zee door den heer Alexander Dalrymple en Rapport etc.* The quote is on the tenth page (no page numbers), in Dutch it reads: "welke kaart men moet aanmerken als de exactste en volkomenste van al degeenen welken tot hier toe in het licht gekomen zijn"

⁷⁸¹ According to <http://resources.huygens.knaw.nl/das/detailVoyage/95667> the *Doggersbank* arrived in Batavia on 02.01.1790. However, prior to that date the ship had arrived in Malacca on 17.10.1789 (described by Van Braam as a "toevallige komst" - accidental arrival, cf. Hullu (1920), p. 292). The earliest moment that Van Braam could have been notified of the wrecking of the *Admiraal de Suffren* was at the Cape where the *Doggersbank* was between 27.05.89 and 10.06.1789. Shortly before (between 10.04.1789 and 06.05.1789), three of the ships carrying crewmembers of the *Admiraal de Suffren* (the *Leiden*, the *Gouverneur-generaal Maatsuijker* and the *Blitterswijk*) had stayed for some time at the Cape, en route between Canton and the Republic. The fourth vessel from Canton, the *Goede Trouw* probably made no stop at the Cape. See <http://resources.huygens.knaw.nl/das>, "homebound voyages" from "china" between late 1788 and early 1789.

⁷⁸² See section 4.3 *A dangerous trade*

⁷⁸³ NA 1.04.02/4580, the quote is on the tenth page (no page numbers), in Dutch it reads: "welke kaart men moet aanmerken als de exactste en volkomenste van al degeenen welken tot hier toe in het licht gekomen zijn"

⁷⁸⁴ Also known as Kornelis Pietersen (cf. the website DAS and Bruijn (2008), p. 209 & 227). As we saw in section 4.3, Pietersz seemed to have favourably commented on Van Braam's chart of the approaches to Canton. This Kornelis Pietersz/Pietersen should not be confused with Cornelis Pietersen/Pietersz who was employed by the Zeeland chamber, as we saw in chapter 3.

turn was based on the chart by Dalrymple) was not to be preferred over the chart that had been provided through the Batavia chart makers offices during twenty years.⁷⁸⁵ He offered a number of reasons for this, the first about a very small difference in the longitude of the bank “*Royaard*”, the second about the position of the *Ladrones* near the Chinese coast which were supposedly too much to the East on Dalrymple’s chart, the third about a cliff near the island of Lincoln which should be to the North of that island and the fourth about the wrong position of an island near Poulo Sapatto. Particularly the third remark is rather curious as an argument in favour of the company’s own chart: the island of Lincoln had been completely absent on that chart until the *Admiraal de Suffren* was wrecked upon it whereas it had been marked on Dalrymple’s chart since the early 1770s. Moreover, the remark about the cliff is puzzling: Pietersz argued that the officers of the *Admiraal de Suffren* also noticed the cliff to be to the North of that island, but when one looks at the chart of the island as drawn by these officers (fig. 4.10), one sees that the visible cliff is to the South of the island – and the invisible submerged cliffs on which the *Admiraal de Suffren* foundered are all around the island. Pietersz went on to argue that it would have been better if Van Braam had transferred the Batavia produced chart from Banca Strait to the China Coast onto a larger scale instead of doing so with the chart of D’Après de Manneville. He then added that the quality of the charts copied in the offices in Batavia left sometimes something to be desired, and that some of these charts had in a few cases contributed to accidents that had befallen ships of the company. It would be better - suggested Pietersz - when an “improved” copy of the Batavia chart was brought over to Amsterdam and printed there, something – he wrote – that had already been proposed by Pybo Steenstra, his predecessor. Although Pietersz agreed with Steenstra on the topic of printed charts being preferable to charts copied by hand, he obviously disagreed with his predecessor on the quality of the charts by D’Après de Manneville and Dalrymple.

Pietersz seems here to undermine his own argument that the Batavian produced charts were preferable to French or English charts, because (as he wrote) this would only be the case if and when an improved version of the Batavia chart was produced; this had obviously not yet happened. Still on the subject of improving the company’s own charts, Pietersz echoed the proposal made by Mohr more than twenty years earlier when he wrote that establishing longitude and latitude of significant landmarks could lead to the correct positioning on the company’s charts of the corners of all islands, cliffs

⁷⁸⁵ Unfortunately, this chart by Van Braam is not included in the file, although the University of Leiden (Special Collections) has in its possession two charts of the Malacca Straits that have been redrawn by Van Braam (COLLBN 006-13-013 and COLLBN 006-14-015).

and banks.⁷⁸⁶ On the one hand, Pietersz can be seen to oppose a wholesale introduction of the charts by D'Après de Manneville/Dalrymple (which had already taken place for the ships in the China trade), on the other hand he recognized the occurrence of incorrect positioning of landmarks on the company's own charts.⁷⁸⁷

The last mention that is made of anything related to the introduction of the new charts (before the VOC ceased to exist in the final years of the eighteenth century) is in the *Generale Resolutieën van het Kasteel Batavia* (the General Resolutions of the Castle Batavia) which contains on 8 July 1791 the following remark: "*De verplaatsing van het eiland Lincoln en de bank de "Rooijaard" in de kaart van de Chinasche zee, bij de zeilaas-ordre te doen bekend stellen*" (To make known by sailing order the repositioning of the island Lincoln and the bank Rooijaard on the chart of the China Sea), which implies that also vessels that hadn't been provided with the charts by D'Après de Manneville were informed of the changed position of some dangers in the South China Seas.⁷⁸⁸

The reluctance of gentlemen and the power of charts

When we consider the availability and development of advanced charts and of recently acquired astronomical and geographical knowledge that might contribute in a positive way to the navigation on the ships of the VOC, there seems to have been more reluctance in implementing such charts and knowledge than that which had occurred when earlier discussions had taken place about a suggested change in the design of the *retourschepen* of the company. Then at least the Zeeland chamber had been granted permission (at least for a limited time) to experiment with the design, even when further introduction had become a rather protracted affair, as we have seen in the preceding chapter. The intervention of a society in 1780 had played an important role in the recognition of the advantages of the new technology. In the case of charts even the intervention of the *Bataviaasch Genootschap voor Kunsten en Wetenschappen* (the Batavia society) had no effect, although their comments and recommendations were published at about the same time (1779 and 1780) that the *Zeeland Transactions* had succeeded in putting the

⁷⁸⁶ Mohr's proposal of 1768 was already mentioned in section 4.2

⁷⁸⁷ NA 1.04.02/4580 (after 1789) final page ("*naamelijk om daardoor in staat te geraaken van alle de hoeken (van?) Eylanden, klippen en droogtens op hun ware Lengte en Breedte in de Comp's kaarten te kunnen plaatsen*")

⁷⁸⁸ Bataviaasch Genootschap van Kunsten en Wetenschappen (eds.) *Realia* p. 395. This was of course most urgent for ships that sailed to and from Japan or ships that were supplied by the authorities in Batavia as replacement for ships in the Canton trade that had been delayed on the outbound voyage from the Republic.

three-decker back onto the agenda of the VOC. Complaints by skippers, suggestions by the official examiners of the company, astronomical observations by foreigners at the Cape of Good Hope and by people involved with the VOC itself on Java, and charts produced by the independently minded staff at the company's office in Canton, they all failed to get through to the directors of the VOC or if they got through no response was forthcoming. This had even been the case when it might have seemed rather obvious that newly acquired knowledge could contribute to the overall goals of the VOC, either by providing longitudinal and latitudinal coordinates for important destinations such as the Cape of Good Hope, Batavia, and the coast of Java or by introducing experiential local knowhow that was superior to what was known at the central chartmakers' offices. Leaving aside the difficulties related to determining longitude while at sea, knowing the exact coordinates of one's destination or intermediate landmarks would have been a great help in compiling more useful charts, for better navigating and for correcting the dead reckoning, not to mention the advantage of having detailed knowledge available on where to find shelter in case of adverse conditions.

It took almost twenty years after the High Government in Batavia had recognized the unreliability of some of its East Indian charts before official action was undertaken in the Republic. How many times skippers meanwhile had followed their own experiential and theoretical knowledge we will never know – apart from the (posthumously published) occasion that was mentioned in section 4.3. Metaphorically speaking one might say that it needed a long drawn out detour through an uncharted Chinese island to get Batavia's charts replaced in Amsterdam by French charts. A somewhat uneasy conclusion could be that the company ignored a number of warnings, even after the "Batavian" acknowledgement of 1771 that some charts covering the East Indies were unreliable. Although the staff in Canton in their official *Eerbiedig Rapport* of 1772 (as we have seen in the preceding section) had made it clear that the loss of the *Rijnsburg* in that year was at least partly caused by unreliable charts of the approaches to Canton and had produced an alternative chart, the VOC in the Republic apparently was deaf to their comments and the suggested alternative, although it may have been the case that the High Government in Batavia provided the alternative chart to ships bound for Canton. In any case, the VOC in the Republic did not decisively act upon the loss of the *Rijnsburg* and the drowning of almost its complete crew, apart from that the value of the bullion and cargo in the wreck seems to have been considered important enough to mount a salvage operation from Canton that lasted several years; there is also no evidence that the company reacted sufficiently upon suggestions by skippers (who complained - one gets the impression – on a very regular basis) and upon two publications in the *Transactions* of the Batavia Society of 1779 and 1780. In the end, the huge

financial loss incurred by the wrecking of the company's flagship, the *Admiral de Suffren*, seems to have been the straw that broke the camel's back. That disaster brought to a (compromised) end the company's long reluctance to look beyond its own boundaries in the continuous search for up-to-date geographical and navigational knowledge.

The company's reluctance may have been connected to concerns about losing part of its control over skippers, in this case as far as route finding was concerned; the aim of the VOC to maintain or expand a more centralized grip on its operations in general became already apparent in the preceding three chapters. It may therefore not have been a coincidence that immediately before the decision to experiment with foreign charts was taken, the directors (going against the advice of a qualified majority of the chambers) reconfirmed that skippers had to conform to the existing regulations – this fits in with what we noticed in the second chapter about the increasingly tight grip that the directors of the VOC wished to exert on its nautical operations. The company must have been well aware of the fact that users and interested (and “disinterested”) outsiders were of the opinion that the charts produced for the company and currently used by it could not be trusted completely, which in turn questioned the wisdom of prescribing certain routes. However, as we saw, these same charts (defective in places as they might be) were powerful instruments in the hands of the company, power that might be lost if and when foreign charts had been introduced. By restricting the use of foreign charts and sailing instructions to a very specific and limited part of the trade, namely the profitable but dangerous direct tea trade to China, the company can be seen to square its need for overall control with the need to introduce new and safer foreign charts for navigation. Whereas on the one hand, the decision as it was finally taken could be described as a failure to timely and adequately respond to new developments in charting, we might also consider it as a success in the sense that the VOC managed to uphold its controlling policies while allowing the use of foreign charts and instructions within that part of its commercial enterprise that promised to reap the most benefits of these new instruments.

Looking back at the way charts were described in section 4.1 (“*The character of charts*”) we see that they were characterized as “immutable mobiles” and “practices”, and that they were powerful in two ways. First, in the hands and minds of knowledgeable and experienced users, charts were powerful instruments for navigating ships across the globe; second, these charts acted as powerful surveillance instrument on behalf of the directors of the VOC to see whether their users had followed the prescribed routes as was shown by the routes that these users themselves had drawn on these charts. The power of charts was not absolute, it hinged on the fact whether geographic, hydrographic and longitudinal/latitudinal features were reliably

represented. That means that the flexibility of charts came into play: charts (and sailing instructions) needed almost constantly to be updated. That process of updating not only needed the experience from each and every skipper that used a certain chart, it also needed information and knowledge from other sources, be it a French astronomer at the Cape, a Dutch minister at Batavia, a *supercarga* at Canton, an English cartographer or a French hydrographer. One gets the impression that these sources never actually made it onto the charts nor into the sailing instructions. The only source used for updating both charts and sailing instructions seems to have been the information that became available through the skippers of the company; although – as we have seen – skippers were not always too impressed with the way their comments were acted upon. The situation did not improve during the second half of the eighteenth century: no traces can be found of any updated reprint of the sixth volume of the Van Keulen atlas after the 1757 edition and as far as the manuscript atlas produced in Batavia is concerned, there the Amsterdam examiner Pietersz made it clear that an improved edition was long overdue. One gets the impression that by apparently concentrating on the surveillance aspect of charts and by neglecting to update charts, the VOC may itself have contributed to the fact that its charts became increasingly out of date, as was argued in the *Transactions* of the *Bataviaasch Genootschap*.

When considering the character of charts, I also mentioned the complicated network made up (among other elements) of charts and the *Heeren XVII* as a locus of interactions and negotiations. It seems that in these negotiations the emphasis by the directors of the VOC was directed towards upholding their power over ships, skippers and routes using the external power they had inserted into their charts and sailing instructions. They refused to act on sometimes inconvenient messages from centres outside the recognized centres of Amsterdam and Batavia. Against this we saw that the internal power of foreign charts created a spatial view of seas and routes that differed (sometimes crucially) from the panopticon that the *Heeren XVII* preferred. An introduction of these foreign charts for all ships of the VOC could have implied that foreign policies would take over from the company's policies or that (alternatively) the foreign sailing instructions had to be extensively rewritten to adapt these to the company's policies. It is possible to interpret the "*fuss/omslag*" mentioned during the discussion as pointing towards this last possibility. However that may be, the company could ill afford more losses on its profitable China trade, particularly considering the financial problems that the company was experiencing after the fourth Anglo-Dutch war of 1780-1784. This meant that a possible conflict between the trustworthiness of the company's skippers and the trustworthiness of the charts of the company had to be solved at short notice. The outcome of the

discussion was that in a trade-off between reliable foreign charts and independently minded skippers, foreign charts were only trusted on a specific and limited part of the trade routes of the company, whereas the *Heeren XVII* tried to keep all other skippers in check by using old and trusted charts and sailing instructions on all other routes.

The issue of who or what could be trusted and why seemed earlier (when decisions on ship design were taken as we saw in the preceding chapter) to have been decided in favour of interested outsiders presenting disinterested facts, figures and numbers. However, when the trustworthiness of persons came under scrutiny – either as individuals or as a group – we see that the *Heeren XVII* and their committees (be it the court martial or the *Commissarissen tot de Besognes*) returned to an earlier technology of trust, which covered up the failing of the VOC to engage in time with foreign charts, exonerated skipper and officers against the detailed sworn statement of common sailors and which allowed the company to ignore much of the critique and comments by skippers, societies and former examiners; the result of which was that the central governing body of the VOC maintained a tighter and more centralized system of control over the navigation by the company's skippers than the qualified majority of the separate chambers deemed necessary. The culmination of this centralization came when on 12 March 1795 the directors proposed to introduce a single central board of directors whereby in fact the autonomy of the six chambers would be dissolved.⁷⁸⁹ A year later (on 1 March 1796), the directors were replaced by the "*Committé tot de zaken van de Oostindische Handel en Bezittingen*" which meant that the VOC was *de facto* nationalized and irrevocably centralized.⁷⁹⁰ Ironically, the only two factories of the VOC that continued to be managed by (former) VOC staff, that never fell into foreign hands and that continued their trade well into the nineteenth century were the very small and very de-central factories at Dejima in Japan and at Canton in China.

⁷⁸⁹ NA 3.02.33/24 letter of 12.03.1795

⁷⁹⁰ The committee for the affairs of the East India Trade and Territories, cf. Eyck van Heslinga, van (1988), p. 49

CONCLUSIONS

CONCLUSIONS

Reflecting on the connection between the VOC and technology in the eighteenth century, it becomes clear that the *retourschepen* of the VOC played a central role. On and through these ships, relations between technology, knowledge, safety, health, nature and trade were woven into a tightly knit fabric or network of which sometimes societies were also a part. It is therefore not surprising that these powerful *retourschepen* continuously sail through all chapters of this dissertation. For the enlightened public of the eighteenth century, some of these relations had already become visible through entries in the *Transactions* of a number of societies such as the *Zeeuwsch Genootschap* in Middelburg, the *Bataafsch Genootschap* in Rotterdam and the *Bataviaasch Genootschap* in Batavia. Building on archival materials such as minutes of meetings of the *Heeren XVII* (the directors of the VOC), letters, journals, logbooks, treatises, charts and atlases I have tried to make visible the network of which they were a part by using insights and methods offered by Science and Technology Studies as I explained in the introduction.

In the first chapter I turned my attention to the ships as such. In the way the ships were designed and built, a movement became visible from embodied artisanal knowledge towards more established inscribed knowledge. This became possible through the medium of measured design drawings. Knowledge that had originally been embodied in the bodies and minds of shipwrights became increasingly externalized in these drawings that were introduced in the 1740s. The *retourschepen* of the VOC became then the materialized outcome of existing and evolving experiential knowledge coupled with the newly established knowledge of producing, reading and following drawings. This meant that these ships could be characterized as hybrid: hybrid in the sense of being the result of human and non-human interaction during the design and building process brought forth by an amalgam of experiential and established knowledge. The standardized design and production of the company's ships needed the immutability of the design drawings and of the materials that were used. But the ships displayed another layer of hybridity because of the demands of the VOC on the way its ships were to operate. The comings and goings of these *retourschepen* when they connected the opposite ends of the VOC's trading empire depended on their mutability. Of course, they had to be sturdy, seaworthy, innovative and standardized, but these qualities were not ends in themselves. To fulfil the roles appointed to them, they needed to change character between outward bound voyage and homebound voyage. In other words, they showed different aspects of the hybrid character with which they were endowed. The immutable and mobile character that the *retourschip* displayed through its materiality was complemented by the mutable mobile character of its use:

mobile in the sense that it sailed back and forth between the Republic and the East Indies (and often – in between voyages - within the East Indies), mutable in the sense that to fulfil its role it was able to change the character and the content of the accumulation that took place below decks between the outward bound journey and the homebound journey. In its mutable mobility, the *retourschip* demonstrated a second level of hybridity: the different capacities through which it could connect the Republic and the East Indies.

Thinking about the issue of embodied knowledge in relation to the ships, one can distinguish two forms of embodiment, either concentrating on artisans who use their embodied knowledge when producing an artefact such as a ship or concentrating on the artefactual ship itself, which embodied in its materialized form both artisanal and established inscribed knowledge. These two forms of embodied knowledge present the present-day historian with the problem of how to retrieve such knowledge out of (the remnants of) a historic artefact and how to uncover such knowledge, embodied in artisans that lived in the eighteenth century.⁷⁹¹ In the case of the VOC, only tiny fragments of its original ships still exist; as far as artisans such as its shipwrights are concerned, it is obvious that they took any (non-published) embodied knowledge with them when they passed away. Of course, they passed their embodied knowledge on through guilds, apprenticeships, learning on the job, etc., but through ongoing processes of oral and manual tradition (to which should be added the increasing role of established inscribed knowledge) this knowledge was susceptible to change over time. This means that the know-how of a present-day traditional shipbuilder - even when he might be able to trace his tradition back to the eighteenth century – is not the same as it was over two centuries ago. Therefore the only solution is closely looking at what is left in the form of contemporary drawings and models, and of texts written by shipwrights and others at the time, through which they made a part of their skills and knowledge explicit – which has been part of the research underpinning this dissertation.

The *retourschip* mirrored the activities of the VOC in its linking of two networks of accumulation. On the one hand, it occupied pride of place in the centre of a centralized constructive network through the immutable mobile of its design. That design was in turn inextricably linked with the building methods and the accumulation of materials and know-how centred on the company's shipyards; the connection between the six local shipyards was strengthened by the design itself. On the other hand, the *retourschip* was the powerful mobile centrepiece of an extensive and complicated trading network through the mutable mobility on its journeys, leaving the Republic with people, ballast, coins and goods and returning to its port of departure with an

⁷⁹¹ An issue that was also discussed by Roberts (2012)

impressive array of Asian goods, to be accumulated again in the huge storehouses that had contained most materials for its inception and equipment before it took to the seas. The common crew (sailors and soldiers) were characterized as “dispensable” because a certain death rate on the way out and within the East Indies had been calculated. However, when outbreak of contagious diseases suddenly led to more loss of life, the VOC was presented with the problem that there were too few crewmembers available to sufficiently man its ships operating in the intra-Asian trade, let alone the ships returning to the Republic. In addition, when such diseases manifested themselves, the number of soldiers available for the protection of the company’s interest in Asia became equally much smaller than needed. These problems, the analyses of their causes, the different solutions that were sought and the measures that were taken were considered in the next chapter.

In this second chapter I noticed in more detail that the *retourschepen* of the VOC had a great impact on the wellbeing of their crews, because of a third, socio-material layer of hybridity that was part and parcel of these ships. This layer became visible when these ships embarked on their long journeys during which all on board (be it skippers, officers, common sailors, soldiers or passengers) were physically cut off from the outside world. The micro-society that existed during the time of the journey was demarcated by the sheer physical space (cramped as it might be) offered by the ship. But the demands that the ship imposed on those who sailed on it meant that the ship played an active role in the micro-society on board. Crew, officers and ship were dependent on each other for surviving the journey through a powerful and often hostile environment. That tensions could arise within this strictly and often harshly regulated society seems self-evident in normal circumstances, but the situation could become even more complicated when severe health problems occurred, often caused by the outbreak of contagious diseases on board. However, tensions were not confined to individual ships; the wider network to which the ships belonged was tension-filled as well – and there the situation became more complicated because of these diseases. Whereas solutions to health problems were for a time sought through the use of machines, we saw that – as the eighteenth century wore on – the measures that were taken took instead the form of centrally prescribed procedures. This implied that ships were increasingly seen as part of the centralized enterprise that the directors of the VOC tried to establish. This led to tensions within the network of the VOC – tensions between the centralized commercial enterprise that concentrated on the profitability, the preservation and the expansion of its trading empire on the one hand and the independence of the chambers of the VOC, of the skippers on their ships out on the ocean, and of those who were in charge of the company’s settlements in Asia on the other hand. Examples of these tensions became clear in this and the following chapters.

At the turn of the seventeenth/eighteenth century we saw attempts to improve the health situation on board through the introduction of mechanical means. This occurred in the form of distillation machines that were introduced on board of the ships. These machines produced drinking water out of seawater which was seen as a partial alternative to carrying large amounts of drinking water in wooden casks, the quality of which usually deteriorated rapidly and which took up much valuable space as well. The machines were abolished after about fifteen years because of objections voiced by skippers, who were supported by the High Government in Batavia. Whereas the introduction of seawater distillation had been based on “gentlemanly trust” within the circle of directors of the VOC, users (or rather outspoken non-users) played an important role in the abolition of the system. Skippers feared resistance among their crew on the homebound voyage against the machines and against the perceived obligation to sail with a smaller water supply and they refused to do so to avoid tensions on board. The late 1760s saw a very short-lived re-introduction of distillators, this time instigated from Batavia instead of from the Republic. Following a negative advice by the Amsterdam chamber, the directors of the VOC decided that all distillators that would arrive from Batavia should be returned immediately.

In the 1740s, hand-driven mechanical ventilators were introduced to improve the air quality on board. These machines were used considerably longer than the distillators, and they were even replaced in the 1760s by an apparently more efficient model. However, refusal of skippers to use these machines when returning to the Republic (because of the cumbersome way these machines had to be operated) led to a partial abolition of these machines. Strangely, this happened in 1772 at a time when the VOC was involved in probably the most severe health crisis the company had ever to contend with. Sudden outbreaks of *rotkoorts* (putrid fever, currently known as typhus or spotted fever) led to a large loss of life on the outward bound journeys, especially between the Republic and the Cape. Solutions were sought in an increase in procedures. On the one hand this concerned the way sailors and soldiers should to be enlisted and controlled before they were allowed on board. On the other hand it entailed procedures to deal with sickness when a contagious disease became apparent. These procedures dealt with how to dispense medicines, the keeping of notes of the efficiency of medicines, how to separate the sick from those still healthy, the dispensing of food and drink to those that had fallen ill, and weekly meetings of officers to discuss the situation. An experiment that was set in motion to establish whether overcrowding was a cause for the outbreak of diseases yielded no conclusive results. However, the effect was that – even after the diseases had disappeared - the number of crewmembers on board continued to decrease considerably (with about a quarter) until the fourth Anglo-Dutch war broke out.

Although two societies (the *Zeeuwsch Genootschap* and the *Bataafsch Genootschap*) published essays in which (among other suggestions) the continued use of machines was advocated, in the end solutions were increasingly sought through centralized and standardized procedures instead of through machines. Whereas machines offered skippers some scope for individual decision making or even invited them to act independently, the prescribed procedures had to be followed to the letter, as proof of which reports had to be submitted. The irony is that the skippers themselves, either through their role as outspoken anti-users (in the case of the original *waterwerk*) or as tacit non-users (in the case of ventilators) can be thought to have contributed to a decline of their independence. The procedural approach obliged officers to create - through their reports - a paper shadow, traces of which can still found in archives, to the great benefit of present-day historians, although it also presents some challenges when it comes to how to interpret these shadows.

As we saw, the people on board lived for months on end in a micro-society, cut off from the larger society they had left in the Republic and that of the East Indies where they might arrive. To get an impression of what it meant to operate the ships of the VOC and to live in this micro-society during times of disease, letters, logs and reports of skippers, mates, surgeons and passengers were quoted at the end of the second chapter. Quite often these writings went beyond what was formally asked by the VOC to be put into reports and they often contained very personal and direct remarks.

The gradual change in approach by the VOC, relying on standardized procedures rather than on machines can be seen as an effort to turn the fleet of the VOC that sailed between the Republic and the East Indies into a centrally organized ensemble within the VOC network; an ensemble of which each individual ship was only a part, operated by an increasingly tightly controlled workforce, officers and ordinary sailors alike. The whole process of centralized disciplining signaled a move away from the originally conceived decentralized organizational model to a much more centralized enterprise. That this move led to tensions within the network (on the level of the company as such or on the level of ships) and was not accepted without opposition (either overt or covert) was shown in the third and fourth chapter.

The first instance when the move towards more centralization was contested was described in the third chapter. It occurred when the Zeeland chamber suggested a re-design of the current standardized *retourschepen*, when in fact it had already gone ahead with building such a vessel. This change in the design of the *retourschip* was intended to make the ship more powerful against the forces of nature, to offer a healthier environment for the crew and to increase the prospects of profitable trade: in addition (intentionally or not) it might reclaim a certain amount of independence for

some of the chambers of the VOC as local centres of accumulation and calculation. In a protracted discussion lasting more than a decade and a half about the pros and cons of the so-called three-decker design, detached reasoning and quantification played an important role in the decision that was finally taken. Essays published in the *Transactions of the Zeeuwisch Genootschap* as the outcome of a competition provided arguments based on experiences by users in favour of this new design. Experience not only showed that the new design was better able to cope with the forces of nature, more suited to a profitable trade and offered a healthier environment, in one of the essays it was also shown (again based on experience) that it offered better opportunities for a stricter and more efficient system of supervision, thereby strengthening the centralized way in which the directors of the VOC tried to get a tighter grip on ships and officers. At the time, a technology of trust based on the literary technology of creating virtual witnesses (a technology that had been in place in societies since the late seventeenth century) rendered the arguments put forward in the *Transactions* neutral and reliable. Then the VOC responded in a positive way to the arguments contained in the essays by allowing its shipwrights to deviate locally from the standardized ship design.

However, in the final chapter we saw that centralized control remained the favoured approach of the VOC. It could also be detected in the production and adaptation of charts and sailing instructions and procedures regarding route-finding. Charts and sailing instructions were described as powerful in two senses of the word. First, they were of huge significance for navigation as they offered skippers and officers a view beyond the visible horizon. Secondly, upon return the charts in particular were used to disclose whether skippers and officers had stuck to the prescribed routes – the route that skippers and officers had plotted on the charts while *en route* clearly showed whether that had been the case. However, we also saw that uncharted events in the literal sense of unreliable charts provided by the VOC had quite an impact on the safe passage of ships, especially in the China trade. Not only the original *retourschepen* of the classic design but even the more powerful three-deckers were to quite some degree powerless against unreliable charts, unless the expertise and the critical sense of skippers and officers managed to steer them away from (metaphorical or literal) hidden dangers. Just as had happened in the case of the introduction of the three-decker on the instigation of individuals outside of the central offices of the *Heeren XVII*, locally produced improved charts tried to re-assert the importance of small de-central centres of accumulation *vis-à-vis* the efforts of the *Heeren XVII* to emphasize the importance of centralization in the Republic. The reluctance of the directors of the VOC to engage with local or foreign expertise in chart making became also visible when it concerned the expansion of astronomical and geographical knowledge, either produced by foreign astronomers at the Cape or by a Dutch

astronomer in Batavia. The only example where de-centrally acquired knowledge made it into the official body of navigational knowledge of the company (in this case the sailing instructions) was the information regarding magnetic declination that was continuously collected by skippers and officers *en route*. Here the ships of the VOC were important active and passive instruments in the collection, production and circulation of knowledge on which they in turn depended for safe navigation. We came across one documented case of a skipper using de-centrally and privately acquired navigational knowledge to improve his position-finding and navigation. As we saw in the final chapter, Johan Splinter Stavorinus used the “lunar distance” method to ascertain his position on the ocean more than a decade before the VOC finally introduced a variant of this method. Stavorinus must have come by the necessary information through publication by the *Académie des Sciences* in Paris, which again showed the importance of societies and their publications. To make their knowledge publicly known, astronomers, cartographers, physicians, and artisans (be it “professionals” or “amateurs”) often relied on the societies of the time. Through their meetings, discussions, competitions and publications these institutions produced and circulated knowledge that was considered trustworthy through the procedures they had in place. Their publications are still of great benefit to present-day historians, as the *Transactions* that were published at the time are still available.

As far as charts were concerned, skippers were not always impressed with the response of the officials when they reported what they called “inaccuracies” in charts. Not only skippers commented on the company’s charts, also the small (and very de-central) factory in Canton tried to introduce local knowledge into the official body of navigational knowledge of the company, but it is doubtful whether this met with much success. Even when the *Bataviaasch Genootschap* published a number of comments and recommendations in 1779 and again in 1780, these remarks seem to have had no effect whatsoever - in contrast to the Zeeland *Transactions* of the same year that had succeeded in putting the three-decker back onto the agenda of the VOC. It showed however that the societies continued their involvement with the VOC.

A shipping disaster in the South China Seas finally spurred the VOC into a form of recognition that foreign charts might be preferable to the company’s own charts and instructions. A court martial sparked by the wrecking of a richly laden *retourschip* from Canton on an island, not marked on the company’s charts but indeed shown on a number of foreign charts, paved the way for providing foreign charts in an (admittedly) restricted number of cases, although route finding by skippers was still confined to the official sailing instructions. The company’s reluctance may have been connected to concerns about losing part of its control over skippers, in this

case as far as route finding was concerned. It may therefore not have been a coincidence that immediately before the decision to experiment with foreign charts was taken, the directors (going against the advice of a qualified majority of the chambers) reconfirmed that skippers had to conform to the existing regulations. This fits with what we noticed in the second chapter about the increasingly tight grip that the directors of the VOC wished to exert on its nautical operations. Earlier, when decisions on ship design were taken, the issue of trust seemed to have been assigned to the literary technology of virtual witnessing whereby disinterested writers presented unbiased experiences, facts, figures and numbers. However, when the trustworthiness of persons came under scrutiny – either as individuals or as a group – we saw that the *Heeren XVII* and their committees returned to an earlier (gentlemanly) technology of trust. This conveniently covered up the failing of the VOC to engage in time with improved charts, exonerated skipper and officers against detailed accusations of poor seamanship and discord. It also allowed the company to ignore much of the critique and comments by skippers, societies and others. The result of this was that the central governing body of the VOC maintained a more tight and centralized system of control over the navigation by the company's skippers than the qualified majority of the separate chambers deemed necessary.

The centralistic approach regarding the introduction, use, replacement and abolition of technology within the VOC that became visible in the different chapters not only effected shipwrights, skippers and surgeons, it also endangered the independent position of the six chambers. They had to comply with the procedures laid down by the *Heeren XVII*, moving away from the VOC's original federal structure. Ironically, it was precisely the de-central aspects of the VOC's structure that seemed to bring about most of the technological advancement of the company, as can be seen by the first introduction of distillators that originated in Amsterdam, the new 1742 ship design that also had its origins in Amsterdam, the re-introduction of distillators that emerged in Batavia, the improved ventilator from Rotterdam, the three-decker design from Zeeland and several astronomical, navigational and cartographic suggestions coming from the company's examiners in Amsterdam, foreign astronomers at the Cape, a Dutch astronomer in Batavia or company staff in Canton. And we should not overlook the experiments that were undertaken by an individual skipper when he used new navigational techniques that had become available through (foreign) societies.

Technological knowledge was (well into the eighteenth century) mainly preserved, developed, expanded and transmitted through education and apprenticeships, and it was embodied in persons, institutions and practices. In that respect, the role of guilds springs to mind, as the institutions through which such apprenticeships were organized and knowledge was

passed on. When, in the late 1760s, Adam Smith stressed the importance of division of labour and the accumulation of capital in creating economic growth, he took issue with guilds (or corporations as he called them) because he considered them as institutions that kept knowledge private, instigated unnecessarily long apprenticeships and kept prices artificially high.⁷⁹² Whatever the truth may be in Smith's condemnation of guilds, it was obvious that the master shipwrights at the Zeeland yard of the VOC (educated as they must have been through the classic father/son or master/apprentice system) did everything they could to circulate their knowledge to the other VOC chambers instead of keeping it private. Looking at what I discussed in this dissertation, we can detect within the VOC a movement from an almost physical embodiment of knowledge (or "know-how" as I called in the first chapter) by master shipwrights on the yards of the company (aided by collective accumulated embodiment in organizations such as guilds) towards an embodiment of knowledge in inscriptions, either in the form of the immutable mobiles used at the shipyards of the VOC (as mentioned in the first chapter), in the form of treatises published by master shipwrights or in essays published by societies in their *Transactions* as we came across in the second, third and fourth chapter. The literary technology of virtual witnessing led to knowledge becoming increasingly publicly accessible; it also created a certain distance between matters of personal opinion on the one hand and experience, experiments and knowledge on the other hand. Although membership of societies was often limited to the higher echelons of society, societal status was not a defining issue when somebody took part in a competition organized by a society. In many cases entries had to be submitted under a motto and judging took place anonymously. It created a different technology of trust; instead of the earlier idea of gentlemanly trust, now trust was found in texts based on experience and experiments and filtered by the socially and culturally sanctioned procedures of the societies that published these texts.

Against this trend of increased openness to experiences, we noticed (especially in the second, third and fourth chapter) that the individual ("subjective") experience of skippers and officers, shipwrights, astronomers and nautical experts was increasingly replaced by the centralized ("objective")

⁷⁹² References to Smith are made following the 1843 edition of *An Inquiry into the Nature and Causes of the Wealth of Nations*, i.e. Smith (1843), Book I Ch. VII & Ch. X, Part II. Present-day research by S. R. Epstein suggests that guilds were far from the reactionary forces that Adam Smith considered them to be. "Dutch craft guilds – including those associated with the two industrial sectors in which the Dutch excelled, shipbuilding and windmill technology – were at the forefront of technological innovation, both through inventions within their ranks and in their adoption of novelties from abroad" (Epstein (1998), p. 701)

approach that the directors of the VOC introduced. Theodore Porter once wrote “(...) objectivity has come to be distinguished first of all by what it leaves out, by the absence of subjectivity.”⁷⁹³ In the case of the VOC, individual approaches (“subjectivity”) were not only left out or even discouraged; they were explicitly replaced by a standardized (“objective”) approach. This shift from the individuality exercised to a certain degree by (e.g.) skippers at sea towards the centralized standardization imposed by the directors in the Republic implied a shift in power from the company’s staff (either at sea or on land) to directors, and it led to an increased disciplining, especially of those sailing on the ships of the company through texts, orders and prescriptions. However, as we have seen, some skippers were still able to find room for resistance and their own interpretation of the rules. In fact, something similar happened when shipwrights introduced important technological changes in ship design, despite the standardized design of the ships they were building. Also, right up to the demise of the company, some staff members kept questioning the reliability of the company’s charts and the wisdom of having to follow its sailing instructions to the letter. But as we noticed, to get one’s experiences accepted by the *Heeren XVII* was at best a very time consuming affair if not virtually impossible. When we consider the role of the *Heeren XVII*, the directors of the VOC in this respect, some comments of their contemporary Adam Smith seem at least partly appropriate. He wrote that directors of joint stock companies

(...) cannot well be expected to watch over it with the same anxious vigilance with which the partners in a private copartnery frequently watch over their own. (...) Negligence and profusion, therefore, must always prevail, more or less, in the management of affairs of such a company (...) It is upon this account, that joint-stock companies for foreign trade have seldom been able to maintain the competition against private adventurers.⁷⁹⁴

Accusing the *Heeren XVII* of negligence is probably too harsh, but (as the eighteenth century wore on) they certainly lacked openness to the experiences of their employees, to observations by foreign or local astronomers and to foreign and de-centralized hydrographical expertise. Their attempts to get a more centralized grip on the company they governed might in part have been to blame for their reluctance to engage with new (technological) insights. It is tempting to speculate on what might have happened if in the second half of the eighteenth century the VOC had opted for a more de-central approach granting local chambers and individual skippers more room to manoeuvre (along the lines of how the company was conceived

⁷⁹³ Porter (1992), p. 645

⁷⁹⁴ Smith (1843), Book V, Ch. I, Part III, Art. I (p. 311)

originally) instead of choosing the centralistic option.⁷⁹⁵ At least as far as technology was concerned it might have yielded interesting results and might have had a profound effect on the chances of survival of the VOC as a company.

⁷⁹⁵ Although, as has been shown in this dissertation and by Roberts (2014), centralization can never be taken to be absolute – it is always entwined with decentral aspects.

NEDERLANDSE SAMENVATTING

De *Vereenigde Oostindische Compagnie VOC* heeft bijna twee eeuwen lang een indrukwekkend systeem van handels- en scheepvaartactiviteiten in stand gehouden. Dat is voor een niet onbelangrijk gedeelte te danken is geweest aan technologieën die werden ontwikkeld, ingevoerd, gebruikt, verbeterd en soms weer aan de kant geschoven ten behoeve van de scheepvaart van de *VOC* tussen de Republiek der Zeven Verenigde Nederlanden en Azië. Zulke technologieën lagen niet kant-en-klaar voor het oprapen maar de *VOC*, haar directeuren (waaronder de *Heeren XVII*), schippers en bemanningsleden moesten een weg vinden door opkomende en verdwijnende technologieën. Daarbij speelden veel zaken een rol: oceanen, ondieptes, orkanen, niet gekarteerde eilanden en andere aspecten van de fysieke omgeving, maar ook ziekte en gezondheid, weerstand van schippers en bemanning ten opzichte van een technologie die hen (naar hun gevoel) werd opgedrongen, en spanningen tussen de verschillende bestuurslagen van de *VOC* in de Republiek en tussen de bestuurders in de Republiek en die in Azië. In dit krachtenveld was het “succes” of de “mislukking” van een technologie niet een technologisch bepaalde uitkomst, maar het was de uitkomst van vaak gecompliceerde onderhandelingen waarbij niet alleen menselijke actoren binnen de *VOC* een rol speelden maar ook niet-menselijke actoren zoals hiervoor al genoemd werden en bovenal de schepen zelf. Daarnaast speelden ook bestuursorganen uit de Republiek een rol en enkele van de genootschappen die in de tweede helft van de achttiende eeuw in de Republiek ontstaan waren.

Om zicht te krijgen op wat er speelde rond de technologieën van de *VOC* heb ik archieven uit de achttiende eeuw van de *VOC* en verwante instanties of personen geraadpleegd, zowel bij het *Nationaal Archief* in Den Haag als bij het *Zeeuws Archief* in Middelburg. Daarnaast kon ik beschikken over gedigitaliseerd materiaal uit de *VOC* archieven bij de *National Archives of the Republic of Indonesia (ARSIP)* in Jakarta en bij de *Cape Town Archives Repository* in Kaapstad. Een aantal achttiende-eeuwse manuscripten, boeken en atlassen heb ik kunnen inzien bij de *Special Collections* van de *Universiteitsbibliotheek Leiden* en bij de *Bijzondere Collecties* van de *Bibliotheek van de Universiteit van Amsterdam*. Jaarboeken en andere publicaties van achttiende-eeuwse genootschappen zijn vaak digitaal beschikbaar. Gegevens over de scheepvaart van de *VOC* tussen de Republiek en Azië zijn te vinden op de website “*Dutch-Asiatic Shipping in the 17th and 18th centuries*”, die over bemanningen op de website “*VOC Opvarenden*”. Het bestuderen van de bronnen heb ik geprobeerd zo onbevangen mogelijk te doen, en niet met wijsheid achteraf vanuit de een-en-twintigste eeuw. Duidelijk werd dat technologie voortdurend verbonden was met politieke, commerciële en

organisatorische aspecten en met gezondheidskwesties; dat wordt ook zichtbaar in de beschrijvingen en verhalen die ik op basis van mijn bronnen geschreven heb. Dat heb ik op een “onmethodische” manier gedaan, dat wil zeggen dat ik de verhalen niet in een vooraf bedachte mal heb gegoten maar dat ik zoveel mogelijk heb geprobeerd “om het verleden te benaderen op zijn eigen voorwaarden”.⁷⁹⁶ De daarop volgende interpretatie van die verhalen is gebaseerd op perspectieven, principes en methodes vanuit het vakgebied van *Science & Technology Studies*. Tot nu toe is er relatief weinig gepubliceerd over de verwevenheid tussen de *VOC* en technologie en zelfs nog minder door techniekhistorici die gebruik maken van de verworvenheden van STS. Deze studie heeft door de gevolgde aanpak een aantal nieuwe inzichten opgeleverd, bestaande opvattingen bevestigd of kanttekeningen geplaatst bij sommige opvattingen.

Drie STS methodes zijn vruchtbaar bij het interpreteren van de relatie tussen technologie en de *VOC*: *Social Construction of Technology (SCOT)*, *Large-scale Technological Systems (LTS)* en *Actor-Network Theory (ANT)*. Aan al die methodes ligt een belangrijk beginsel uit de *Sociology of Scientific Knowledge* ten grondslag, namelijk de gedachte dat verklaringen symmetrisch moeten zijn. Vertaald naar technologie houdt dat in dat als men het “succes” of het “mislukken” van een technologie wil verklaren men zich in beide gevallen van dezelfde aanpak moet bedienen. Anders gezegd, “succesvolle” technologie moet niet bevoorrecht worden boven “mislukte” technologie; verklaringen die uitgaan van de uiteindelijke uitkomst kunnen gemakkelijk argumenten miskennen die in oorspronkelijke discussies een rol speelden. Kort samengevat behelzen de gebruikte methodes het volgende.

SCOT beschouwt de rol die verschillende groepen van (niet)-gebruikers spelen bij de constructie of ontwikkeling van een technologie of een technologisch artefact. Technologie kan (en zal vaak) op verschillende manieren geïnterpreteerd worden door verschillende groepen. Wil een technologie stabiel worden, dan moet op een of andere manier het debat over die technologie gesloten worden. Dat kan óf door een retorische afsluiting, wat inhoudt dat de verschillende groepen het “probleem” van de technologie in kwestie als opgelost zien, óf door een herdefinitie van het probleem; dit laatste betekent dat erkend wordt dat de technologie (ook) een andere betekenis kan hebben dan bij het aanvankelijke ontwerp voorzien was.⁷⁹⁷

LTS concentreert zich op de verwevenheid van mensen en materiele zaken in een technologisch systeem van aanzienlijke omvang. Deze “technologische systemen bevatten rommelige, complexe en probleem-

⁷⁹⁶ Feyerabend (1993/2002), p. ix (“... to approach the past in its own terms...”)

⁷⁹⁷ Voor een uitgebreidere beschrijving, zie Bijker e.a. (1987/2012), pp. 11-44

oplossende componenten. Ze zijn enerzijds maatschappelijk geconstrueerd en anderzijds vormen ze de maatschappij.”⁷⁹⁸

ANT legt de nadruk op het hybride karakter van netwerken. Zulke netwerken moeten niet gezien worden als louter technologische of sociale netwerken; ze zijn daarentegen opgebouwd uit zowel menselijke als niet-menselijke actoren (of actanten). Beide types actoren geven vorm aan de verbindingen en routes die binnen deze netwerken tot stand komen; dat betekent dat invloed en macht niet alleen wordt toegekend aan mensen maar ook aan technologie en aan technologische artefacten.⁷⁹⁹

Het **eerste hoofdstuk** is gewijd aan de *retourschepen* van de *VOC*; dat waren de schepen die speciaal ontworpen waren voor de retourvaart tussen de republiek en Azië. Ik onderzoek de invoering van een nieuwe technologie voor het ontwerp en de bouw van deze schepen die zijn beslag heeft gekregen rond 1742, besteed aandacht aan de manier waarop de schepen gebruikt werden en tenslotte laat ik zien dat elk *retourschip* een spiegelbeeld vormde van de *VOC*. Door het gebruik van gestandaardiseerde gedetailleerde technische bouwtekeningen werd een grotere standaardisatie en centralisatie van de scheepsbouwpraktijk van de *VOC* doorgevoerd op de scheepswerven van de *VOC*, niet alleen op de Amsterdamse werf (die veruit de grootste was) maar ook de kleinere werven in Middelburg, Rotterdam, Delfshaven, Enkhuizen en Hoorn. Dit leidde er toe dat de *VOC* gezien kan worden als een *large-scale technological system*: de standaardisatie die al begonnen was in de loop van de zeventiende eeuw bereikte – door de invoering van de technische bouwtekeningen - zijn culminatie in de veertiger jaren van de achttiende eeuw. Deze tekeningen verbonden werven, materialen, werkwijzen en scheepstimmerlieden. Als de materiële neerslag van een proces van kennisverwerving in een omvangrijk netwerk waren ze hybride van karakter. Een vergelijkbaar hybride karakter was ook zichtbaar tijdens de bouw van de schepen toen ontwerp, materialen (vanuit alle hoeken van Europa) en werkers samen een schip tot stand brachten in een gecompliceerd netwerk van menselijke en niet-menselijke actoren; daarin kan men aspecten van *ANT* herkennen. Het basisontwerp van 1742 bleef dienst bleef doen totdat de *VOC* aan het eind van de achttiende eeuw teloor ging, maar het ontwerp was niet absoluut onveranderlijk. In het derde hoofdstuk wordt duidelijk dat een zekere mate van flexibiliteit onderhandelbaar kon zijn.

Wanneer de schepen hun rol speelden op de wereldzeeën tussen de Republiek en Azië bleken die rollen op uitreis en thuisreis verschillend te zijn.

⁷⁹⁸ Voor een uitgebreidere beschrijving, zie Bijker e.a. (1987/2012), pp. 45-76. Het vertaalde citaat is de openingszin van het artikel.

⁷⁹⁹ De term “actor-network” werd geïntroduceerd in Bijker e.a. (1987/2012), pp. 86-91. Voor een uitgebreidere beschrijving, zie Latour (1986/1990), Latour (1987) en Latour (1993). De term “hybride” werd geïntroduceerd in Latour (1993), pp. 10-11

Op de uitreis was een *retourschip* volgestouwd met mensen (op de grootste schepen vaak meer dan 200 gewone zeelui en ruim 100 soldaten), ballast, voorraden, edele metalen en handelsgoederen. Op de thuisreis werd het schip bemand met de minimaal vereiste bemanning (ongeveer 100 zeelui), voorraden en zoveel Aziatische handelswaar (specerijen, zijden stoffen, thee en wat dies meer zij) als het schip maar dragen kon en bij voorkeur nog wat meer. Zo kan men het *retourschip* karakteriseren als mobiel en veranderlijk: het schip is uiteraard mobiel maar het verandert van karakter als men de uitreis met de thuisreis vergelijkt. Dankzij die veranderlijke mobiliteit speelt elk schip een sleutelrol in het gecompliceerde en uitgebreide handelsnetwerk van de VOC. Het laat zien hoe de VOC opereerde, niet alleen op handelsgebied maar ook in de wijze waarop het gewone personeel als een verbruiksartikel werd gezien. Het verschil van 200 personen tussen uit- en thuisreis, veroorzaakt door sterfte onderweg maar vooral in Azië, moest aangevuld worden vanuit de arbeidsmarkt in de Republiek. Dat is iets wat nadrukkelijk in het tweede hoofdstuk naar voren komt; toen door het uitbreken van besmettelijke ziektes in bepaalde periodes plotseling het sterftecijfer tijdens de uitreis toenam ontstonden er problemen met het voldoende bemannen van de schepen in het intra-Aziatische verkeer en met name op de thuisreis.

In dat **tweede hoofdstuk** wordt beschreven dat de schepen van de VOC een grote invloed hadden op het welzijn van de bemanning; dat laat een extra aspect van hybriditeit zien. Daarbij gaat het om het socio-materiële karakter van de *retourschepen*, binnen het grotere netwerk van de VOC dat op zich al te maken had met allerlei spanningen tussen (bijvoorbeeld) de verschillende bestuurslagen. Spanningen die aan boord optraden binnen de micro-maatschappij daar (meer dan 300 personen op een schip van ongeveer 40 meter lengte) werden gedurende de achttiende eeuw regelmatig verhevigd wanneer er besmettelijke ziektes uitbraken die een ergere aanslag op de gezondheid van de bemanning deden dan een “normale” kwaal als scheurbuik. Uit contemporaine beschrijvingen blijkt dat deze ziektes waarschijnlijk een vorm van tyfus waren. Langs twee wegen werd geprobeerd om greep te krijgen op de algemene gezondheidssituatie aan boord en op deze ziektes in het bijzonder. De ene manier was een mechanische aanpak, die tot uiting kwam in de introductie (rond 1695) van distillatie-apparaten om drinkwater te bereiden vanuit zeewater en de introductie van mechanische ventilatoren (rond 1745) om de luchtkwaliteit tussendecks te verbeteren. Hoewel de voorstanders van zeewater distillatie betoogden dat het systeem bijdroeg aan het verlagen van sterftecijfers lijken uiteindelijk een aantal schippers (in een rol van niet-gebruikers) meer invloed gehad te hebben. Het resultaat was dat in 1707 zeewater distillatie weer werd afgeschaft, hoewel er zestig jaar later een zeer kortstondige herintroductie plaatsvond, ditmaal vanuit Batavia. Mechanische ventilatoren werden ingevoerd tijdens een periode van

wisselende epidemieën aan boord van de schepen, ze werden in 1760 vervangen door een verbeterd ontwerp, in 1772 afgeschaft op de thuisreis en in 1791 geheel afgeschaft. Die afschaffing had te maken met het feit dat schippers weigerden om de machines te gebruiken op de thuisreis omdat – naar ze betoogden – het in de praktijk onmogelijk was om de apparatuur te gebruiken op een volgeladen schip. Dit wijst weer op de invloed van (niet)-gebruikers in relatie tot een technologie. Het merkwaardige feit doet zich voor dat de gedeeltelijke afschaffing plaatsvond op het moment dat de ergste epidemie in het bestaan van de *VOC* zich voordeed. In plaats van zich te concentreren op een mechanische oplossing kozen de directeuren van de *VOC* voor een centralistische, gestandaardiseerde procedurele aanpak, hoewel de voorschriften om de ventilatoren te gebruiken op de uitreis nog een tijdlang bleven bestaan. Het aantal voorschriften waaraan schippers moesten voldoen nam in de laatste decennia van de achttiende eeuw sterk toe; als gevolg daarvan nam de (formele) vrijheid van handelen van schippers af terwijl hun verplichting tot rapportage toenam. Er is wat ironie in het feit dat schippers – door hun afwijzing van mechanische hulpmiddelen – bijdroegen aan een vermindering van hun zelfstandigheid. Een meer praktische oplossing van het gezondheidsprobleem bestond uit het experimenteren met kleinere bemanningen. Uit de archieven blijkt dat er destijds geen verband gevonden werd tussen omvang van bemanning en sterftecijfers. De onderliggende rapportages van de verschillende kamers zijn niet meer te vinden maar op grond van ziekte- en sterftecijfers die beschikbaar zijn op basis van algemene rapportages is het mogelijk om het effect van het experiment alsnog vast te stellen en ook nu is de uitkomst dat er geen verband te zien is tussen omvang bemanning en sterftecijfers. Het levert wel de verrassende uitkomst op dat de gemiddelde bemanningsomvang ook na het beëindigen van het experiment bleef dalen – dit in tegenstelling tot wat in de bestaande literatuur wordt aangenomen. Dat de toenemende centralistische tendens binnen de *VOC* tot spanningen leidde tussen de afzonderlijke kamers en de hoofddirectie en tussen schippers en directie wordt in de volgende hoofdstukken duidelijk.

Het **derde hoofdstuk** laat zien hoe het standaard scheepsontwerp onderhandelbaar bleek te zijn, zij het dat het een zeer langdurig proces werd. De Zeeuwse scheepsbouwers van de *VOC* stelden in 1763 voor om de *retourschepen* te veranderen in driedekkers – in plaats van dat het bovenste dek bestond uit een hoog voor- en achtergedeelte en een laag middenstuk (de kuil) wilden ze het bovenste dek glad laten doorlopen. Daardoor zou (vooral bij stormweer) de zeewaardigheid van de schepen toenemen, ontstond er op de heenreis meer ruimte voor de bemanning en was op de terugreis meer ruimte beschikbaar voor lading. De *VOC* werf Zeeland mocht aanvankelijk een aantal schepen volgens de nieuwe specificaties bouwen maar na tien jaar werd die toestemming ingetrokken vooral vanwege oppositie van andere

scheepsbouwers van de *VOC*. Dit laat een belangrijk inzicht uit SCOT zien: de (mogelijke) superioriteit van een innovatie is zelden duidelijk maar moet vaak in een langdurig proces uitonderhandeld worden waarbij getallen, ervaringen en het aantal medestanders van belang is. Bij het beëindigen van de slepende discussie over het herontwerp speelde het *Zeeuwsch Genootschap der Wetenschappen* een belangrijke rol. Dankzij het feit dat de *Verhandelingen* van het genootschap gebruik maakten van wat Shapin heeft benoemd als “literary technology”, bleek het mogelijk om de gepolitiseerde discussie naar een neutraler niveau te verplaatsen.⁸⁰⁰ Het genootschap schreef een wedstrijd uitschreef voor essays waarin moest worden betoogd welk scheepsontwerp het best geschikt was voor de *VOC*, gebaseerd op proefondervindelijke en niet op theoretische argumenten. De uiteindelijke winnaars bleken een Zeeuwse scheepsarts van de *VOC* te zijn en een van de Zeeuwse scheepsbouwers van de *VOC*. Hoewel men zou kunnen denken dat er hier sprake was van doorgestoken kaart, maakt de procedure die het genootschap volgde dat onaannemelijk. De “literaire technologie” die gevolgd werd bestond er onder andere uit dat de inzendingen volstrekt anoniem beoordeeld werden door een deskundige jury. Praktische ervaringen met zeewaardigheid, met kwesties van ziekte en gezondheid en met handelsprofijt leidden beide winnaars tot de conclusie dat de driedekker superieur was. Toen het punt weer aan de orde kwam in een vergadering van de centrale directie van de *VOC* (de *Heeren XVII*) vormde de publicatie van beide essays expliciet het doorslaggevende argument. Daarbij worden beide aspecten zichtbaar die SCOT aangeeft als mogelijke afsluiting: de retorische afsluiting en de herdefinitie van het “probleem”.

In het **vierde hoofdstuk** staat navigatie centraal, waarbij de nadruk ligt op zeekaarten en zeilaanwijzingen: hoe ging de *VOC* om met nieuwe ervaringen, nieuwe kennis op geografisch, nautisch en astronomisch gebied en met nieuwe zeekaarten. Veel nieuwe informatie kwam beschikbaar vanuit het buitenland, via buitenlandse onderzoekers die verbleven op plekken die de *VOC* bestuurdde, via schippers of via personeel van de *VOC* op diverse locaties, zoals een privé sterrenwacht op Java of de factorij in Canton.

De geheimhouding die de *VOC* aanvankelijk betrachtte ten aanzien van zeekaarten en zeilaanwijzingen verdween in zekere mate rond de introductie van gedrukte zeekaarten in 1753 die (althans voor kaarten geproduceerd in de Republiek) in de plaats kwamen van met de hand gekopieerde kaarten. Ondanks de nieuwe productiemethode bleven schippers regelmatig klagen over de in hun ogen onbetrouwbaarheid van het verstrekte kaartmateriaal en de onnodige belemmeringen van de zeilaanwijzingen. Ze beklagden zich over het feit dat wijzigingen die ze aangaven op hun kaarten en in hun logboeken

⁸⁰⁰ Shapin (1984) introduceerde het begrip “literary technology” als opvolger van de “gentlemanly technology of trust” die zich baseerde op maatschappelijke status.

(die ter controle na elke reis ingeleverd moesten worden) niet of niet in voldoende mate verwerkt werden. Op dat punt lijken de gebruikers minder invloed te hebben gehad dan zij wilden, ook al vonden ze regelmatig de examinatoren van de *VOC* aan hun kant. Anderzijds werden nieuwe gegevens over de magnetische declinatie die schippers moesten leveren wel regelmatig gebruikt om de zeilaanwijzingen bij de tijd te houden; op dat punt waren gebruikers wel belangrijk.

In 1772 verging een *retourschip* onderweg naar Canton, een ramp waarbij schip en lading volledig verloren gingen en bijna de hele bemanning omkwam. Die ramp was – aldus een staflid van de *VOC* in Canton - te wijten aan een onbetrouwbare en onvolledige weergave van het laatste deel van de route. Of zijn verbeterde kaart ooit is ingevoerd blijft onduidelijk. In 1788 verging het grootste schip ooit gebouwd voor de *VOC* op de thuisreis vanuit Canton doordat het strandde op een eiland dat niet op de kaarten van de *VOC* was aangegeven. Het eiland stond wel aangegeven op een Franse kaart die een aantal jaren daarvoor door de *VOC* van de hand was gewezen. Schip en lading gingen verloren maar het grootste deel van de bemanning werd gered.

Pas na de zeekrijgsraad die het vergaan van het schip onderzocht kwam het tot een uitgebreid debat bij de *Heeren XVII* over de invoering van buitenlandse kaarten en zeilaanwijzingen. In tegenstelling tot een oorspronkelijk voorstel om dit materiaal in te voeren en de schippers een vrijere hand te geven in het bepalen van hun route werden de buitenlandse kaarten en zeilaanwijzingen slechts ingevoerd voor schepen op de route van en naar China. Het voorstel voor een vrijere routebepaling werd terzijde geschoven. Het lijkt erop dat de mogelijkheid om schippers te kunnen controleren belangrijker was dan de introductie van ander kaartmateriaal. Dat suggereert dat ook op dit punt de *VOC* volhardde in de centralistische aanpak die ook al zichtbaar is geworden in voorgaande hoofdstukken.

In de **conclusies** waag ik mij aan de stelling dat het toenemende streven naar centralisatie een voorname oorzaak was voor het gebrek aan openheid bij de directie van de *VOC* voor suggesties en ervaringen van hun personeel, voor lokale innovaties en voor buitenlands of decentraal geproduceerde hydrografische expertise. Het is verleidelijk om te speculeren wat er gebeurd zou zijn met de *VOC* als de plaatselijke kamers in de Republiek (inclusief hun scheepstimmerlieden) en individuele schippers meer speelruimte hadden gekregen. Technologisch had dat mogelijk tot boeiende resultaten kunnen leiden.

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APPENDICES

The information given in all appendices has been based on numbers provided at the DAS-website <http://resources.huygens.knaw.nl/das>.

APPENDIX A

This appendix contains details on the *retourschepen* that left with either a reduced crew or a standard crew for the Amsterdam chamber and the Zeeland chamber between 1772 and 1776. The details were derived from the DAS website.

Headings of the columns (when not self-evident) are as follows:

"Number"	refers to the number on the DAS website
"Tonnage"	carrying capacity as calculated on the DAS website
"Dates" etc	when no date is given after arrival the ship did not sail on to a further destination, when no date is given after departure the ship was lost <i>en route</i>
"onbcategory"	the number of people on board (either as a total or as specified)
"I"	the number on board at departure
"II"	the number dying between the Netherlands and the Cape
"III"	the number who left the ship at the Cape
"IV"	the number who came on board at the Cape
"V"	the number dying on the whole voyage
"VI"	the number on board on arrival in Asia

SHIPS LEAVING AMSTERDAM IN 1772/1773									
Number	Name of ship	Tonnage	Date of departure	Arrival at Cape	Departure from Cape	Date of arrival at destination	Place of arrival	onbcategory	I II III IV V VI
4147.5	ASCHAT	1150	20-10-1772	15-04-1773	14-06-1773	08-09-1773	Batavia	Total	288 47 11
4148.3	AZIE	1100	20-10-1772	11-04-1773	26-05-1773	25-08-1773	Batavia	Total	305 62 30
4151.1	OVERHOUT	1150	20-10-1772	14-04-1773	14-06-1773	08-09-1773	Batavia	Total	297 100 4
4152.4	JONGE THOMAS	1150	20-10-1772	29-03-1773				Total	300 70 41
4153.1	VOORBERG	1150	20-10-1772	17-04-1773	24-04-1773	07-07-1773	Batavia	Total	298 86 3
4154.3	DIJVENBRUG	850	21-10-1772	11-04-1773	01-07-1773	02-10-1773	Batavia	Total	185 36 33
4157.1	HOLLAND	1150	15-11-1772	09-04-1773	24-04-1773	03-07-1773	Batavia	Total	299 65 50
4159.5	HUIS TE BIJWEG	1100	25-12-1772	15-04-1773	05-05-1773	07-07-1773	Batavia	Total	243 72 14
4160.3	LANDSKROON	1150	25-12-1772	09-04-1773	15-05-1773	08-07-1773	Ceylon	Total	323 101 36
4161.3	'T LOO	1150	25-12-1772	06-04-1773	26-05-1773	05-08-1773	Batavia	Total	307 58 40
4162.3	OOSTKAPELLE	1150	25-12-1772	15-04-1773	05-05-1773	17-07-1773	Batavia	Total	355 107 36
4164.5	'S LANDS WELVAREN	880	25-12-1772	07-04-1773	26-05-1773	28-08-1773	Bengal	Total	242 54 26
4168.3	BLEIJENBURG	880	05-05-1773	07-11-1773	08-12-1773	10-03-1774	Batavia	Seafarers	131 40 38 59 48 107
4168.3	BLEIJENBURG	880	05-05-1773	07-11-1773	08-12-1773	10-03-1774	Batavia	Soldiers	63
4168.3	BLEIJENBURG	880	05-05-1773	07-11-1773	08-12-1773	10-03-1774	Batavia	Craftsmen	11
4169.6	VROUWE GEERTRUIDA	1100	05-05-1773	01-08-1773	24-08-1773	28-11-1773	Batavia	Total	300 52
4170.5	PALLAS	1150	05-05-1773	05-09-1773	02-11-1773	04-02-1774	Batavia	Seafarers	163 48 37 19 51 110
4170.5	PALLAS	1150	05-05-1773	05-09-1773	02-11-1773	04-02-1774	Batavia	Soldiers	85 71
4170.5	PALLAS	1150	05-05-1773	05-09-1773	02-11-1773	04-02-1774	Batavia	Craftsmen	12 9
4170.5	PALLAS	1150	05-05-1773	05-09-1773	02-11-1773	04-02-1774	Batavia	Passengers	4 4

SHIPS LEAVING AMSTERDAM IN 1773/1774									
Number	Name of ship	Tonnage	Date of departure	Arrival at Cape	Departure from Cape	Date of arrival at destination	Place of arrival	onbcategory	I II III IV V VI
4180.2	ALKEMADE	1150	08-12-1773	01-05-1774	12-07-1774	09-09-1774	Batavia	Seafarers	172 28 18 41 29 172
4180.2	ALKEMADE	1150	08-12-1773	01-05-1774	12-07-1774	09-09-1774	Batavia	Soldiers	22 18
4180.2	ALKEMADE	1150	08-12-1773	01-05-1774	12-07-1774	09-09-1774	Batavia	Craftsmen	11 7
4180.2	ALKEMADE	1150	08-12-1773	01-05-1774	12-07-1774	09-09-1774	Batavia	Passengers	6 5
4181.1	CERES	1150	08-12-1773	27-04-1774	11-05-1774	19-07-1774	Batavia	Seafarers	203 14 46 0 17 189
4181.1	CERES	1150	08-12-1773	27-04-1774	11-05-1774	19-07-1774	Batavia	Soldiers	82 0 36
4181.1	CERES	1150	08-12-1773	27-04-1774	11-05-1774	19-07-1774	Batavia	Craftsmen	12 0 9
4182.2	HONKOOP	1150	08-12-1773	25-04-1774	08-06-1774	06-09-1774	Batavia	Seafarers	247 47 18 29 60 202
4182.2	HONKOOP	1150	08-12-1773	25-04-1774	08-06-1774	06-09-1774	Batavia	Soldiers	43 34
4182.2	HONKOOP	1150	08-12-1773	25-04-1774	08-06-1774	06-09-1774	Batavia	Craftsmen	13 11
4182.2	HONKOOP	1150	08-12-1773	25-04-1774	08-06-1774	06-09-1774	Batavia	Passengers	5 4

4184.1	VENUS	1150 08-12-1773	03-05-1774	16-05-1774	30-08-1774	Batavia	Seafarers	183	100	69	34	119	138
4184.1	VENUS	1150 08-12-1773	03-05-1774	16-05-1774	30-08-1774	Batavia	Soldiers	120					22
4184.1	VENUS	1150 08-12-1773	03-05-1774	16-05-1774	30-08-1774	Batavia	Craftsmen	12					1
4184.1	VENUS	1150 08-12-1773	03-05-1774	16-05-1774	30-08-1774	Batavia	Passengers	8					8
4185.1	AMSTERDAM	1150 09-12-1773	25-04-1774	31-05-1774	09-08-1774	Batavia	Seafarers	170	20	35	42	25	156
4185.1	AMSTERDAM	1150 09-12-1773	25-04-1774	31-05-1774	09-08-1774	Batavia	Soldiers	60					54
4185.1	AMSTERDAM	1150 09-12-1773	25-04-1774	31-05-1774	09-08-1774	Batavia	Craftsmen	7					6
4185.1	AMSTERDAM	1150 09-12-1773	25-04-1774	31-05-1774	09-08-1774	Batavia	Passengers	1					1
4186.2	GROENENDAAL	1150 09-12-1773	24-04-1774	23-05-1774	26-07-1774	Batavia	Seafarers	265	17	85	1	19	183
4186.2	GROENENDAAL	1150 09-12-1773	24-04-1774	23-05-1774	26-07-1774	Batavia	Soldiers	50					29
4186.2	GROENENDAAL	1150 09-12-1773	24-04-1774	23-05-1774	26-07-1774	Batavia	Craftsmen	16					13
4187.1	VRIJHEID	1150 09-12-1773	10-04-1774	21-04-1774	07-07-1774	Batavia	Seafarers	241	42	33	3	46	187
4187.1	VRIJHEID	1150 09-12-1773	10-04-1774	21-04-1774	07-07-1774	Batavia	Soldiers	32					13
4187.1	VRIJHEID	1150 09-12-1773	10-04-1774	21-04-1774	07-07-1774	Batavia	Craftsmen	12					9
4191.2	BOTLAND	1150 14-12-1773	24-04-1774	23-05-1774	21-07-1774	Batavia	Seafarers	225	1	56	1	3	184
4191.2	BOTLAND	1150 14-12-1773	24-04-1774	23-05-1774	21-07-1774	Batavia	Soldiers	61					46
4191.2	BOTLAND	1150 14-12-1773	24-04-1774	23-05-1774	21-07-1774	Batavia	Craftsmen	17					14
4192.4	BOVENKERKER POLDER	850 15-12-1773	30-04-1774	16-05-1774	23-09-1774	Bengal	Total	262	3	25			
4193.3	PRINSES VAN ORANJE	1150 15-12-1773	14-05-1774	25-06-1774	22-09-1774	Batavia	Seafarers	237	44	50	52	48	207
4193.3	PRINSES VAN ORANJE	1150 15-12-1773	14-05-1774	25-06-1774	22-09-1774	Batavia	Soldiers	96					76
4193.3	PRINSES VAN ORANJE	1150 15-12-1773	14-05-1774	25-06-1774	22-09-1774	Batavia	Craftsmen	14					11
4194.5	ZUID-BEVELAND	1100 15-12-1773	25-04-1774	12-05-1774	13-07-1774	Ceylon	Total	322	79	13	34	89	254
4195.3	VELDHOEN	1150 29-12-1773	30-04-1774	15-05-1774	11-07-1774	Ceylon	Total	372	104	38		108	221
4199.4	WOESTDUIN	1150 01-05-1774	06-09-1774	27-09-1774	18-11-1774	Batavia	Total	239	21				
4200.1	MORGENSTER	1150 04-05-1774	10-09-1774	27-09-1774	13-12-1774	Batavia	Total	301	16				
4202.1	WAKKERHEID	1150 20-05-1774	11-09-1774	09-10-1774	26-12-1774	Batavia	Total	249	2				
4210.1	INDIAAN	1150 15-09-1774	24-01-1775	08-02-1775	17-06-1775	Batavia	Seafarers	230	1	8	14	17	220
4210.1	INDIAAN	1150 15-09-1774	24-01-1775	08-02-1775	17-06-1775	Batavia	Soldiers	55					52
4210.1	INDIAAN	1150 15-09-1774	24-01-1775	08-02-1775	17-06-1775	Batavia	Craftsmen	14					13
4211.6	JONGE LIEVE	1150 15-09-1774	17-02-1775	28-03-1775	08-07-1775	Batavia	Seafarers	168	9	17	4	10	155
4211.6	JONGE LIEVE	1150 15-09-1774	17-02-1775	28-03-1775	08-07-1775	Batavia	Soldiers	49					42
4211.6	JONGE LIEVE	1150 15-09-1774	17-02-1775	28-03-1775	08-07-1775	Batavia	Craftsmen	14					9
4212.4	RIDDERKERK	850 15-09-1774	06-02-1775	16-03-1775	19-06-1775	Batavia	Seafarers	139	22	12	2	28	238
4212.4	RIDDERKERK	850 15-09-1774	06-02-1775	16-03-1775	19-06-1775	Batavia	Soldiers	37					47
4212.4	RIDDERKERK	850 15-09-1774	06-02-1775	16-03-1775	19-06-1775	Batavia	Craftsmen	10					9
4212.4	RIDDERKERK	850 15-09-1774	06-02-1775	16-03-1775	19-06-1775	Batavia	Passengers	2					0
4214.4	'T LOO	1150 26-09-1774	24-01-1775	02-03-1775	18-06-1775	Batavia	Seafarers	268	20	58	33	37	224
4214.4	'T LOO	1150 26-09-1774	24-01-1775	02-03-1775	18-06-1775	Batavia	Soldiers	71					51
4214.4	'T LOO	1150 26-09-1774	24-01-1775	02-03-1775	18-06-1775	Batavia	Craftsmen	14					14

SHIPS LEAVING AMSTERDAM IN 1775/1776														
Number	Name of ship	Tonnage	Date of departure	Arrival at Cape	Departure from Cape	Date of arrival at destination	Place of arrival	oncategory	I	II	III	IV	V	VI
4251.3	ALKEMADE	1150	04-11-1775	17-02-1776	06-04-1776	29-06-1776	Batavia	Total	342	13				
4252.1	MENTOR	1150	04-11-1775	17-02-1776	10-03-1776	02-06-1776	Batavia	Total	290	0				
4253.2	VRIJHEID	1150	04-11-1775	21-02-1776	10-03-1776	03-06-1776	Batavia	Total	326	4				
4254.1	BLOK	1150	08-11-1775	16-03-1776	29-03-1776	23-06-1776	Batavia	Total	309	2				
4255.3	HONKOOP	1150	16-12-1775	21-05-1776	08-06-1776	30-07-1776	Ceylon	Total	274	30	28	80	40	286
4256.5	WESTERVELD	1100	16-12-1775	16-04-1776	03-05-1776	04-07-1776	Ceylon	Total	309	47	27	113	60	335
4257.5	BOVENKELDER POLDER	850	02-01-1776	13-04-1776	03-05-1776	04-07-1776	Batavia	Total	219	5				
4259.3	TEMPEL	850	02-01-1776	10-07-1776	26-07-1776	25-10-1776	Bengal	Total	224	5				
4262.4	OOSTKAPELLE	1150	11-05-1776	07-08-1776	24-08-1776	22-10-1776	Batavia	Seafarers	185	6	2	28	1	204
4262.6	OOSTKAPELLE	1150	11-05-1776	07-08-1776	24-08-1776	22-10-1776	Batavia	Soldiers	85	0	6	3	0	82
4262.4	OOSTKAPELLE	1150	11-05-1776	07-08-1776	24-08-1776	22-10-1776	Batavia	Craftsmen	15	0	0	0	0	15
4262.4	OOSTKAPELLE	1150	11-05-1776	07-08-1776	24-08-1776	22-10-1776	Batavia	Passengers	8	0	3	1	0	6
4263.4	VELDHOEN	1150	11-05-1776	16-08-1776	09-09-1776	17-11-1776	Batavia	Seafarers	169	19	31	41	23	156
4263.4	VELDHOEN	1150	11-05-1776	16-08-1776	09-09-1776	17-11-1776	Batavia	Soldiers	63	10	7	16	10	60
4263.4	VELDHOEN	1150	11-05-1776	16-08-1776	09-09-1776	17-11-1776	Batavia	Craftsmen	12	5	2	4	5	9
4263.4	VELDHOEN	1150	11-05-1776	16-08-1776	09-09-1776	17-11-1776	Batavia	Passengers	1	0	0	0	0	1
4266.2	BEEMSTER WELVAREN	850	27-06-1776	28-11-1776	31-12-1776	10-04-1777	Batavia	Total	186	4				
4267.4	COMPAGNIES WELVAREN	1150	27-06-1776	13-11-1776	08-12-1776	20-02-1777	Batavia	Total	307	5				
4273.1	ZEEPAARD	1150	08-09-1776	21-12-1776	18-01-1777	07-04-1777	Batavia	Total	300	0				
4275.1	BEHEMOTH	1150	19-09-1776	20-12-1776	18-01-1777	21-03-1777	Batavia	Total	286	0				

SHIPS LEAVING ZEELAND IN 1772/1773									
Number	Name of ship	Tonnage	Date of departure	Arrival at Cape	Departure from Cape	Date of arrival at destination	Place of arrival	onbcategory I	II III IV V VI
4155.1	EUROPA	1200	23-10-1772	09-04-1773	24-04-1773	07-07-1773	Batavia	Total	353 150 67
4156.6	BLEISWIJK	880	15-11-1772	26-09-1773	28-10-1773	01-02-1774	Batavia	Seafarers	167 139 20 144 152 137
4156.6	BLEISWIJK	880	15-11-1772	26-09-1773	28-10-1773	01-02-1774	Batavia	Soldiers	87 52
4156.6	BLEISWIJK	880	15-11-1772	26-09-1773	28-10-1773	01-02-1774	Batavia	Craftsmen	17 7
4156.6	BLEISWIJK	880	15-11-1772	26-09-1773	28-10-1773	01-02-1774	Batavia	Passengers	1 2
4165.3	OUD HAARLEM	1150	26-12-1772	11-04-1773	15-05-1773	16-07-1773	Ceylon	Total	301 42 75 10 50 186
4166.1	ZEEDUIN	1150	08-02-1773	26-05-1773	07-07-1773	10-09-1773	Batavia	Total	307 63 40
4173.5	HUIS OM	1150	30-06-1773	15-03-1774	25-04-1774	19-07-1774	Batavia	Seafarers	163 79 43 73 82 122
4173.5	HUIS OM	1150	30-06-1773	15-03-1774	25-04-1774	19-07-1774	Batavia	Soldiers	78 70
4173.5	HUIS OM	1150	30-06-1773	15-03-1774	25-04-1774	19-07-1774	Batavia	Craftsmen	21 8
4175.4	BORSSELE	1150	14-07-1773	16-10-1773	02-12-1773	01-02-1774	Batavia	Seafarers	173 29 76 37 29 134
4175.4	BORSSELE	1150	14-07-1773	16-10-1773	02-12-1773	01-02-1774	Batavia	Soldiers	85 57
4175.4	BORSSELE	1150	14-07-1773	16-10-1773	02-12-1773	01-02-1774	Batavia	Craftsmen	18 11
4175.4	BORSSELE	1150	14-07-1773	16-10-1773	02-12-1773	01-02-1774	Batavia	Passengers	1 1

SHIPS LEAVING ZEELAND IN 1773/1774									
Number	Name of ship	Tonnage	Date of departure	Arrival at Cape	Departure from Cape	Date of arrival at destination	Place of arrival	onbcategory I	II III IV V VI
4189.1	MARS	1150	13-12-1773	30-04-1774	11-05-1774	21-07-1774	Batavia	Seafarers	270 163 19 36 166 162
4189.1	MARS	1150	13-12-1773	30-04-1774	11-05-1774	21-07-1774	Batavia	Soldiers	62 22
4189.1	MARS	1150	13-12-1773	30-04-1774	11-05-1774	21-07-1774	Batavia	Craftsmen	11 5
4190.4	WILLEM DE VIJFDE	1150	13-12-1773	30-04-1774	16-05-1774	28-07-1774	Batavia	Seafarers	218 129 65 52 132 160
4190.4	WILLEM DE VIJFDE	1150	13-12-1773	30-04-1774	16-05-1774	28-07-1774	Batavia	Soldiers	98 16
4190.4	WILLEM DE VIJFDE	1150	13-12-1773	30-04-1774	16-05-1774	28-07-1774	Batavia	Craftsmen	10 5
4196.3	OUWERKERK	1150	10-03-1774	12-07-1774	03-08-1774	28-10-1774	Batavia	Passengers	3 3
4197.3	BOT	1150	28-04-1774	10-09-1774	09-10-1774	19-12-1774	Batavia	Total	366 10 25 79
4206.5	BARTHA PETRONELLA	880	26-07-1774	20-11-1774	18-12-1774	01-03-1775	Batavia	Seafarers	117 2 11 23 4 121
4206.5	BARTHA PETRONELLA	880	26-07-1774	20-11-1774	18-12-1774	01-03-1775	Batavia	Soldiers	62 67
4206.5	BARTHA PETRONELLA	880	26-07-1774	20-11-1774	18-12-1774	01-03-1775	Batavia	Craftsmen	9 6
4208.1	STAVENISSE	1150	26-07-1774	13-11-1774	13-12-1774	22-02-1775	Batavia	Seafarers	199 8 65 78 10 195
4208.1	STAVENISSE	1150	26-07-1774	13-11-1774	13-12-1774	22-02-1775	Batavia	Soldiers	90 87
4208.1	STAVENISSE	1150	26-07-1774	13-11-1774	13-12-1774	22-02-1775	Batavia	Craftsmen	17 20
4213.5	NIEUW RHOON	1150	18-09-1774	30-12-1774	24-01-1775	25-04-1775	Batavia	Seafarers	200 9 31 28 54 174
4213.5	NIEUW RHOON	1150	18-09-1774	30-12-1774	24-01-1775	25-04-1775	Batavia	Soldiers	97 64
4213.5	NIEUW RHOON	1150	18-09-1774	30-12-1774	24-01-1775	25-04-1775	Batavia	Craftsmen	15 15

SHIPS LEAVING ZEELAND IN 1774/1775														
Number	Name of ship	Tonnage	Date of departure	Arrival at Cape	Departure from Cape	Date of arrival at destination	Place of arrival	onbcategory	I	II	III	IV	V	VI
4221.2	EUROPA	1200	05-11-1774	21-02-1775	28-03-1775	02-07-1775	Batavia	Seafarers	195	5	25	19	15	185
4221.2	EUROPA	1200	05-11-1774	21-02-1775	28-03-1775	02-07-1775	Batavia	Soldiers	53					41
4221.2	EUROPA	1200	05-11-1774	21-02-1775	28-03-1775	02-07-1775	Batavia	Craftsmen	11					11
4223.1	HOF TER LINDEN	1150	06-12-1774	19-04-1775	25-05-1775	08-08-1775	Batavia	Seafarers	261	7	26	41	50	220
4223.1	HOF TER LINDEN	1150	06-12-1774	19-04-1775	25-05-1775	08-08-1775	Batavia	Soldiers	29					38
4223.1	HOF TER LINDEN	1150	06-12-1774	19-04-1775	25-05-1775	08-08-1775	Batavia	Craftsmen	12					8
4223.1	HOF TER LINDEN	1150	06-12-1774	19-04-1775	25-05-1775	08-08-1775	Batavia	Passengers	1					1
4230.4	OUD HAARLEM	1150	07-04-1775	08-07-1775	27-07-1775	06-11-1775	Ceylon	Total	303	1	16	67	60	294
4233.5	WESTFRIESLAND	880	02-06-1775	09-11-1775	02-12-1775	15-02-1776	Batavia	Total	258	3				
4238.3	POPKENSBURG	880	22-07-1775	12-01-1776	07-02-1776	10-05-1776	Batavia	Total	180	2				
4245.5	ZILVEREN LEEUW	880	23-09-1775	18-01-1776	10-03-1776	02-06-1776	Batavia	Total	232	10				
4246.5	VREEBURG	850	23-09-1775	05-03-1776	06-04-1776	30-06-1776	Batavia	Total	230	12				

SHIPS LEAVING ZEELAND IN 1775/1776														
Number	Name of ship	Tonnage	Date of departure	Arrival at Cape	Departure from Cape	Date of arrival at destination	Place of arrival	onbcategory	I	II	III	IV	V	VI
4249.2	CERES	1150	03-11-1775	22-02-1776	10-03-1776	27-05-1776	Batavia	Total	286	6				
4261.1	WILLEM/FREDERIK	1150	16-01-1776	16-04-1776	03-05-1776	13-07-1776	Batavia	Total	293	11				
4264.2	MARS	1150	17-05-1776	16-09-1776	09-10-1776	03-01-1777	Batavia	Seafarers	159	5	27	32	13	151
4264.2	MARS	1150	17-05-1776	16-09-1776	09-10-1776	03-01-1777	Batavia	Soldiers	120	3	34	15	12	89
4264.2	MARS	1150	17-05-1776	16-09-1776	09-10-1776	03-01-1777	Batavia	Craftsmen	24	1	4	1	2	19
4264.2	MARS	1150	17-05-1776	16-09-1776	09-10-1776	03-01-1777	Batavia	Passengers	1	0	0	0	0	1
4269.1	CONCORDIA	1150	01-08-1776	07-12-1776	31-12-1776	20-03-1777	Batavia	Total	310	3				
4274.4	AZË	1100	19-09-1776	20-12-1776	18-01-1777	21-04-1777	Batavia	Total	231	11				

APPENDIX B

This appendix contains the crew-numbers, mortality rates and the “man-to-ton ratio” of all ships that left between 1687 – 1700 and between 1730-1794. These were the periods during which contagious diseases occurred on the outbound fleets.

1687		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1138	278	2	0,72	0,24	-0,36
		647	289	1	0,35	0,45	
		740	204	3	1,47	0,28	
		1194	255	15	5,88	0,21	
		759	256	10	3,91	0,34	
		762	226	4	1,77	0,30	
		638	202	10	4,95	0,32	
		1138	277	10	3,61	0,24	
		484	111	14	12,61	0,23	
		398	101	6	5,94	0,25	
		585	159	2	1,26	0,27	
		762	207	3	1,45	0,27	
		604	150	0	0,00	0,25	
		558	160	0	0,00	0,29	
	Mean	743,36	205,36	5,71	2,78	0,276	
	Stdev	239,24	59,73	4,95	3,31	0,06	

1688	All ships					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	320	95	0	0,00	0,30	-0,50
	500	148	13	8,78	0,30	
	722	230	17	7,39	0,32	
	1124	267	19	7,12	0,24	
	623	152	9	5,92	0,24	
	710	208	4	1,92	0,29	
	892	207	37	17,87	0,23	
	60	24	0	0,00	0,40	
	594	150	1	0,67	0,25	
	1173	292	0	0,00	0,25	
Mean	671,80	177,30	10,00	5,64	0,264	
Stdev	323,14	76,37	11,34	5,43	0,05	

1689	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	710	267	17	6,37	0,38	-0,12	
	595	150	12	8,00	0,25		
	740	241	1	0,41	0,33		
	756	231	68	29,44	0,31		
	760	250	24	9,60	0,33		
	1140	317	34	10,73	0,28		
	1138	314	30	9,55	0,28		
	544	107	6	5,61	0,20		
	648	268	28	10,45	0,41		
	700	216	12	5,56	0,31		
	644	154	57	37,01	0,24		
	759	246	36	14,63	0,32		
	685	210	5	2,38	0,31		
	1138	299	3	1,00	0,26		
	100	28	0	0,00	0,28		
	<i>Mean</i>	<i>737,13</i>	<i>219,87</i>	<i>22,20</i>	<i>10,10</i>	<i>0,298</i>	
	<i>Stdev</i>	<i>254,29</i>	<i>77,52</i>	<i>19,73</i>	<i>10,06</i>	<i>0,05</i>	

1690	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	524	161	5	3,11	0,31	0,32	
	1177	316	10	3,16	0,27		
	544	164	66	40,24	0,30		
	597	140	30	21,43	0,23		
	843	191	39	20,42	0,23		
	506	148	5	3,38	0,29		
	749	236	60	25,42	0,32		
	1145	327	213	65,14	0,29		
	790	206	5	2,43	0,26		
	494	77	2	2,60	0,16		
	1138	288	4	1,39	0,25		
	722	262	42	16,03	0,36		
	606	157	18	11,46	0,26		
	817	250	41	16,40	0,31		
	297	95	30	31,58	0,32		
	594	141	3	2,13	0,24		
	604	150	13	8,67	0,25		
	<i>Mean</i>	<i>714,53</i>	<i>194,65</i>	<i>34,47</i>	<i>17,71</i>	<i>0,272</i>	
	<i>Stdev</i>	<i>242,13</i>	<i>71,83</i>	<i>48,86</i>	<i>16,66</i>	<i>0,05</i>	

1691	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	762	242	48	19,83	0,32	-0,07	
	1123	299	35	11,71	0,27		
	733	232	36	15,52	0,32		
	280	131	6	4,58	0,47		
	222	137	6	4,38	0,62		
	558	147	2	1,36	0,26		
	762	243	11	4,53	0,32		
	1173	287	15	5,23	0,24		
	500	118	8	6,78	0,24		
	582	109	2	1,83	0,19		
	740	238	54	22,69	0,32		
	759	259	70	27,03	0,34		
	759	259	16	6,18	0,34		
	585	170	27	15,88	0,29		
	320	102	4	3,92	0,32		
	710	236	24	10,17	0,33		
	700	300	19	6,33	0,43		
	785	228	31	13,60	0,29		
	818	297	27	9,09	0,36		
	Mean	677,42	212,32	23,21	10,93	0,313	
	Stdev	237,10	67,30	18,53	7,11	0,09	

1692	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	100	50	1	2,00	0,50	-0,12	
	125	75	3	4,00	0,60		
	759	310	35	11,29	0,41		
	246	80	5	6,25	0,33		
	579	217	101	46,54	0,37		
	644	200	40	20,00	0,31		
	544	255	33	12,94	0,47		
	506	178	28	15,73	0,35		
	1138	299	221	73,91	0,26		
	603	189	3	1,59	0,31		
	875	241	4	1,66	0,28		
	494	194	2	1,03	0,39		
	70	10	0	0,00	0,14		
	751	291	16	5,50	0,39		
	843	283	51	18,02	0,34		
	759	253	60	23,72	0,33		
	70	10	1	10,00	0,14		
	544	141	3	2,13	0,26		
	90	30	1	3,33	0,33		
	588	233	1	0,43	0,40		
	Mean	516,40	176,95	30,45	17,21	0,343	
	Stdev	300,78	98,26	50,86	17,73	0,10	

1693		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		477	175	11	6,29	0,37	0,04
		825	249	11	4,42	0,30	
		140	75	2	2,67	0,54	
		597	192	7	3,65	0,32	
		616	140	3	2,14	0,23	
		749	250	5	2,00	0,33	
		759	264	8	3,03	0,35	
		595	200	15	7,50	0,34	
		538	204	39	19,12	0,38	
		70	10	1	10,00	0,14	
		1197	307	37	12,05	0,26	
		832	243	23	9,47	0,29	
		100	21	0	0,00	0,21	
		759	254	134	52,76	0,33	
		1138	325	9	2,77	0,29	
		1145	318	17	5,35	0,28	
		606	213	2	0,94	0,35	
		685	208	38	18,27	0,30	
		832	252	41	16,27	0,30	
	<i>Mean</i>	<i>666,32</i>	<i>205,26</i>	<i>21,21</i>	<i>10,33</i>	<i>0,308</i>	
	<i>Stdev</i>	<i>312,83</i>	<i>87,43</i>	<i>29,86</i>	<i>11,68</i>	<i>0,08</i>	

1694		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		594	241	39	16,18	0,41	-0,10
		1075	288	23	7,99	0,27	
		826	236	30	12,71	0,29	
		90	24	1	4,17	0,27	
		411	100	15	15,00	0,24	
		603	203	11	5,42	0,34	
		280	175	13	7,43	0,63	
		588	186	43	23,12	0,32	
		818	256	88	34,38	0,31	
		740	259	15	5,79	0,35	
		297	77	16	20,78	0,26	
		700	250	32	12,80	0,36	
		1173	293	13	4,44	0,25	
		500	123	51	41,46	0,25	
		710	185	16	8,65	0,26	
		831	236	6	2,54	0,28	
		604	159	60	37,74	0,26	
		1123	238	74	31,09	0,21	
		582	169	68	40,24	0,29	
		759	254	30	11,81	0,33	
		324	74	1	1,35	0,23	
		816	258	17	6,59	0,32	
		558	157	1	0,64	0,28	
		648	279	59	21,15	0,43	
		756	225	7	3,11	0,30	
		1089	292	1	0,34	0,27	
		626	175	1	0,57	0,28	
		595	179	13	7,26	0,30	
		396	103	0	0,00	0,26	
	<i>Mean</i>	659,03	196,34	25,66	13,07	0,298	
	<i>Stdev</i>	254,52	71,05	24,30	12,57	0,08	

1695	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1139	301	11	3,65	0,26	-0,12	
	320	95	2	2,11	0,30		
	622	174	23	13,22	0,28		
	622	178	32	17,98	0,29		
	817	231	16	6,93	0,28		
	616	124	12	9,68	0,20		
	762	214	25	11,68	0,28		
	825	233	19	8,15	0,28		
	436	174	17	9,77	0,40		
	588	175	18	10,29	0,30		
	759	263	38	14,45	0,35		
	544	175	20	11,43	0,32		
	280	75	8	10,67	0,27		
	90	31	0	0,00	0,34		
	477	155	6	3,87	0,32		
	816	225	29	12,89	0,28		
	1138	283	35	12,37	0,25		
	635	130	14	10,77	0,20		
	1075	272	13	4,78	0,25		
	288	80	9	11,25	0,28		
	Mean	642,45	179,40	17,35	9,67	0,279	
	Stdev	278,52	72,81	10,28	4,39	0,04	

1696	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	588	159	47	29,56	0,27	-0,22	
	213	40	3	7,50	0,19		
	759	226	104	46,02	0,30		
	280	150	6	4,00	0,54		
	380	134	7	5,22	0,35		
	100	50	1	2,00	0,50		
	644	154	15	9,74	0,24		
	826	218	28	12,84	0,26		
	832	252	49	19,44	0,30		
	794	249	6	2,41	0,31		
	759	242	2	0,83	0,32		
	597	181	3	1,66	0,30		
	616	140	5	3,57	0,23		
	1145	315	18	5,71	0,28		
	Mean	609,50	179,29	21,00	11,71	0,294	
	Stdev	272,79	74,55	27,72	12,45	0,09	

1697	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	506	150	8	5,33	0,30	0,09	
	816	228	18	7,89	0,28		
	80	47	4	8,51	0,59		
	785	108	3	2,78	0,14		
	759	226	9	3,98	0,30		
	648	238	5	2,10	0,37		
	594	187	2	1,07	0,31		
	626	186	9	4,84	0,30		
	685	193	3	1,55	0,28		
	1139	285	13	4,56	0,25		
	290	150	1	0,67	0,52		
	900	227	22	9,69	0,25		
	603	178	12	6,74	0,30		
	70	12	0	0,00	0,17		
	845	245	2	0,82	0,29		
	1080	280	29	10,36	0,26		
	<i>Mean</i>	651,63	183,75	8,75	4,76	0,282	
	<i>Stdev</i>	295,90	74,23	8,03	3,28	0,11	

1698	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	816	175	15	8,57	0,21	0,20	
	875	195	6	3,08	0,22		
	618	113	7	6,19	0,18		
	749	198	2	1,01	0,26		
	616	150	0	0,00	0,24		
	622	153	1	0,65	0,25		
	784	211	4	1,90	0,27		
	635	178	3	1,69	0,28		
	380	83	1	1,20	0,22		
	1089	286	27	9,44	0,26		
	1075	286	33	11,54	0,27		
	436	168	5	2,98	0,39		
	250	177	13	7,34	0,71		
	831	175	5	2,86	0,21		
	759	205	2	0,98	0,27		
	<i>Mean</i>	702,33	183,53	8,27	4,50	0,261	
	<i>Stdev</i>	225,79	51,74	9,51	3,55	0,12	

1699		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		242	179	9	5,03	0,74	-0,06
		280	157	1	0,64	0,56	
		816	230	1	0,43	0,28	
		759	200	2	1,00	0,26	
		785	125	1	0,80	0,16	
		825	209	2	0,96	0,25	
		616	138	7	5,07	0,22	
		588	180	2	1,11	0,31	
		1145	279	4	1,43	0,24	
		832	212	1	0,47	0,25	
		794	219	5	2,28	0,28	
		90	50	1	2,00	0,56	
		776	226	6	2,65	0,29	
		826	206	1	0,49	0,25	
		506	95	2	2,11	0,19	
		392	45	3	6,67	0,11	
		1173	252	46	18,25	0,21	
		553	79	14	17,72	0,14	
		832	216	7	3,24	0,26	
		740	200	21	10,50	0,27	
		1009	273	3	1,10	0,27	
		192	53	0	0,00	0,28	
		762	174	1	0,57	0,23	
		576	135	1	0,74	0,23	
		288	54	0	0,00	0,19	
		614	40	0	0,00	0,07	
		554	83	0	0,00	0,15	
		688	200	6	3,00	0,29	
		618	109	0	0,00	0,18	
		1139	282	3	1,06	0,25	
		526	87	0	0,00	0,17	
		1080	286	9	3,15	0,26	
		656	184	2	1,09	0,28	
	Mean	674,91	165,36	4,88	2,95	0,245	
	Stdev	268,95	74,68	8,52	4,43	0,13	

1700		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		759	250	10	4,00	0,33	0,45
		670	235	1	0,43	0,35	
		759	231	2	0,87	0,30	
		290	74	1	1,35	0,26	
		759	206	1	0,49	0,27	
		244	40	0	0,00	0,16	
		845	257	11	4,28	0,30	
		603	182	7	3,85	0,30	
		550	101	0	0,00	0,18	
		700	228	37	16,23	0,33	
		818	242	1	0,41	0,30	
		1008	234	0	0,00	0,23	
		875	239	5	2,09	0,27	
		759	233	8	3,43	0,31	
		130	14	0	0,00	0,11	
		817	207	1	0,48	0,25	
		596	132	0	0,00	0,22	
		825	205	0	0,00	0,25	
		280	75	1	1,33	0,27	
		804	210	6	2,86	0,26	
		324	79	0	0,00	0,24	
		836	198	5	2,53	0,24	
		756	177	1	0,56	0,23	
		759	213	10	4,69	0,28	
		762	175	4	2,29	0,23	
		554	134	6	4,48	0,24	
		616	155	0	0,00	0,25	
		606	153	4	2,61	0,25	
		616	159	3	1,89	0,26	
		759	224	9	4,02	0,30	
	Mean	655,97	175,40	4,47	2,55	0,267	
	Stdev	207,80	65,72	6,97	3,06	0,05	

1730		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1180	256	7	2,73	0,22	0,31
		850	207	8	3,86	0,24	
		850	215	6	2,79	0,25	
		1140	264	6	2,27	0,23	
		810	209	5	2,39	0,26	
		850	200	9	4,50	0,24	
		900	200	11	5,50	0,22	
		580	153	12	7,84	0,26	
		650	183	9	4,92	0,28	
		600	189	9	4,76	0,32	
		600	179	3	1,68	0,30	
		900	252	20	7,94	0,28	
		880	249	12	4,82	0,28	
		500	91	3	3,30	0,18	
		600	189	8	4,23	0,32	
		650	180	17	9,44	0,28	
		1150	287	15	5,23	0,25	
		370	78	3	3,85	0,21	
		705	193	10	5,18	0,27	
		600	177	86	48,59	0,30	
		850	241	29	12,03	0,28	
		600	191	8	4,19	0,32	
		1000	199	8	4,02	0,20	
		600	193	26	13,47	0,32	
		1150	312	19	6,09	0,27	
		450	85	2	2,35	0,19	
		650	190	4	2,11	0,29	
		450	84	4	4,76	0,19	
		850	188	0	0,00	0,22	
		520	180	9	5,00	0,35	
		850	243	6	2,47	0,29	
		660	193	6	3,11	0,29	
		580	184	75	40,76	0,32	
		1100	309	29	9,39	0,28	
		1150	295	8	2,71	0,26	
		1140	304	1	0,33	0,27	
		650	193	11	5,70	0,30	
		850	240	13	5,42	0,28	
		1150	306	2	0,65	0,27	
	Mean	785,00	207,21	13,31	6,42	0,264	
	Stdev	231,19	59,40	17,15	9,32	0,04	

1731		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		850	254	31	12,20	0,30	0,41
		600	185	4	2,16	0,31	
		600	179	3	1,68	0,30	
		600	185	3	1,62	0,31	
		810	241	9	3,73	0,30	
		600	180	4	2,22	0,30	
		850	237	89	37,55	0,28	
		650	180	4	2,22	0,28	
		805	240	47	19,58	0,30	
		1140	312	45	14,42	0,27	
		792	252	184	73,02	0,32	
		528	188	157	83,51	0,36	
		1150	299	21	7,02	0,26	
		580	185	9	4,86	0,32	
		650	170	10	5,88	0,26	
		850	251	46	18,33	0,30	
		650	187	3	1,60	0,29	
		650	198	11	5,56	0,30	
		1150	217	25	11,52	0,19	
		850	239	43	17,99	0,28	
		650	186	4	2,15	0,29	
		800	241	25	10,37	0,30	
		600	161	4	2,48	0,27	
		400	77	0	0,00	0,19	
		850	192	11	5,73	0,23	
		850	230	13	5,65	0,27	
		810	241	6	2,49	0,30	
		850	239	40	16,74	0,28	
		850	236	20	8,47	0,28	
	<i>Mean</i>	<i>759,14</i>	<i>213,17</i>	<i>30,03</i>	<i>14,09</i>	<i>0,281</i>	
	<i>Stdev</i>	<i>178,82</i>	<i>45,15</i>	<i>43,12</i>	<i>19,44</i>	<i>0,03</i>	

1732	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	650	100	3	3,00	0,15	0,15	
	850	249	11	4,42	0,29		
	850	234	14	5,98	0,28		
	1150	195	9	4,62	0,17		
	850	243	14	5,76	0,29		
	1150	280	12	4,29	0,24		
	600	148	5	3,38	0,25		
	1180	273	7	2,56	0,23		
	810	253	9	3,56	0,31		
	550	165	30	18,18	0,30		
	630	158	5	3,16	0,25		
	1100	286	38	13,29	0,26		
	600	151	2	1,32	0,25		
	650	159	4	2,52	0,24		
	1140	277	23	8,30	0,24		
	850	225	67	29,78	0,26		
	850	229	15	6,55	0,27		
	800	190	24	12,63	0,24		
	600	160	64	40,00	0,27		
	650	150	59	39,33	0,23		
	650	153	23	15,03	0,24		
	850	236	13	5,51	0,28		
	600	158	6	3,80	0,26		
	450	93	4	4,30	0,21		
	1150	297	7	2,36	0,26		
	350	86	0	0,00	0,25		
	850	193	10	5,18	0,23		
	850	234	2	0,85	0,28		
	600	171	6	3,51	0,29		
	1150	298	2	0,67	0,26		
	650	100	2	2,00	0,15		
	650	158	5	3,16	0,24		
	650	100	1	1,00	0,15		
	1100	299	58	19,40	0,27		
	850	242	9	3,72	0,28		
	<i>Mean</i>	<i>797,43</i>	<i>198,37</i>	<i>16,09</i>	<i>8,11</i>	<i>0,249</i>	
	<i>Stdev</i>	<i>222,09</i>	<i>63,86</i>	<i>18,55</i>	<i>9,93</i>	<i>0,04</i>	

1733		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		350	84	4	4,76	0,24	-0,42
		850	239	6	2,51	0,28	
		800	225	18	8,00	0,28	
		1140	286	16	5,59	0,25	
		810	231	11	4,76	0,29	
		600	172	18	10,47	0,29	
		800	225	6	2,67	0,28	
		850	229	17	7,42	0,27	
		810	238	7	2,94	0,29	
		600	153	8	5,23	0,26	
		1150	290	115	39,66	0,25	
		850	220	8	3,64	0,26	
		600	164	6	3,66	0,27	
		600	149	15	10,07	0,25	
		350	87	50	57,47	0,25	
		600	150	32	21,33	0,25	
		600	169	18	10,65	0,28	
		850	226	33	14,60	0,27	
		650	150	53	35,33	0,23	
		650	166	29	17,47	0,26	
		600	163	17	10,43	0,27	
		1150	292	8	2,74	0,25	
		580	164	26	15,85	0,28	
		650	153	10	6,54	0,24	
		850	252	15	5,95	0,30	
		650	200	7	3,50	0,31	
	<i>Mean</i>	<i>730,38</i>	<i>195,27</i>	<i>21,27</i>	<i>10,89</i>	<i>0,267</i>	
	<i>Stdev</i>	<i>202,93</i>	<i>54,87</i>	<i>22,61</i>	<i>12,98</i>	<i>0,02</i>	

1735		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		850	250	5	2,00	0,29	0,20
		650	183	1	0,55	0,28	
		650	189	7	3,70	0,29	
		1150	310	6	1,94	0,27	
		850	253	4	1,58	0,30	
		705	187	7	3,74	0,27	
		650	182	1	0,55	0,28	
		350	98	2	2,04	0,28	
		650	187	8	4,28	0,29	
		520	189	6	3,17	0,36	
		810	256	11	4,30	0,32	
		600	187	9	4,81	0,31	
		850	253	11	4,35	0,30	
		850	256	1	0,39	0,30	
		810	271	3	1,11	0,33	
		850	180	7	3,89	0,21	
		850	268	20	7,46	0,32	
		850	265	27	10,19	0,31	
		500	113	4	3,54	0,23	
		650	177	14	7,91	0,27	
		850	279	55	19,71	0,33	
		850	264	14	5,30	0,31	
		850	250	11	4,40	0,29	
		650	195	7	3,59	0,30	
		650	134	2	1,49	0,21	
		850	248	6	2,42	0,29	
		650	193	5	2,59	0,30	
		580	193	0	0,00	0,33	
		600	188	4	2,13	0,31	
		650	194	22	11,34	0,30	
		800	184	5	2,72	0,23	
	Mean	729,84	212,13	9,19	4,33	0,291	
	Stdev	151,17	49,56	10,42	3,87	0,03	

1736		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		350	107	1	0,93	0,31	-0,34
		650	175	9	5,14	0,27	
		1180	333	11	3,30	0,28	
		650	194	10	5,15	0,30	
		600	172	2	1,16	0,29	
		650	175	4	2,29	0,27	
		1150	295	9	3,05	0,26	
		850	250	5	2,00	0,29	
		850	263	8	3,04	0,31	
		650	178	9	5,06	0,27	
		650	181	12	6,63	0,28	
		850	257	9	3,50	0,30	
		650	176	17	9,66	0,27	
		850	251	9	3,59	0,30	
		650	175	3	1,71	0,27	
		450	122	4	3,28	0,27	
		850	219	3	1,37	0,26	
		630	168	9	5,36	0,27	
		800	237	2	0,84	0,30	
		650	162	9	5,56	0,25	
		650	158	12	7,59	0,24	
		800	246	5	2,03	0,31	
		650	164	1	0,61	0,25	
		850	239	3	1,26	0,28	
		600	171	1	0,58	0,29	
		850	242	21	8,68	0,28	
		665	158	31	19,62	0,24	
		850	247	6	2,43	0,29	
		1135	240	5	2,08	0,21	
		650	185	5	2,70	0,28	
	Mean	743,67	204,67	7,83	3,83	0,275	
	Stdev	182,90	50,51	6,31	3,73	0,02	

1737	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	800	257	79	30,74	0,32	0,12	
	500	106	6	5,66	0,21		
	850	246	22	8,94	0,29		
	1150	201	29	14,43	0,17		
	850	246	5	2,03	0,29		
	850	167	11	6,59	0,20		
	650	160	10	6,25	0,25		
	810	256	175	68,36	0,32		
	850	252	26	10,32	0,30		
	600	177	11	6,21	0,30		
	1140	307	36	11,73	0,27		
	650	134	27	20,15	0,21		
	500	114	2	1,75	0,23		
	650	173	37	21,39	0,27		
	650	176	31	17,61	0,27		
	650	174	15	8,62	0,27		
	650	176	16	9,09	0,27		
	705	182	11	6,04	0,26		
	850	191	23	12,04	0,22		
	650	198	0	0,00	0,30		
	575	193	4	2,07	0,34		
	1100	321	9	2,80	0,29		
	810	230	22	9,57	0,28		
	650	161	2	1,24	0,25		
	650	190	6	3,16	0,29		
	650	176	16	9,09	0,27		
	650	168	54	32,14	0,26		
	850	225	26	11,56	0,26		
	650	169	4	2,37	0,26		
	250	160	13	8,13	0,64		
	450	128	0	0,00	0,28		
	850	248	3	1,21	0,29		
	600	164	25	15,24	0,27		
	850	237	15	6,33	0,28		
	850	241	15	6,22	0,28		
	850	186	17	9,14	0,22		
	810	241	23	9,54	0,30		
	850	247	21	8,50	0,29		
	600	185	10	5,41	0,31		
	1150	317	27	8,52	0,28		
	525	128	2	1,56	0,24		
	1000	194	4	2,06	0,19		
	850	187	4	2,14	0,22		
	850	259	48	18,53	0,30		
	650	184	11	5,98	0,28		
	850	180	31	17,22	0,21		
	850	258	76	29,46	0,30		
	650	180	16	8,89	0,28		
	600	61	2	3,28	0,10		
	850	260	49	18,85	0,31		
	550	175	44	25,14	0,32		
	Mean	743,63	198,94	22,96	11,54	0,268	
	Stdev	179,68	52,42	27,83	11,33	0,07	

1738	All ships		Dead	Mortality	Man/Ton	Corr.
	Tonnage	Crew				
	850	254	55	21,65	0,30	0,13
	650	175	7	4,00	0,27	
	800	250	26	10,40	0,31	
	850	242	38	15,70	0,28	
	650	171	27	15,79	0,26	
	650	189	23	12,17	0,29	
	650	181	5	2,76	0,28	
	650	171	22	12,87	0,26	
	850	260	80	30,77	0,31	
	1180	316	61	19,30	0,27	
	850	255	47	18,43	0,30	
	850	263	31	11,79	0,31	
	650	190	5	2,63	0,29	
	350	103	0	0,00	0,29	
	650	185	21	11,35	0,28	
	650	166	6	3,61	0,26	
	650	183	9	4,92	0,28	
	850	217	17	7,83	0,26	
	650	152	8	5,26	0,23	
	650	151	26	17,22	0,23	
	850	244	14	5,74	0,29	
	650	147	14	9,52	0,23	
	650	167	5	2,99	0,26	
	850	230	8	3,48	0,27	
	800	238	60	25,21	0,30	
	450	123	0	0,00	0,27	
	575	182	8	4,40	0,32	
	1100	229	6	2,62	0,21	
	650	178	3	1,69	0,27	
	650	194	1	0,52	0,30	
	650	195	12	6,15	0,30	
	650	187	2	1,07	0,29	
	850	192	3	1,56	0,23	
	600	102	8	7,84	0,17	
	600	104	8	7,69	0,17	
	850	273	22	8,06	0,32	
	850	267	1	0,37	0,31	
	650	193	23	11,92	0,30	
	350	105	0	0,00	0,30	
	850	268	35	13,06	0,32	
	350	108	8	7,41	0,31	
	650	191	17	8,90	0,29	
	Mean	707,26	195,02	18,38	9,42	0,276
	Stdev	168,42	52,57	18,73	7,22	0,04

1739		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		650	187	5	2,67	0,29	-0,33
		1135	253	17	6,72	0,22	
		600	184	1	0,54	0,31	
		650	192	10	5,21	0,30	
		450	131	6	4,58	0,29	
		705	198	13	6,57	0,28	
		850	224	29	12,95	0,26	
		830	262	8	3,05	0,32	
		810	276	21	7,61	0,34	
		650	162	0	0,00	0,25	
		650	159	8	5,03	0,24	
		600	175	9	5,14	0,29	
		650	164	7	4,27	0,25	
		850	232	6	2,59	0,27	
		850	234	45	19,23	0,28	
		850	227	7	3,08	0,27	
		850	264	14	5,30	0,31	
		580	154	39	25,32	0,27	
		650	168	66	39,29	0,26	
		850	263	3	1,14	0,31	
		850	255	4	1,57	0,30	
		650	193	6	3,11	0,30	
		650	189	6	3,17	0,29	
		540	181	8	4,42	0,34	
		850	252	7	2,78	0,30	
		650	185	5	2,70	0,28	
		650	193	3	1,55	0,30	
		650	186	5	2,69	0,29	
		600	190	1	0,53	0,32	
		850	266	2	0,75	0,31	
		650	190	2	1,05	0,29	
	<i>Mean</i>	719,35	206,10	11,71	5,68	0,287	
	<i>Stdev</i>	135,79	39,17	14,34	8,07	0,03	

1740		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1000	192	24	12,50	0,19	-0,15
		850	260	7	2,69	0,31	
		850	234	14	5,98	0,28	
		850	250	5	2,00	0,29	
		850	172	11	6,40	0,20	
		850	266	13	4,89	0,31	
		850	242	19	7,85	0,28	
		850	235	13	5,53	0,28	
		850	259	23	8,88	0,30	
		850	243	17	7,00	0,29	
		850	247	9	3,64	0,29	
		800	243	69	28,40	0,30	
		850	254	44	17,32	0,30	
		800	249	20	8,03	0,31	
		850	262	43	16,41	0,31	
		810	239	15	6,28	0,30	
		850	262	13	4,96	0,31	
		850	178	24	13,48	0,21	
		650	168	66	39,29	0,26	
		650	163	6	3,68	0,25	
		650	160	4	2,50	0,25	
		525	111	33	29,73	0,21	
		650	156	67	42,95	0,24	
		650	191	63	32,98	0,29	
		600	108	4	3,70	0,18	
		650	172	55	31,98	0,26	
		550	178	10	5,62	0,32	
		650	181	3	1,66	0,28	
	Mean	769,11	209,82	24,79	11,81	0,273	
	Stdev	117,11	46,74	21,03	12,11	0,04	

1741		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		850	256	62	24,22	0,30	-0,11
		810	250	51	20,40	0,31	
		850	243	74	30,45	0,29	
		850	253	4	1,58	0,30	
		850	183	3	1,64	0,22	
		850	257	37	14,40	0,30	
		850	265	42	15,85	0,31	
		850	259	53	20,46	0,30	
		850	257	36	14,01	0,30	
		650	174	66	37,93	0,27	
		650	179	44	24,58	0,28	
		650	184	38	20,65	0,28	
		650	176	5	2,84	0,27	
		600	179	11	6,15	0,30	
		650	159	30	18,87	0,24	
		600	103	22	21,36	0,17	
		650	157	4	2,55	0,24	
		650	158	17	10,76	0,24	
		600	151	52	34,44	0,25	
		650	154	66	42,86	0,24	
		650	186	2	1,08	0,29	
		650	193	21	10,88	0,30	
		650	190	5	2,63	0,29	
		650	183	20	10,93	0,28	
		600	153	16	10,46	0,26	
		650	180	18	10,00	0,28	
		650	183	31	16,94	0,28	
		650	189	41	21,69	0,29	
		650	175	25	14,29	0,27	
		650	183	6	3,28	0,28	
		650	178	18	10,11	0,27	
		540	174	16	9,20	0,32	
		450	109	9	8,26	0,24	
	Mean	687,88	190,09	28,64	15,06	0,276	
	Stdev	104,50	41,62	20,72	10,61	0,03	

1742		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1100	264	33	12,50	0,24	-0,12
		1135	224	45	20,09	0,20	
		1150	374	12	3,21	0,33	
		1150	312	2	0,64	0,27	
		1000	185	20	10,81	0,19	
		850	189	7	3,70	0,22	
		850	241	30	12,45	0,28	
		850	239	35	14,64	0,28	
		850	248	17	6,85	0,29	
		850	252	9	3,57	0,30	
		850	256	19	7,42	0,30	
		800	250	40	16,00	0,31	
		850	393	36	9,16	0,46	
		850	409	10	2,44	0,48	
		900	403	18	4,47	0,45	
		850	392	43	10,97	0,46	
		850	269	22	8,18	0,32	
		600	91	1	1,10	0,15	
		600	167	0	0,00	0,28	
		650	180	23	12,78	0,28	
		650	170	10	5,88	0,26	
		650	187	34	18,18	0,29	
		650	187	16	8,56	0,29	
	Mean	849,35	255,74	20,96	8,19	0,301	
	Stdev	166,32	85,62	13,45	5,56	0,09	

1743		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	273	23	8,42	0,24	0,02
		1150	306	9	2,94	0,27	
		850	274	64	23,36	0,32	
		850	275	31	11,27	0,32	
		850	300	25	8,33	0,35	
		850	186	33	17,74	0,22	
		850	284	18	6,34	0,33	
		850	263	15	5,70	0,31	
		850	223	8	3,59	0,26	
		850	174	13	7,47	0,20	
		850	225	7	3,11	0,26	
		850	264	12	4,55	0,31	
		850	221	13	5,88	0,26	
		850	277	11	3,97	0,33	
		800	271	15	5,54	0,34	
		830	276	20	7,25	0,33	
		575	176	37	21,02	0,31	
		525	155	2	1,29	0,30	
		600	83	3	3,61	0,14	
		650	178	7	3,93	0,27	
		650	214	21	9,81	0,33	
		550	219	10	4,57	0,40	
		650	180	8	4,44	0,28	
		650	178	15	8,43	0,27	
		650	159	14	8,81	0,24	
		650	195	3	1,54	0,30	
		650	182	4	2,20	0,28	
		665	181	41	22,65	0,27	
		540	166	5	3,01	0,31	
		650	188	12	6,38	0,29	
	<i>Mean</i>	759,50	218,20	16,63	7,62	0,287	
	<i>Stdev</i>	155,06	52,91	13,30	5,91	0,05	

1744		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	254	6	2,36	0,22	0,48
		1150	328	21	6,40	0,29	
		1150	312	12	3,85	0,27	
		850	330	12	3,64	0,39	
		850	227	25	11,01	0,27	
		850	203	5	2,46	0,24	
		810	271	54	19,93	0,33	
		850	281	58	20,64	0,33	
		850	239	8	3,35	0,28	
		850	227	3	1,32	0,27	
		850	233	41	17,60	0,27	
		900	279	1	0,36	0,31	
		850	217	7	3,23	0,26	
		850	405	108	26,67	0,48	
		850	330	77	23,33	0,39	
		850	251	15	5,98	0,30	
		650	196	11	5,61	0,30	
		600	115	6	5,22	0,19	
		650	273	3	1,10	0,42	
		650	177	15	8,47	0,27	
		650	177	14	7,91	0,27	
		650	221	10	4,52	0,34	
	Mean	834,55	252,09	23,27	9,23	0,302	
	Stdev	155,41	62,83	27,04	7,71	0,07	

1745	All ships						
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	270	23	8,52	0,23	0,18
		1150	357	22	6,16	0,31	
		1150	310	6	1,94	0,27	
		1150	317	1	0,32	0,28	
		1100	272	7	2,57	0,25	
		850	189	24	12,70	0,22	
		850	278	24	8,63	0,33	
		850	318	145	45,60	0,37	
		850	240	24	10,00	0,28	
		850	241	14	5,81	0,28	
		850	304	9	2,96	0,36	
		850	232	11	4,74	0,27	
		850	234	10	4,27	0,28	
		850	94	1	1,06	0,11	
		650	185	11	5,95	0,28	
		600	212	3	1,42	0,35	
		550	173	7	4,05	0,31	
		650	206	31	15,05	0,32	
		650	182	137	75,27	0,28	
		650	213	2	0,94	0,33	
		650	172	2	1,16	0,26	
		650	208	12	5,77	0,32	
		650	194	1	0,52	0,30	
		600	129	8	6,20	0,22	
		650	204	2	0,98	0,31	
		575	204	12	5,88	0,35	
		600	133	7	5,26	0,22	
		150	18	0	0,00	0,12	
	Mean	772,32	217,46	19,86	9,13	0,282	
	Stdev	224,93	71,92	34,66	15,33	0,06	

1746	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	331	24	7,25	0,29	0,39	
	1150	292	6	2,05	0,25		
	1150	305	10	3,28	0,27		
	1150	306	20	6,54	0,27		
	1150	335	46	13,73	0,29		
	1150	344	14	4,07	0,30		
	1150	350	61	17,43	0,30		
	1150	356	54	15,17	0,31		
	1150	354	81	22,88	0,31		
	850	256	15	5,86	0,30		
	850	224	11	4,91	0,26		
	850	244	3	1,23	0,29		
	850	265	37	13,96	0,31		
	850	231	11	4,76	0,27		
	850	303	54	17,82	0,36		
	850	259	40	15,44	0,30		
	850	263	10	3,80	0,31		
	850	201	4	1,99	0,24		
	850	320	21	6,56	0,38		
	830	284	87	30,63	0,34		
	800	206	28	13,59	0,26		
	850	246	35	14,23	0,29		
	875	235	0	0,00	0,27		
	850	318	21	6,60	0,37		
	850	279	48	17,20	0,33		
	850	285	5	1,75	0,34		
	850	315	6	1,90	0,37		
	850	272	48	17,65	0,32		
	810	310	39	12,58	0,38		
	850	235	16	6,81	0,28		
	665	184	6	3,26	0,28		
	650	183	5	2,73	0,28		
	650	177	3	1,69	0,27		
	525	171	22	12,87	0,33		
	650	183	2	1,09	0,28		
	540	191	44	23,04	0,35		
	650	207	2	0,97	0,32		
	Mean	876,89	265,41	25,38	9,56	0,303	
	Stdev	178,91	55,58	22,46	7,53	0,04	

1747		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	339	67	19,76	0,29	0,18
		850	295	70	23,73	0,35	
		850	285	82	28,77	0,34	
		850	246	57	23,17	0,29	
		850	355	95	26,76	0,42	
		850	314	14	4,46	0,37	
		850	273	38	13,92	0,32	
		850	247	11	4,45	0,29	
		850	240	18	7,50	0,28	
		850	254	20	7,87	0,30	
		850	338	102	30,18	0,40	
		850	242	5	2,07	0,28	
		850	254	14	5,51	0,30	
		850	240	89	37,08	0,28	
		900	313	50	15,97	0,35	
		850	295	12	4,07	0,35	
		850	248	28	11,29	0,29	
		850	305	0	0,00	0,36	
		850	258	43	16,67	0,30	
		850	200	29	14,50	0,24	
		600	149	1	0,67	0,25	
		550	208	4	1,92	0,38	
	<i>Mean</i>	<i>840,91</i>	<i>268,09</i>	<i>38,59</i>	<i>14,39</i>	<i>0,319</i>	
	<i>Stdev</i>	<i>105,14</i>	<i>48,26</i>	<i>32,19</i>	<i>10,66</i>	<i>0,05</i>	

1748		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	324	11	3,40	0,28	-0,06
		1150	339	12	3,54	0,29	
		1150	342	70	20,47	0,30	
		1150	344	72	20,93	0,30	
		1150	296	130	43,92	0,26	
		1150	325	9	2,77	0,28	
		1150	325	26	8,00	0,28	
		850	254	54	21,26	0,30	
		850	300	41	13,67	0,35	
		850	204	3	1,47	0,24	
		850	230	4	1,74	0,27	
		850	207	72	34,78	0,24	
		850	248	76	30,65	0,29	
		850	222	29	13,06	0,26	
		850	247	40	16,19	0,29	
		850	217	50	23,04	0,26	
		650	224	24	10,71	0,34	
		650	211	10	4,74	0,32	
		850	214	46	21,50	0,25	
		665	201	33	16,42	0,30	
		600	165	23	13,94	0,28	
		250	52	0	0,00	0,21	
	Mean	880,23	249,59	37,95	15,21	0,284	
	Stdev	228,30	69,13	31,08	11,41	0,03	

1749	All ships					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	326	56	17,18	0,28	0,00
	1150	319	87	27,27	0,28	
	1150	311	24	7,72	0,27	
	1150	362	52	14,36	0,31	
	1150	298	8	2,68	0,26	
	1150	297	10	3,37	0,26	
	1150	319	4	1,25	0,28	
	1150	318	5	1,57	0,28	
	1150	315	22	6,98	0,27	
	1150	319	9	2,82	0,28	
	1150	317	1	0,32	0,28	
	1150	327	3	0,92	0,28	
	1150	318	5	1,57	0,28	
	850	253	32	12,65	0,30	
	850	231	1	0,43	0,27	
	850	246	29	11,79	0,29	
	850	259	7	2,70	0,30	
	850	274	4	1,46	0,32	
	850	248	24	9,68	0,29	
	850	282	6	2,13	0,33	
	850	235	11	4,68	0,28	
	850	279	7	2,51	0,33	
	800	213	0	0,00	0,27	
	850	282	8	2,84	0,33	
	850	246	11	4,47	0,29	
	830	287	5	1,74	0,35	
	850	238	31	13,03	0,28	
	850	244	26	10,66	0,29	
	850	242	12	4,96	0,28	
	850	278	53	19,06	0,33	
	850	247	20	8,10	0,29	
	850	270	7	2,59	0,32	
	850	194	29	14,95	0,23	
	850	248	46	18,55	0,29	
	850	250	25	10,00	0,29	
	850	250	53	21,20	0,29	
	850	254	51	20,08	0,30	
	850	271	17	6,27	0,32	
	650	124	3	2,42	0,19	
	575	214	0	0,00	0,37	
	650	203	5	2,46	0,31	
	550	196	1	0,51	0,36	
	600	143	4	2,80	0,24	
	525	161	2	1,24	0,31	
	650	201	2	1,00	0,31	
	600	107	2	1,87	0,18	
	300	85	0	0,00	0,28	
	150	22	1	4,55	0,15	
	Mean	862,08	248,40	17,10	6,89	0,288
	Stdev	227,06	67,74	19,39	6,74	0,04

1750		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	323	5	1,55	0,28	0,01
		1150	328	34	10,37	0,29	
		1150	329	3	0,91	0,29	
		1150	322	3	0,93	0,28	
		1150	319	11	3,45	0,28	
		1150	312	9	2,88	0,27	
		1150	321	49	15,26	0,28	
		1150	309	12	3,88	0,27	
		1150	321	1	0,31	0,28	
		1150	308	4	1,30	0,27	
		1150	324	4	1,23	0,28	
		850	251	5	1,99	0,30	
		880	246	1	0,41	0,28	
		850	249	9	3,61	0,29	
		850	204	7	3,43	0,24	
		850	256	21	8,20	0,30	
		850	193	1	0,52	0,23	
		850	249	3	1,20	0,29	
		850	253	7	2,77	0,30	
		850	238	18	7,56	0,28	
		850	244	14	5,74	0,29	
		850	246	7	2,85	0,29	
		850	91	8	8,79	0,11	
		850	237	29	12,24	0,28	
		850	256	3	1,17	0,30	
		850	244	9	3,69	0,29	
		850	239	9	3,77	0,28	
		650	199	7	3,52	0,31	
		650	123	1	0,81	0,19	
		250	38	0	0,00	0,15	
	Mean	927,67	252,40	9,80	3,88	0,272	
	Stdev	204,12	70,38	10,72	3,74	0,04	

1751		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	280	5	1,79	0,24	0,31
		1150	324	8	2,47	0,28	
		1150	318	5	1,57	0,28	
		1150	335	6	1,79	0,29	
		1150	408	20	4,90	0,35	
		1150	321	10	3,12	0,28	
		1150	314	4	1,27	0,27	
		1150	321	3	0,93	0,28	
		1150	360	6	1,67	0,31	
		1150	316	2	0,63	0,27	
		1150	372	1	0,27	0,32	
		1150	380	11	2,89	0,33	
		850	266	3	1,13	0,31	
		850	241	5	2,07	0,28	
		850	269	17	6,32	0,32	
		850	254	7	2,76	0,30	
		850	303	3	0,99	0,36	
		850	196	2	1,02	0,23	
		850	258	6	2,33	0,30	
		850	230	3	1,30	0,27	
		850	239	5	2,09	0,28	
		850	245	6	2,45	0,29	
		880	243	9	3,70	0,28	
		850	255	6	2,35	0,30	
		850	235	5	2,13	0,28	
		650	180	1	0,56	0,28	
		650	186	3	1,61	0,29	
	Mean	969,63	283,30	6,00	2,12	0,292	
	Stdev	169,37	58,38	4,34	1,30	0,03	

1752		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	368	3	0,82	0,32	0,24
		1150	343	2	0,58	0,30	
		1150	331	9	2,72	0,29	
		1150	365	15	4,11	0,32	
		1150	364	9	2,47	0,32	
		1150	367	3	0,82	0,32	
		1150	368	5	1,36	0,32	
		1150	353	37	10,48	0,31	
		850	250	9	3,60	0,29	
		850	272	9	3,31	0,32	
		850	244	3	1,23	0,29	
		850	197	0	0,00	0,23	
		850	277	17	6,14	0,33	
		850	245	1	0,41	0,29	
		880	249	16	6,43	0,28	
		880	269	2	0,74	0,31	
		850	308	3	0,97	0,36	
		850	264	3	1,14	0,31	
		850	226	0	0,00	0,27	
		880	244	11	4,51	0,28	
		800	287	7	2,44	0,36	
		880	255	3	1,18	0,29	
		850	217	2	0,92	0,26	
		850	300	6	2,00	0,35	
		850	248	2	0,81	0,29	
		850	236	8	3,39	0,28	
		875	279	3	1,08	0,32	
		850	252	3	1,19	0,30	
		830	331	3	0,91	0,40	
		650	208	1	0,48	0,32	
		600	144	4	2,78	0,24	
		525	150	0	0,00	0,29	
		540	240	18	7,50	0,44	
	Mean	892,12	274,27	6,58	2,40	0,307	
	Stdev	171,69	59,91	7,32	2,37	0,04	

1753		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	354	3	0,85	0,31	0,10
		1150	296	4	1,35	0,26	
		1150	323	2	0,62	0,28	
		1150	359	18	5,01	0,31	
		1150	360	4	1,11	0,31	
		1150	359	14	3,90	0,31	
		1150	363	10	2,75	0,32	
		1150	368	7	1,90	0,32	
		1150	313	5	1,60	0,27	
		1150	356	60	16,85	0,31	
		850	259	15	5,79	0,30	
		850	274	1	0,36	0,32	
		850	272	58	21,32	0,32	
		850	300	3	1,00	0,35	
		880	269	5	1,86	0,31	
		850	277	12	4,33	0,33	
		880	300	6	2,00	0,34	
		850	247	10	4,05	0,29	
		880	240	0	0,00	0,27	
		880	251	3	1,20	0,29	
		850	248	3	1,21	0,29	
		850	241	6	2,49	0,28	
		880	245	7	2,86	0,28	
		850	298	10	3,36	0,35	
		900	325	4	1,23	0,36	
		850	281	1	0,36	0,33	
		300	109	0	0,00	0,36	
		250	56	0	0,00	0,22	
	<i>Mean</i>	923,21	283,68	9,68	3,41	0,307	
	<i>Stdev</i>	225,15	70,23	14,44	4,70	0,03	

1754		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	293	2	0,68	0,25	-0,01
		1150	298	5	1,68	0,26	
		1150	352	6	1,70	0,31	
		1150	307	14	4,56	0,27	
		1150	351	39	11,11	0,31	
		1150	357	13	3,64	0,31	
		1150	358	7	1,96	0,31	
		1150	356	7	1,97	0,31	
		1150	362	10	2,76	0,31	
		1150	351	2	0,57	0,31	
		1150	352	3	0,85	0,31	
		1150	342	12	3,51	0,30	
		1150	352	8	2,27	0,31	
		880	248	3	1,21	0,28	
		850	264	4	1,52	0,31	
		880	271	8	2,95	0,31	
		880	275	4	1,45	0,31	
		850	265	2	0,75	0,31	
		880	268	4	1,49	0,30	
		850	276	6	2,17	0,32	
		875	272	0	0,00	0,31	
		850	209	2	0,96	0,25	
		880	238	1	0,42	0,27	
		850	238	45	18,91	0,28	
		850	258	5	1,94	0,30	
		850	236	9	3,81	0,28	
		850	297	20	6,73	0,35	
		850	284	3	1,06	0,33	
	Mean	995,54	297,50	8,71	2,93	0,299	
	Stdev	144,18	46,20	10,26	3,78	0,02	

1755		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	305	23	7,54	0,27	-0,02
		1150	326	3	0,92	0,28	
		1150	321	6	1,87	0,28	
		1150	310	29	9,35	0,27	
		1150	229	13	5,68	0,20	
		1150	354	10	2,82	0,31	
		1150	356	6	1,69	0,31	
		880	263	22	8,37	0,30	
		850	229	3	1,31	0,27	
		850	181	2	1,10	0,21	
		880	215	14	6,51	0,24	
		850	271	26	9,59	0,32	
		880	288	3	1,04	0,33	
		850	278	1	0,36	0,33	
		880	271	30	11,07	0,31	
	<i>Mean</i>	<i>998,00</i>	<i>279,80</i>	<i>12,73</i>	<i>4,55</i>	<i>0,280</i>	
	<i>Stdev</i>	<i>142,60</i>	<i>49,21</i>	<i>10,22</i>	<i>3,68</i>	<i>0,04</i>	

1756		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	329	3	0,91	0,29	0,14
		1150	362	3	0,83	0,31	
		1150	276	3	1,09	0,24	
		1150	351	24	6,84	0,31	
		1150	228	2	0,88	0,20	
		1150	241	8	3,32	0,21	
		1150	302	6	1,99	0,26	
		1150	290	19	6,55	0,25	
		1150	305	9	2,95	0,27	
		1150	311	3	0,96	0,27	
		1150	310	16	5,16	0,27	
		1150	358	11	3,07	0,31	
		1150	350	3	0,86	0,30	
		1150	351	71	20,23	0,31	
		1150	350	24	6,86	0,30	
		1150	352	73	20,74	0,31	
		1150	348	1	0,29	0,30	
		850	204	3	1,47	0,24	
		880	262	5	1,91	0,30	
		850	286	6	2,10	0,34	
		850	275	0	0,00	0,32	
		850	187	11	5,88	0,22	
		880	231	9	3,90	0,26	
		850	233	14	6,01	0,27	
		880	271	3	1,11	0,31	
		880	261	4	1,53	0,30	
		850	249	5	2,01	0,29	
		850	263	21	7,98	0,31	
		600	142	6	4,23	0,24	
	Mean	1021,38	285,45	12,62	4,42	0,279	
	Stdev	160,21	56,17	17,49	4,97	0,03	

1757		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	309	9	2,91	0,27	-0,08
		1150	293	93	31,74	0,25	
		1150	292	35	11,99	0,25	
		1150	298	114	38,26	0,26	
		1150	282	6	2,13	0,25	
		1100	356	34	9,55	0,32	
		1150	376	89	23,67	0,33	
		1150	353	89	25,21	0,31	
		1150	347	71	20,46	0,30	
		850	268	64	23,88	0,32	
		850	253	24	9,49	0,30	
		850	235	12	5,11	0,28	
		850	224	37	16,52	0,26	
		850	187	14	7,49	0,22	
		880	225	41	18,22	0,26	
		850	226	62	27,43	0,27	
		850	232	22	9,48	0,27	
		850	285	6	2,11	0,34	
		880	288	7	2,43	0,33	
		850	263	8	3,04	0,31	
		850	262	32	12,21	0,31	
		880	279	48	17,20	0,32	
		600	150	4	2,67	0,25	
		525	160	3	1,88	0,30	
	<i>Mean</i>	<i>940,21</i>	<i>268,46</i>	<i>38,50</i>	<i>14,34</i>	<i>0,286</i>	
	<i>Stdev</i>	<i>177,72</i>	<i>57,02</i>	<i>32,50</i>	<i>10,40</i>	<i>0,03</i>	

1758		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	282	41	14,54	0,25	-0,02
		1150	312	59	18,91	0,27	
		1150	306	22	7,19	0,27	
		1150	306	81	26,47	0,27	
		1150	311	43	13,83	0,27	
		1150	314	63	20,06	0,27	
		1150	359	101	28,13	0,31	
		1150	356	42	11,80	0,31	
		1100	361	48	13,30	0,33	
		1100	352	38	10,80	0,32	
		880	235	34	14,47	0,27	
		880	300	14	4,67	0,34	
		850	242	24	9,92	0,28	
		880	189	30	15,87	0,21	
		880	230	53	23,04	0,26	
		880	208	8	3,85	0,24	
		850	241	12	4,98	0,28	
		875	304	9	2,96	0,35	
		880	273	50	18,32	0,31	
		880	269	40	14,87	0,31	
		850	271	62	22,88	0,32	
		600	145	0	0,00	0,24	
	Mean	981,14	280,27	39,73	14,17	0,286	
	Stdev	156,10	55,87	24,20	7,59	0,03	

1759		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	345	118	34,20	0,30	0,51
		1150	303	19	6,27	0,26	
		1150	298	7	2,35	0,26	
		1150	313	13	4,15	0,27	
		1100	291	24	8,25	0,26	
		1150	301	3	1,00	0,26	
		1100	317	21	6,62	0,29	
		1100	311	10	3,22	0,28	
		1150	326	29	8,90	0,28	
		1100	208	6	2,88	0,19	
		850	175	0	0,00	0,21	
		850	238	25	10,50	0,28	
		850	250	4	1,60	0,29	
		880	227	6	2,64	0,26	
		850	230	18	7,83	0,27	
		880	252	5	1,98	0,29	
		880	238	4	1,68	0,27	
		850	268	55	20,52	0,32	
		850	299	40	13,38	0,35	
		880	235	10	4,26	0,27	
		880	237	11	4,64	0,27	
		850	230	13	5,65	0,27	
		880	220	3	1,36	0,25	
		850	178	8	4,49	0,21	
	Mean	974,17	262,08	18,83	7,19	0,269	
	Stdev	133,13	46,14	24,26	7,30	0,03	

1760		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	283	10	3,53	0,25	0,50
		1150	301	7	2,33	0,26	
		1150	308	2	0,65	0,27	
		1150	269	5	1,86	0,23	
		1150	305	8	2,62	0,27	
		1150	310	21	6,77	0,27	
		1150	304	53	17,43	0,26	
		880	200	0	0,00	0,23	
		850	271	26	9,59	0,32	
		880	217	5	2,30	0,25	
		880	210	6	2,86	0,24	
		850	232	23	9,91	0,27	
		880	213	12	5,63	0,24	
		850	180	5	2,78	0,21	
	Mean	1008,57	257,36	13,07	5,08	0,255	
	Stdev	141,82	45,06	13,46	4,54	0,02	

1761		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	211	12	5,69	0,18	-0,11
		1150	271	10	3,69	0,24	
		1150	337	4	1,19	0,29	
		1150	352	37	10,51	0,31	
		1150	331	32	9,67	0,29	
		1150	336	11	3,27	0,29	
		1150	363	6	1,65	0,32	
		1150	286	41	14,34	0,25	
		1150	347	7	2,02	0,30	
		1150	354	11	3,11	0,31	
		1150	350	6	1,71	0,30	
		1150	301	6	1,99	0,26	
		1150	324	29	8,95	0,28	
		1100	345	11	3,19	0,31	
		1100	350	48	13,71	0,32	
		1150	359	11	3,06	0,31	
		1150	338	20	5,92	0,29	
		1100	309	14	4,53	0,28	
		1150	340	70	20,59	0,30	
		1100	318	113	35,53	0,29	
		1100	346	13	3,76	0,31	
		1150	345	57	16,52	0,30	
		850	273	6	2,20	0,32	
		875	252	5	1,98	0,29	
		850	259	1	0,39	0,30	
		850	250	14	5,60	0,29	
		850	271	9	3,32	0,32	
		850	242	36	14,88	0,28	
		880	248	13	5,24	0,28	
		850	204	1	0,49	0,24	
		850	298	3	1,01	0,35	
		880	224	5	2,23	0,25	
		880	238	6	2,52	0,27	
		850	301	3	1,00	0,35	
		850	267	4	1,50	0,31	
		880	268	8	2,99	0,30	
		850	269	6	2,23	0,32	
		880	286	8	2,80	0,33	
	Mean	1021,71	299,03	18,34	6,13	0,293	
	Stdev	138,34	45,67	22,41	6,91	0,03	

1762		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	363	5	1,38	0,32	0,01
		1100	350	24	6,86	0,32	
		1150	207	2	0,97	0,18	
		1150	306	7	2,29	0,27	
		1150	348	8	2,30	0,30	
		1150	348	4	1,15	0,30	
		1150	344	44	12,79	0,30	
		1150	269	13	4,83	0,23	
		1150	351	43	12,25	0,31	
		1100	355	15	4,23	0,32	
		1150	351	73	20,80	0,31	
		1150	273	41	15,02	0,24	
		1150	327	6	1,83	0,28	
		880	271	5	1,85	0,31	
		880	237	7	2,95	0,27	
		880	255	4	1,57	0,29	
		850	234	18	7,69	0,28	
		880	227	1	0,44	0,26	
		880	242	0	0,00	0,28	
		850	284	7	2,46	0,33	
		850	279	12	4,30	0,33	
		880	253	18	7,11	0,29	
		880	271	3	1,11	0,31	
		880	294	2	0,68	0,33	
	<i>Mean</i>	<i>1018,33</i>	<i>293,29</i>	<i>15,08</i>	<i>5,14</i>	<i>0,288</i>	
	<i>Stdev</i>	<i>135,73</i>	<i>47,84</i>	<i>17,61</i>	<i>5,24</i>	<i>0,04</i>	

1763		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	303	2	0,66	0,26	0,18
		1150	297	77	25,93	0,26	
		1150	318	9	2,83	0,28	
		1150	390	56	14,36	0,34	
		1150	399	70	17,54	0,35	
		1150	299	13	4,35	0,26	
		1100	399	39	9,77	0,36	
		1100	302	7	2,32	0,27	
		1150	351	3	0,85	0,31	
		1150	308	16	5,19	0,27	
		1150	356	25	7,02	0,31	
		1150	354	8	2,26	0,31	
		1150	336	5	1,49	0,29	
		1150	350	30	8,57	0,30	
		1150	338	18	5,33	0,29	
		850	307	6	1,95	0,36	
		850	290	5	1,72	0,34	
		880	181	3	1,66	0,21	
		880	247	11	4,45	0,28	
		875	296	3	1,01	0,34	
		880	227	18	7,93	0,26	
		850	308	17	5,52	0,36	
		880	297	14	4,71	0,34	
		850	300	14	4,67	0,35	
		850	293	7	2,39	0,34	
		880	267	1	0,37	0,30	
		850	312	45	14,42	0,37	
		850	189	0	0,00	0,22	
		850	260	9	3,46	0,31	
		880	259	2	0,77	0,29	
		880	273	26	9,52	0,31	
	Mean	999,52	303,42	18,03	5,94	0,304	
	Stdev	140,15	51,37	19,64	5,73	0,04	

1764		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	295	5	1,69	0,26	-0,17
		1150	353	7	1,98	0,31	
		1150	350	17	4,86	0,30	
		1150	304	15	4,93	0,26	
		1150	328	12	3,66	0,29	
		1150	318	43	13,52	0,28	
		1150	320	77	24,06	0,28	
		1150	325	16	4,92	0,28	
		1150	356	22	6,18	0,31	
		1100	340	27	7,94	0,31	
		1100	348	5	1,44	0,32	
		1150	350	33	9,43	0,30	
		1150	351	12	3,42	0,31	
		1150	366	8	2,19	0,32	
		1100	354	44	12,43	0,32	
		1150	357	2	0,56	0,31	
		1150	339	54	15,93	0,29	
		1150	341	58	17,01	0,30	
		880	258	18	6,98	0,29	
		850	223	3	1,35	0,26	
		880	301	49	16,28	0,34	
		880	292	47	16,10	0,33	
		880	191	51	26,70	0,22	
		880	234	20	8,55	0,27	
		880	276	45	16,30	0,31	
		880	238	8	3,36	0,27	
		880	304	2	0,66	0,35	
		850	259	5	1,93	0,30	
		880	269	13	4,83	0,31	
		880	294	5	1,70	0,33	
		850	288	48	16,67	0,34	
	<i>Mean</i>	1029,03	307,16	24,87	8,10	0,298	
	<i>Stdev</i>	133,55	45,08	20,40	7,11	0,03	

1765		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	349	3	0,86	0,30	0,33
		1100	325	22	6,77	0,30	
		1150	326	39	11,96	0,28	
		1150	331	27	8,16	0,29	
		1150	326	12	3,68	0,28	
		1150	310	12	3,87	0,27	
		1150	356	11	3,09	0,31	
		1150	350	33	9,43	0,30	
		1150	365	20	5,48	0,32	
		1150	348	54	15,52	0,30	
		1150	357	63	17,65	0,31	
		1150	331	5	1,51	0,29	
		1150	353	3	0,85	0,31	
		1150	267	5	1,87	0,23	
		850	276	13	4,71	0,32	
		880	236	4	1,69	0,27	
		880	244	8	3,28	0,28	
		880	247	2	0,81	0,28	
		880	235	3	1,28	0,27	
		880	259	32	12,36	0,29	
		880	297	3	1,01	0,34	
		880	244	7	2,87	0,28	
		880	297	35	11,78	0,34	
		880	263	0	0,00	0,30	
		880	242	10	4,13	0,28	
		850	254	13	5,12	0,30	
		600	151	0	0,00	0,25	
	Mean	1005,56	294,04	16,26	5,53	0,292	
	Stdev	155,24	52,17	16,43	4,83	0,02	

1766		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1100	307	13	4,23	0,28	-0,09
		1150	300	24	8,00	0,26	
		1150	308	9	2,92	0,27	
		1150	304	28	9,21	0,26	
		1150	320	3	0,94	0,28	
		1100	357	24	6,72	0,32	
		1150	354	4	1,13	0,31	
		1150	354	1	0,28	0,31	
		1150	363	63	17,36	0,32	
		1150	343	18	5,25	0,30	
		1150	366	27	7,38	0,32	
		1150	345	7	2,03	0,30	
		880	238	2	0,84	0,27	
		850	290	10	3,45	0,34	
		880	239	5	2,09	0,27	
		880	227	5	2,20	0,26	
		850	211	8	3,79	0,25	
		850	256	16	6,25	0,30	
		880	252	2	0,79	0,29	
		880	193	19	9,84	0,22	
		880	242	6	2,48	0,28	
		875	262	2	0,76	0,30	
		880	246	6	2,44	0,28	
		880	299	3	1,00	0,34	
		880	351	1	0,28	0,40	
		850	293	3	1,02	0,34	
		880	266	5	1,88	0,30	
		880	269	25	9,29	0,31	
		880	244	2	0,82	0,28	
		880	268	2	0,75	0,30	
		880	187	1	0,53	0,21	
	Mean	977,26	285,61	11,10	3,89	0,292	
	Stdev	131,52	51,25	12,77	3,83	0,04	

1767		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	383	73	19,06	0,33	-0,07
		1150	260	47	18,08	0,23	
		1150	311	67	21,54	0,27	
		1150	309	1	0,32	0,27	
		1150	299	7	2,34	0,26	
		1150	304	27	8,88	0,26	
		1150	368	26	7,07	0,32	
		1150	358	11	3,07	0,31	
		1150	370	18	4,86	0,32	
		1150	364	10	2,75	0,32	
		1150	364	9	2,47	0,32	
		1100	349	3	0,86	0,32	
		1150	361	32	8,86	0,31	
		1100	341	6	1,76	0,31	
		1150	354	28	7,91	0,31	
		1150	348	18	5,17	0,30	
		1100	255	14	5,49	0,23	
		850	173	6	3,47	0,20	
		880	286	14	4,90	0,33	
		880	251	1	0,40	0,29	
		880	197	11	5,58	0,22	
		880	270	8	2,96	0,31	
		880	184	5	2,72	0,21	
		880	198	18	9,09	0,23	
		880	237	12	5,06	0,27	
		880	259	26	10,04	0,29	
		880	278	6	2,16	0,32	
		850	277	4	1,44	0,33	
		850	285	37	12,98	0,34	
		850	280	8	2,86	0,33	
		850	262	22	8,40	0,31	
		880	263	20	7,60	0,30	
		880	262	15	5,73	0,30	
	Mean	1010,00	292,73	18,48	6,31	0,290	
	Stdev	136,25	57,40	16,87	5,19	0,04	

1768		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	306	4	1,31	0,27	0,33
		1100	316	14	4,43	0,29	
		1150	379	51	13,46	0,33	
		1150	359	34	9,47	0,31	
		1150	360	27	7,50	0,31	
		1100	354	22	6,21	0,32	
		1100	352	56	15,91	0,32	
		1150	352	77	21,88	0,31	
		1150	354	34	9,60	0,31	
		1100	235	9	3,83	0,21	
		1150	367	44	11,99	0,32	
		1100	265	5	1,89	0,24	
		1100	285	19	6,67	0,26	
		880	246	2	0,81	0,28	
		880	259	6	2,32	0,29	
		880	233	1	0,43	0,26	
		880	191	4	2,09	0,22	
		880	202	4	1,98	0,23	
		880	226	31	13,72	0,26	
		850	226	14	6,19	0,27	
		880	290	33	11,38	0,33	
		850	297	20	6,73	0,35	
		880	262	67	25,57	0,30	
		850	266	27	10,15	0,31	
		880	360	16	4,44	0,41	
		880	292	12	4,11	0,33	
		850	283	34	12,01	0,33	
		880	277	57	20,58	0,31	
	Mean	990,36	292,64	25,86	8,84	0,295	
	Stdev	128,63	54,19	20,55	6,53	0,04	

1769		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1100	307	1	0,33	0,28	0,27
		1150	304	2	0,66	0,26	
		1150	274	17	6,20	0,24	
		1150	264	25	9,47	0,23	
		1150	355	40	11,27	0,31	
		1150	356	35	9,83	0,31	
		1150	351	32	9,12	0,31	
		1150	355	19	5,35	0,31	
		1150	355	15	4,23	0,31	
		1150	308	48	15,58	0,27	
		1100	356	38	10,67	0,32	
		1150	371	43	11,59	0,32	
		1150	360	27	7,50	0,31	
		850	227	3	1,32	0,27	
		880	259	27	10,42	0,29	
		880	190	5	2,63	0,22	
		880	233	5	2,15	0,26	
		880	254	12	4,72	0,29	
		880	203	3	1,48	0,23	
		880	281	15	5,34	0,32	
		850	290	29	10,00	0,34	
		880	273	10	3,66	0,31	
		850	265	13	4,91	0,31	
		850	273	1	0,37	0,32	
		850	306	7	2,29	0,36	
		880	192	4	2,08	0,22	
		850	281	24	8,54	0,33	
	Mean	999,63	290,48	18,52	6,38	0,291	
	Stdev	138,47	53,25	14,06	4,11	0,04	

1770		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	346	14	4,05	0,30	-0,04
		1150	349	6	1,72	0,30	
		1150	323	7	2,17	0,28	
		1150	331	46	13,90	0,29	
		1150	269	45	16,73	0,23	
		1150	361	140	38,78	0,31	
		1150	360	146	40,56	0,31	
		1150	357	57	15,97	0,31	
		1150	240	41	17,08	0,21	
		1150	364	80	21,98	0,32	
		1100	378	80	21,16	0,34	
		1150	370	54	14,59	0,32	
		1150	361	168	46,54	0,31	
		880	313	9	2,88	0,36	
		880	237	33	13,92	0,27	
		880	252	13	5,16	0,29	
		880	305	31	10,16	0,35	
		850	286	7	2,45	0,34	
		880	306	9	2,94	0,35	
		850	283	21	7,42	0,33	
		850	290	51	17,59	0,34	
		880	296	52	17,57	0,34	
		880	289	51	17,65	0,33	
	Mean	1026,52	315,91	50,48	15,98	0,308	
	Stdev	137,07	42,40	44,91	12,19	0,04	

1771		All ships	without Beekvliet				
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	355	93	26,20	0,31	0,48
		1100	357	98	27,45	0,32	
		1100	366	121	33,06	0,33	
		1150	321	76	23,68	0,28	
		1150	304	120	39,47	0,26	
		1100	369	217	58,81	0,34	
		1150	337	99	29,38	0,29	
		1150	363	59	16,25	0,32	
		1150	365	79	21,64	0,32	
		1100	319	106	33,23	0,29	
		1150	363	131	36,09	0,32	
		1150	323	80	24,77	0,28	
		1150	337	40	11,87	0,29	
		1150	313	29	9,27	0,27	
		1100	328	48	14,63	0,30	
		1150	315	25	7,94	0,27	
		880	280	71	25,36	0,32	
		850	258	18	6,98	0,30	
		850	257	109	42,41	0,30	
		850	244	65	26,64	0,29	
		880	252	116	46,03	0,29	
		880	291	184	63,23	0,33	
		880	268	90	33,58	0,30	
		880	282	101	35,82	0,32	
		880	193	7	3,63	0,22	
		850	266	142	53,38	0,31	
		850	223	19	8,52	0,26	
		880	343	105	30,61	0,39	
		850	276	90	32,61	0,32	
		600	173	17	9,83	0,29	
	Mean	1000,33	301,37	85,17	28,26	0,301	
	Stdev	152,02	51,88	48,07	15,16	0,03	

1771		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	355	93	26,20	0,31	0,49
		1100	357	98	27,45	0,32	
		1100	366	121	33,06	0,33	
		1150	321	76	23,68	0,28	
		1150	304	120	39,47	0,26	
		1100	369	217	58,81	0,34	
		1150	337	99	29,38	0,29	
		1150	363	59	16,25	0,32	
		1150	365	79	21,64	0,32	
		1100	319	106	33,23	0,29	
		1150	363	131	36,09	0,32	
		1150	323	80	24,77	0,28	
		1150	337	40	11,87	0,29	
		1150	313	29	9,27	0,27	
		1100	328	48	14,63	0,30	
		1150	315	25	7,94	0,27	
		880	280	71	25,36	0,32	
		850	258	18	6,98	0,30	
		850	257	109	42,41	0,30	
		850	238	3	1,26	0,28	
		850	244	65	26,64	0,29	
		880	252	116	46,03	0,29	
		880	291	184	63,23	0,33	
		880	268	90	33,58	0,30	
		880	282	101	35,82	0,32	
		880	193	7	3,63	0,22	
		850	266	142	53,38	0,31	
		850	223	19	8,52	0,26	
		880	343	105	30,61	0,39	
		850	276	90	32,61	0,32	
		600	173	17	9,83	0,29	
	<i>Mean</i>	995,48	299,32	82,52	27,57	0,301	
	<i>Stdev</i>	151,89	52,25	49,47	15,63	0,03	

1772		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	325	72	22,15	0,28	0,00
		1100	339	83	24,48	0,31	
		1150	303	60	19,80	0,26	
		1100	211	52	24,64	0,19	
		1150	315	116	36,83	0,27	
		1150	288	47	16,32	0,25	
		1100	305	62	20,33	0,28	
		1150	297	100	33,67	0,26	
		1150	300	70	23,33	0,26	
		1150	298	86	28,86	0,26	
		1200	353	150	42,49	0,29	
		1150	299	65	21,74	0,26	
		1100	243	72	29,63	0,22	
		1150	323	101	31,27	0,28	
		1150	307	58	18,89	0,27	
		1150	355	107	30,14	0,31	
		1150	301	42	13,95	0,26	
		880	283	19	6,71	0,32	
		880	224	42	18,75	0,25	
		880	189	42	22,22	0,21	
		850	239	30	12,55	0,28	
		850	260	36	13,85	0,31	
		850	226	28	12,39	0,27	
		850	272	59	21,69	0,32	
		880	225	36	16,00	0,26	
		880	266	41	15,41	0,30	
		850	235	17	7,23	0,28	
		880	259	44	16,99	0,29	
		850	244	55	22,54	0,29	
		850	264	39	14,77	0,31	
		850	185	36	19,46	0,22	
		880	272	139	51,10	0,31	
		850	224	33	14,73	0,26	
		880	242	54	22,31	0,28	
	Mean	1002,65	272,68	61,56	22,58	0,272	
	Stdev	140,11	43,72	31,97	9,29	0,03	

1773		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	307	63	20,52	0,27	0,17
		1100	300	52	17,33	0,27	
		1150	264	48	18,18	0,23	
		1150	262	79	30,15	0,23	
		1150	277	29	10,47	0,24	
		1150	211	28	13,27	0,18	
		1150	297	14	4,71	0,26	
		1150	308	47	15,26	0,27	
		1150	323	100	30,96	0,28	
		1150	238	20	8,40	0,21	
		1200	331	17	5,14	0,28	
		1150	285	42	14,74	0,25	
		1100	343	163	47,52	0,31	
		1150	329	129	39,21	0,29	
		1150	303	1	0,33	0,26	
		1150	347	44	12,68	0,30	
		1100	322	79	24,53	0,29	
		1150	372	104	27,96	0,32	
		850	247	33	13,36	0,29	
		880	205	40	19,51	0,23	
		850	224	30	13,39	0,26	
		880	266	31	11,65	0,30	
		850	230	11	4,78	0,27	
		850	249	55	22,09	0,29	
		850	280	32	11,43	0,33	
		850	212	9	4,25	0,25	
		850	250	5	2,00	0,29	
		850	262	3	1,15	0,31	
	<i>Mean</i>	1041,43	280,14	46,71	16,68	0,269	
	<i>Stdev</i>	139,61	44,22	38,56	11,31	0,03	

1774		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	366	10	2,73	0,32	-0,10
		1150	294	22	7,48	0,26	
		1150	239	21	8,79	0,21	
		1150	301	16	5,32	0,26	
		1150	249	2	0,80	0,22	
		1150	306	8	2,61	0,27	
		1150	299	1	0,33	0,26	
		1150	231	9	3,90	0,20	
		1150	312	9	2,88	0,27	
		1150	353	20	5,67	0,31	
		1150	298	11	3,69	0,26	
		1150	337	22	6,53	0,29	
		1100	338	4	1,18	0,31	
		1200	259	5	1,93	0,22	
		1150	303	7	2,31	0,26	
		850	218	12	5,50	0,26	
		850	211	28	13,27	0,25	
		880	262	15	5,73	0,30	
		880	237	38	16,03	0,27	
		880	245	8	3,27	0,28	
		880	188	2	1,06	0,21	
		850	188	22	11,70	0,22	
		850	249	4	1,61	0,29	
		850	230	2	0,87	0,27	
		850	262	13	4,96	0,31	
		850	259	8	3,09	0,30	
		600	202	10	4,95	0,34	
	Mean	1011,85	268,00	12,19	4,55	0,265	
	Stdev	162,60	48,58	8,82	3,83	0,04	

1775		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	317	2	0,63	0,28	0,12
		1150	303	6	1,98	0,26	
		1150	303	1	0,33	0,26	
		1150	316	3	0,95	0,27	
		1150	272	12	4,41	0,24	
		1150	342	6	1,75	0,30	
		1150	234	0	0,00	0,20	
		1150	301	17	5,65	0,26	
		1150	286	6	2,10	0,25	
		1150	342	3	0,88	0,30	
		1150	290	0	0,00	0,25	
		1150	326	4	1,23	0,28	
		1100	309	2	0,65	0,28	
		1150	274	30	10,95	0,24	
		1100	309	47	15,21	0,28	
		850	251	42	16,73	0,30	
		850	247	5	2,02	0,29	
		850	198	7	3,54	0,23	
		880	258	3	1,16	0,29	
		850	249	12	4,82	0,29	
		850	278	9	3,24	0,33	
		880	180	2	1,11	0,20	
		850	230	0	0,00	0,27	
		880	232	10	4,31	0,26	
		850	230	12	5,22	0,27	
		850	271	15	5,54	0,32	
		850	262	3	1,15	0,31	
	Mean	1016,30	274,44	9,59	3,50	0,270	
	Stdev	142,86	40,82	11,80	4,26	0,03	

1776		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	293	11	3,75	0,25	0,14
		1150	293	6	2,05	0,25	
		1150	245	34	13,88	0,21	
		1150	284	9	3,17	0,25	
		1150	307	5	1,63	0,27	
		1150	310	3	0,97	0,27	
		1150	300	0	0,00	0,26	
		1100	231	11	4,76	0,21	
		1150	286	0	0,00	0,25	
		1150	348	3	0,86	0,30	
		1150	331	4	1,21	0,29	
		1150	300	11	3,67	0,26	
		1100	275	7	2,55	0,25	
		1150	209	4	1,91	0,18	
		1150	219	0	0,00	0,19	
		850	219	5	2,28	0,26	
		850	222	10	4,50	0,26	
		850	224	5	2,23	0,26	
		880	126	0	0,00	0,14	
		850	217	10	4,61	0,26	
		850	186	4	2,15	0,22	
		880	268	40	14,93	0,30	
		850	253	4	1,58	0,30	
		850	217	2	0,92	0,26	
		850	214	1	0,47	0,25	
		850	246	2	0,81	0,29	
		850	195	5	2,56	0,23	
		850	155	0	0,00	0,18	
	Mean	1009,29	249,04	7,00	2,81	0,247	
	Stdev	144,71	51,95	9,07	3,53	0,04	

1777	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	270	5	1,85	0,23	0,22	
	1150	296	6	2,03	0,26		
	1150	215	1	0,47	0,19		
	1150	291	3	1,03	0,25		
	1150	287	2	0,70	0,25		
	1150	301	12	3,99	0,26		
	1150	263	2	0,76	0,23		
	1100	227	1	0,44	0,21		
	1150	302	0	0,00	0,26		
	1150	294	3	1,02	0,26		
	1150	292	8	2,74	0,25		
	1150	273	8	2,93	0,24		
	1150	287	4	1,39	0,25		
	1150	192	2	1,04	0,17		
	1150	206	0	0,00	0,18		
	850	182	0	0,00	0,21		
	850	241	8	3,32	0,28		
	850	257	5	1,95	0,30		
	850	236	1	0,42	0,28		
	880	188	2	1,06	0,21		
	850	233	3	1,29	0,27		
	850	174	4	2,30	0,20		
	850	205	25	12,20	0,24		
	850	154	0	0,00	0,18		
	Mean	1036,67	244,42	4,38	1,79	0,236	
	Stdev	142,47	45,21	5,27	2,43	0,03	

1778	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	191	2	1,05	0,17	0,06	
	1150	304	7	2,30	0,26		
	1150	237	4	1,69	0,21		
	1150	289	8	2,77	0,25		
	1150	310	8	2,58	0,27		
	1200	297	15	5,05	0,25		
	1150	299	12	4,01	0,26		
	1150	304	3	0,99	0,26		
	1150	270	12	4,44	0,23		
	850	203	15	7,39	0,24		
	850	217	11	5,07	0,26		
	850	195	8	4,10	0,23		
	850	185	16	8,65	0,22		
	880	212	0	0,00	0,24		
	850	177	11	6,21	0,21		
	850	210	43	20,48	0,25		
	Mean	1023,75	243,75	10,94	4,49	0,238	
	Stdev	150,08	48,68	9,49	4,66	0,03	

1779		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	206	4	1,94	0,18	0,08
		1150	230	5	2,17	0,20	
		1150	167	3	1,80	0,15	
		1150	197	2	1,02	0,17	
		1150	183	4	2,19	0,16	
		1150	205	1	0,49	0,18	
		1150	294	2	0,68	0,26	
		1100	203	18	8,87	0,18	
		1150	314	9	2,87	0,27	
		1150	255	4	1,57	0,22	
		1150	209	9	4,31	0,18	
		1150	300	1	0,33	0,26	
		1150	233	1	0,43	0,20	
		1150	279	13	4,66	0,24	
		1150	279	9	3,23	0,24	
		1150	268	11	4,10	0,23	
		1150	259	8	3,09	0,23	
		1150	135	3	2,22	0,12	
		850	199	21	10,55	0,23	
		850	207	3	1,45	0,24	
		850	131	2	1,53	0,15	
		850	182	5	2,75	0,21	
		880	208	21	10,10	0,24	
		850	230	19	8,26	0,27	
		850	224	5	2,23	0,26	
		880	216	23	10,65	0,25	
		850	216	6	2,78	0,25	
		850	201	0	0,00	0,24	
		880	179	3	1,68	0,20	
		850	152	18	11,84	0,18	
		850	225	2	0,89	0,26	
		850	141	7	4,96	0,17	
	Mean	1020,00	216,47	7,56	3,49	0,212	
	Stdev	144,74	46,29	6,73	3,35	0,04	

1780	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	154	2	1,30	0,13	0,08	
	1150	128	1	0,78	0,11		
	1150	298	48	16,11	0,26		
	1150	291	66	22,68	0,25		
	1150	312	9	2,88	0,27		
	1150	318	4	1,26	0,28		
	1150	280	18	6,43	0,24		
	1150	315	4	1,27	0,27		
	1150	270	2	0,74	0,23		
	1150	284	1	0,35	0,25		
	850	191	11	5,76	0,22		
	880	158	22	13,92	0,18		
	880	194	24	12,37	0,22		
	850	248	19	7,66	0,29		
	880	204	3	1,47	0,23		
	850	200	5	2,50	0,24		
	800	65	1	1,54	0,08		
	850	311	7	2,25	0,37		
	850	188	3	1,60	0,22		
	850	210	4	1,90	0,25		
	600	60	4	6,67	0,10		
	<i>Mean</i>	<i>982,86</i>	<i>222,81</i>	<i>12,29</i>	<i>5,51</i>	<i>0,227</i>	
	<i>Stdev</i>	<i>168,61</i>	<i>77,74</i>	<i>16,34</i>	<i>5,95</i>	<i>0,07</i>	

In **1781** no ships left the Republic because of the fourth Anglo-Dutch war.

1782	All ships						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	249	108	43,37	0,22	-0,05	
	1150	301	172	57,14	0,26		
	1150	291	138	47,42	0,25		
	1150	302	110	36,42	0,26		
	1150	253	73	28,85	0,22		
	1150	317	127	40,06	0,28		
	850	289	142	49,13	0,34		
	880	277	51	18,41	0,31		
	<i>Mean</i>	<i>1078,75</i>	<i>284,88</i>	<i>115,13</i>	<i>40,41</i>	<i>0,26</i>	
	<i>Stdev</i>	<i>123,64</i>	<i>22,37</i>	<i>36,37</i>	<i>11,44</i>	<i>0,04</i>	

1783		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	124	1	0,81	0,11	0,11
		1150	129	1	0,78	0,11	
		1150	296	3	1,01	0,26	
		1150	197	11	5,58	0,17	
		1150	282	19	6,74	0,25	
		1150	313	5	1,60	0,27	
		1150	335	9	2,69	0,29	
		1150	326	10	3,07	0,28	
		1150	312	1	0,32	0,27	
		1150	358	6	1,68	0,31	
		1150	326	7	2,15	0,28	
		1150	319	28	8,78	0,28	
		1150	335	9	2,69	0,29	
		1150	361	1	0,28	0,31	
		1150	255	3	1,18	0,22	
		850	114	7	6,14	0,13	
		846	42	0	0,00	0,05	
		880	287	5	1,74	0,33	
		850	259	5	1,93	0,30	
		850	279	14	5,02	0,33	
		850	266	1	0,38	0,31	
		880	285	1	0,35	0,32	
		880	215	3	1,40	0,24	
		880	253	11	4,35	0,29	
		592	252	5	1,98	0,43	
		760	30	0	0,00	0,04	
	Mean	1014,15	251,92	6,38	2,53	0,248	
	Stdev	167,29	90,75	6,36	2,28	0,09	

1784		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	331	13	3,93	0,29	0,13
		1150	345	4	1,16	0,30	
		1150	341	29	8,50	0,30	
		1150	303	9	2,97	0,26	
		1150	343	1	0,29	0,30	
		1150	350	5	1,43	0,30	
		1150	333	8	2,40	0,29	
		1150	350	6	1,71	0,30	
		1150	309	5	1,62	0,27	
		884	347	32	9,22	0,39	
		892	65	4	6,15	0,07	
		880	259	1	0,39	0,29	
		898	377	6	1,59	0,42	
		880	268	0	0,00	0,30	
		850	201	3	1,49	0,24	
		880	228	2	0,88	0,26	
		880	270	2	0,74	0,31	
		650	158	3	1,90	0,24	
		348	111	1	0,90	0,32	
		508	239	3	1,26	0,47	
		790	40	1	2,50	0,05	
		574	254	20	7,87	0,44	
		656	255	18	7,06	0,39	
		600	156	7	4,49	0,26	
		650	130	2	1,54	0,20	
		175	33	1	3,03	0,19	
		550	166	4	2,41	0,30	
		723	175	2	1,14	0,24	
		400	128	1	0,78	0,32	
	<i>Mean</i>	828,21	236,72	6,66	2,81	0,286	
	<i>Stdev</i>	275,32	100,68	8,07	2,54	0,09	

1785		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	355	20	5,63	0,31	0,29
		1150	298	10	3,36	0,26	
		1150	347	28	8,07	0,30	
		1150	316	0	0,00	0,27	
		1150	390	5	1,28	0,34	
		1150	340	5	1,47	0,30	
		846	36	0	0,00	0,04	
		898	320	9	2,81	0,36	
		880	234	1	0,43	0,27	
		850	244	5	2,05	0,29	
		880	270	5	1,85	0,31	
		900	166	1	0,60	0,18	
		880	272	0	0,00	0,31	
		880	248	6	2,42	0,28	
		440	57	1	1,75	0,13	
		708	257	1	0,39	0,36	
		564	54	0	0,00	0,10	
		582	155	2	1,29	0,27	
		780	190	15	7,89	0,24	
		400	110	0	0,00	0,28	
		748	311	14	4,50	0,42	
	<i>Mean</i>	863,62	236,67	6,10	2,58	0,274	
	<i>Stdev</i>	229,31	102,74	7,40	2,40	0,09	

1786		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	354	34	9,60	0,31	-0,14
		1150	317	4	1,26	0,28	
		1150	178	2	1,12	0,15	
		1150	350	3	0,86	0,30	
		1150	350	5	1,43	0,30	
		1150	345	9	2,61	0,30	
		1150	360	15	4,17	0,31	
		1150	350	4	1,14	0,30	
		1300	384	6	1,56	0,30	
		1150	361	5	1,39	0,31	
		1150	362	11	3,04	0,31	
		880	273	36	13,19	0,31	
		908	353	9	2,55	0,39	
		884	312	25	8,01	0,35	
		880	269	9	3,35	0,31	
		758	104	1	0,96	0,14	
		348	30	1	3,33	0,09	
		592	233	21	9,01	0,39	
		600	78	0	0,00	0,13	
		690	258	7	2,71	0,37	
		651	298	4	1,34	0,46	
		650	34	6	17,65	0,05	
		400	77	0	0,00	0,19	
		723	252	1	0,40	0,35	
		678	171	7	4,09	0,25	
		490	199	5	2,51	0,41	
	<i>Mean</i>	<i>882,00</i>	<i>255,85</i>	<i>8,85</i>	<i>3,46</i>	<i>0,290</i>	
	<i>Stdev</i>	<i>274,19</i>	<i>110,29</i>	<i>9,57</i>	<i>4,23</i>	<i>0,10</i>	

1787		All ships (exclusive of packetboats)					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	331	49	14,80	0,29	0,14
		1150	421	23	5,46	0,37	
		1150	342	22	6,43	0,30	
		1150	335	38	11,34	0,29	
		1150	272	11	4,04	0,24	
		1150	332	11	3,31	0,29	
		1150	369	4	1,08	0,32	
		1090	328	17	5,18	0,30	
		1150	345	15	4,35	0,30	
		1150	359	10	2,79	0,31	
		1150	371	14	3,77	0,32	
		850	288	4	1,39	0,34	
		850	254	4	1,57	0,30	
		898	104	10	9,62	0,12	
		880	227	3	1,32	0,26	
		880	223	4	1,79	0,25	
		846	352	32	9,09	0,42	
		880	265	37	13,96	0,30	
		828	196	34	17,35	0,24	
		800	178	3	1,69	0,22	
		846	40	4	10,00	0,05	
		880	270	3	1,11	0,31	
		880	274	11	4,01	0,31	
		686	188	6	3,19	0,27	
		460	161	4	2,48	0,35	
		502	33	0	0,00	0,07	
		600	121	4	3,31	0,20	
		678	221	17	7,69	0,33	
		574	199	8	4,02	0,35	
		660	247	76	30,77	0,37	
		590	205	3	1,46	0,35	
		660	150	1	0,67	0,23	
		175	32	0	0,00	0,18	
	Mean	863,42	243,42	14,61	6,00	0,282	
	Stdev	247,73	101,41	16,47	6,24	0,08	

1788	All ships (exclusive of packetboats)						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	310	17	5,48	0,27	0,10	
	1150	341	4	1,17	0,30		
	1150	350	71	20,29	0,30		
	1150	260	2	0,77	0,23		
	1150	359	1	0,28	0,31		
	1150	360	53	14,72	0,31		
	1150	347	24	6,92	0,30		
	1150	337	6	1,78	0,29		
	1150	356	21	5,90	0,31		
	1150	192	15	7,81	0,17		
	1150	344	11	3,20	0,30		
	1150	289	2	0,69	0,25		
	1150	317	7	2,21	0,28		
	1150	319	3	0,94	0,28		
	1150	289	30	10,38	0,25		
	880	259	6	2,32	0,29		
	880	237	2	0,84	0,27		
	900	207	19	9,18	0,23		
	894	316	1	0,32	0,35		
	880	269	5	1,86	0,31		
	880	288	4	1,39	0,33		
	708	187	1	0,53	0,26		
	651	243	4	1,65	0,37		
	582	128	1	0,78	0,22		
	648	30	0	0,00	0,05		
	592	196	17	8,67	0,33		
	<i>Mean</i>	<i>990,19</i>	<i>274,23</i>	<i>12,58</i>	<i>4,59</i>	<i>0,277</i>	
	<i>Stdev</i>	<i>204,37</i>	<i>78,91</i>	<i>16,59</i>	<i>4,96</i>	<i>0,06</i>	

1789	All ships (exclusive of packetboats)						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	283	4	1,41	0,25	-0,80	
	1150	336	3	0,89	0,29		
	1150	328	1	0,30	0,29		
	1150	315	9	2,86	0,27		
	1150	275	6	2,18	0,24		
	1150	347	4	1,15	0,30		
	1150	311	7	2,25	0,27		
	1150	331	2	0,60	0,29		
	1300	279	21	7,53	0,21		
	1150	324	2	0,62	0,28		
	1150	300	3	1,00	0,26		
	880	276	5	1,81	0,31		
	898	319	22	6,90	0,36		
	880	258	3	1,16	0,29		
	900	304	12	3,95	0,34		
	678	137	13	9,49	0,20		
	650	31	8	25,81	0,05		
	600	181	1	0,55	0,30		
	560	117	5	4,27	0,21		
	Mean	991,89	265,89	6,89	2,59	0,268	
	Stdev	222,75	84,21	6,00	5,75	0,06	

1790	All ships (exclusive of packetboats)						
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	
	1150	348	13	3,74	0,30	0,25	
	1150	358	53	14,80	0,31		
	1150	363	23	6,34	0,32		
	1150	305	13	4,26	0,27		
	1150	259	4	1,54	0,23		
	1150	321	7	2,18	0,28		
	1150	284	2	17,00	0,25		
	1150	304	52	17,11	0,26		
	1150	193	5	2,59	0,17		
	1150	322	8	2,48	0,28		
	1150	350	4	1,14	0,30		
	1150	310	33	10,65	0,27		
	1150	332	16	4,82	0,29		
	1150	359	3	0,84	0,31		
	1150	186	3	1,61	0,16		
	1150	243	15	6,17	0,21		
	1150	238	1	0,42	0,21		
	880	257	3	1,17	0,29		
	880	253	36	14,23	0,29		
	898	121	3	2,48	0,13		
	880	160	5	3,13	0,18		
	Mean	1099,43	279,33	14,38	5,15	0,254	
	Stdev	104,31	68,28	15,64	5,44	0,05	

1791		All ships (exclusive of packetboats)					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	357	1	0,28	0,31	-0,01
		1150	266	36	13,53	0,23	
		1150	300	12	4,00	0,26	
		1150	305	9	2,95	0,27	
		1150	213	4	1,88	0,19	
		1150	236	1	0,42	0,21	
		1150	240	17	17,00	0,21	
		1150	240	16	6,67	0,21	
		1150	348	54	15,52	0,30	
		1150	371	79	21,29	0,32	
		880	204	0	0,00	0,23	
		880	175	0	0,00	0,20	
		828	338	4	1,18	0,41	
		880	136	10	7,35	0,15	
		880	198	8	4,04	0,23	
		880	207	6	2,90	0,24	
		964	339	1	0,29	0,35	
		880	231	0	0,00	0,26	
		880	300	5	1,67	0,34	
		690	84	2	2,38	0,12	
		400	63	0	0,00	0,16	
		723	188	3	1,60	0,26	
		600	159	4	2,52	0,27	
		490	217	3	1,38	0,44	
	Mean	931,46	238,13	11,46	4,81	0,256	
	Stdev	223,31	81,50	18,67	5,93	0,08	

1792		All ships (exclusive of packetboats)				Man/Ton	Corr.
		Tonnage	Crew	Dead	Mortality		
		1150	297	7	2,36	0,26	-0,02
		1150	402	3	0,75	0,35	
		1150	308	6	1,95	0,27	
		1150	360	6	1,67	0,31	
		1150	347	1	0,29	0,30	
		1150	349	7	2,01	0,30	
		1150	372	7	1,88	0,32	
		1150	380	24	6,32	0,33	
		1150	371	14	3,77	0,32	
		1150	387	9	2,33	0,34	
		800	308	5	1,62	0,39	
		880	179	4	2,23	0,20	
		880	267	4	1,50	0,30	
		880	308	4	1,30	0,35	
	Mean	1067,14	331,07	7,21	2,18	0,310	
	Stdev	132,31	56,83	5,52	1,40	0,04	

1793		All ships (exclusive of packetboats)					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	301	2	0,66	0,26	0,10
		1150	375	3	0,80	0,33	
		1150	363	4	1,10	0,32	
		1150	294	16	5,44	0,26	
		1150	254	13	5,12	0,22	
		1150	215	3	1,40	0,19	
		1150	283	1	0,35	0,25	
		1150	200	4	2,00	0,17	
		1150	193	6	3,11	0,17	
		1150	243	7	2,88	0,21	
		900	226	32	14,16	0,25	
		880	231	16	6,93	0,26	
		880	279	18	6,45	0,32	
		900	50	0	0,00	0,06	
		880	210	6	2,86	0,24	
		880	261	9	3,45	0,30	
		560	200	0	0,00	0,36	
	<i>Mean</i>	1022,35	245,76	8,24	3,35	0,240	
	<i>Stdev</i>	169,38	71,44	8,16	3,46	0,07	

1794		All ships					
		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
		1150	224	6	2,68	0,19	-1,00
		900	210	3	1,43	0,23	
	<i>Mean</i>	1025,00	217,00	4,50	2,07	0,212	
	<i>Stdev</i>	125,00	7,00	1.50	0.63	0.02	

APPENDIX C

This appendix contains the crew-numbers of the ships of the first and second charter, showing the sustained decrease in those numbers after the 1771/72 outbreak of rotkoorts. This decrease was at first the outcome of the experiments with a smaller crew, but the decrease continued after the experiments had been ended.

1761	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	211	12	5,69	0,18	-0,01		850	273	6	2,20	0,32	-0,19
	1150	271	10	3,69	0,24			875	252	5	1,98	0,29	
	1150	337	4	1,19	0,29			850	259	1	0,39	0,30	
	1150	352	37	10,51	0,31			850	250	14	5,60	0,29	
	1150	331	32	9,67	0,29			850	271	9	3,32	0,32	
	1150	336	11	3,27	0,29			850	242	36	14,88	0,28	
	1150	363	6	1,65	0,32			880	248	13	5,24	0,28	
	1150	286	41	14,34	0,25			850	204	1	0,49	0,24	
	1150	347	7	2,02	0,30			850	298	3	1,01	0,35	
	1150	354	11	3,11	0,31			880	224	5	2,23	0,25	
	1150	350	6	1,71	0,30			880	238	6	2,52	0,27	
	1150	301	6	1,99	0,26			850	301	3	1,00	0,35	
	1150	324	29	8,95	0,28			850	267	4	1,50	0,31	
	1100	345	11	3,19	0,31			880	268	8	2,99	0,30	
	1100	350	48	13,71	0,32			850	269	6	2,23	0,32	
	1150	359	11	3,06	0,31			880	286	8	2,80	0,33	
	1150	338	20	5,92	0,29								
	1100	309	14	4,53	0,28								
	1150	340	70	20,59	0,30								
	1100	318	113	35,53	0,29								
	1100	346	13	3,76	0,31								
	1150	345	57	16,52	0,30								
Mean	1138,64	327,86	25,86	7,89	0,29		Mean	860,94	259,38	8,00	3,08	0,30	
Stdev	20,95	34,36	26,19	8,04	0,03		Stdev	14,17	24,78	8,06	3,35	0,03	

1762	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	363	5	1,38	0,32	0,14		880	271	5	1,85	0,31	-0,09
	1100	350	24	6,86	0,32			880	237	7	2,95	0,27	
	1150	207	2	0,97	0,18			880	255	4	1,57	0,29	
	1150	306	7	2,29	0,27			850	234	18	7,69	0,28	
	1150	348	8	2,30	0,30			880	227	1	0,44	0,26	
	1150	348	4	1,15	0,30			880	242	0	0,00	0,28	
	1150	344	44	12,79	0,30			850	284	7	2,46	0,33	
	1150	269	13	4,83	0,23			850	279	12	4,30	0,33	
	1150	351	43	12,25	0,31			880	253	18	7,11	0,29	
	1100	355	15	4,23	0,32			880	271	3	1,11	0,31	
	1150	351	73	20,80	0,31			880	294	2	0,68	0,33	
	1150	273	41	15,02	0,24								
	1150	327	6	1,83	0,28								
Mean	1142,31	322,46	21,92	6,80	0,28		Mean	871,82	258,82	7,00	2,70	0,30	
Stdev	18,04	44,54	20,96	6,20	0,04		Stdev	13,36	21,34	6,08	2,49	0,03	

1763	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	303	2	0,66	0,26	0,24		850	307	6	1,95	0,36	0,30
	1150	297	77	25,93	0,26			850	290	5	1,72	0,34	
	1150	318	9	2,83	0,28			880	181	3	1,66	0,21	
	1150	390	56	14,36	0,34			880	247	11	4,45	0,28	
	1150	399	70	17,54	0,35			875	296	3	1,01	0,34	
	1150	299	13	4,35	0,26			880	227	18	7,93	0,26	
	1100	399	39	9,77	0,36			850	308	17	5,52	0,36	
	1100	302	7	2,32	0,27			880	297	14	4,71	0,34	
	1150	351	3	0,85	0,31			850	300	14	4,67	0,35	
	1150	308	16	5,19	0,27			850	293	7	2,39	0,34	
	1150	356	25	7,02	0,31			880	267	1	0,37	0,30	
	1150	354	8	2,26	0,31			850	312	45	14,42	0,37	
	1150	336	5	1,49	0,29			850	189	0	0,00	0,22	
	1150	350	30	8,57	0,30			850	260	9	3,46	0,31	
	1150	338	18	5,33	0,29			880	259	2	0,77	0,29	
								880	273	26	9,52	0,31	
Mean	1143,33	340,00	25,20	7,41	0,30		Mean	864,69	269,13	11,31	4,20	0,31	
Stdev	17,00	34,65	23,76	6,91	0,03		Stdev	14,73	39,45	11,16	3,74	0,05	

1764	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	295	5	1,69	0,26	-0,17		880	258	18	6,98	0,29	-0,20
	1150	353	7	1,98	0,31			850	223	3	1,35	0,26	
	1150	350	17	4,86	0,30			880	301	49	16,28	0,34	
	1150	304	15	4,93	0,26			880	292	47	16,10	0,33	
	1150	328	12	3,66	0,29			880	191	51	26,70	0,22	
	1150	318	43	13,52	0,28			880	234	20	8,55	0,27	
	1150	320	77	24,06	0,28			880	276	45	16,30	0,31	
	1150	325	16	4,92	0,28			880	238	8	3,36	0,27	
	1150	356	22	6,18	0,31			880	304	2	0,66	0,35	
	1100	340	27	7,94	0,31			850	259	5	1,93	0,30	
	1100	348	5	1,44	0,32			880	269	13	4,83	0,31	
	1150	350	33	9,43	0,30			880	294	5	1,70	0,33	
	1150	351	12	3,42	0,31			850	288	48	16,67	0,34	
	1150	366	8	2,19	0,32								
	1100	354	44	12,43	0,32								
	1150	357	2	0,56	0,31								
	1150	339	54	15,93	0,29								
	1150	341	58	17,01	0,30								
Mean	1141,67	338,61	25,39	7,50	0,30		Mean	873,08	263,62	24,15	9,16	0,30	
Stdev	18,63	19,02	20,97	6,37	0,02		Stdev	12,64	32,87	19,56	7,90	0,04	

1765	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	349	3	0,86	0,30	0,28		850	276	13	4,71	0,32	0,37
	1100	325	22	6,77	0,30			880	236	4	1,69	0,27	
	1150	326	39	11,96	0,28			880	244	8	3,28	0,28	
	1150	331	27	8,16	0,29			880	247	2	0,81	0,28	
	1150	326	12	3,68	0,28			880	235	3	1,28	0,27	
	1150	310	12	3,87	0,27			880	259	32	12,36	0,29	
	1150	356	11	3,09	0,31			880	297	3	1,01	0,34	
	1150	350	33	9,43	0,30			880	244	7	2,87	0,28	
	1150	365	20	5,48	0,32			880	297	35	11,78	0,34	
	1150	348	54	15,52	0,30			880	263	0	0,00	0,30	
	1150	357	63	17,65	0,31			880	242	10	4,13	0,28	
	1150	331	5	1,51	0,29			850	254	13	5,12	0,30	
	1150	353	3	0,85	0,31								
	1150	267	5	1,87	0,23								
Mean	1146,43	335,29	22,07	6,58	0,29		Mean	875,00	257,83	10,83	4,20	0,29	
Stdev	12,88	24,32	18,45	5,24	0,02		Stdev	11,18	20,80	10,92	3,89	0,02	

1766	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1100	307	13	4,23	0,28	0,13		880	238	2	0,84	0,27	-0,26
	1150	300	24	8,00	0,26			850	290	10	3,45	0,34	
	1150	308	9	2,92	0,27			880	239	5	2,09	0,27	
	1150	304	28	9,21	0,26			880	227	5	2,20	0,26	
	1150	320	3	0,94	0,28			850	211	8	3,79	0,25	
	1100	357	24	6,72	0,32			850	256	16	6,25	0,30	
	1150	354	4	1,13	0,31			880	252	2	0,79	0,29	
	1150	354	1	0,28	0,31			880	193	19	9,84	0,22	
	1150	363	63	17,36	0,32			880	242	6	2,48	0,28	
	1150	343	18	5,25	0,30			875	262	2	0,76	0,30	
	1150	366	27	7,38	0,32			880	246	6	2,44	0,28	
	1150	345	7	2,03	0,30			880	299	3	1,00	0,34	
								880	351	1	0,28	0,40	
								850	293	3	1,02	0,34	
								880	266	5	1,88	0,30	
								880	269	25	9,29	0,31	
								880	244	2	0,82	0,28	
								880	268	2	0,75	0,30	
								880	187	1	0,53	0,21	
Mean	1141,67	335,08	18,42	5,50	0,29		Mean	873,42	254,37	6,47	2,55	0,29	
Stdev	18,63	24,22	16,36	4,59	0,02		Stdev	12,15	37,32	6,48	2,76	0,04	

1767	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	383	73	19,06	0,33	-0,22		850	173	6	3,47	0,20	0,09
	1150	260	47	18,08	0,23			880	286	14	4,90	0,33	
	1150	311	67	21,54	0,27			880	251	1	0,40	0,29	
	1150	309	1	0,32	0,27			880	197	11	5,58	0,22	
	1150	299	7	2,34	0,26			880	270	8	2,96	0,31	
	1150	304	27	8,88	0,26			880	184	5	2,72	0,21	
	1150	368	26	7,07	0,32			880	198	18	9,09	0,23	
	1150	358	11	3,07	0,31			880	237	12	5,06	0,27	
	1150	370	18	4,86	0,32			880	259	26	10,04	0,29	
	1150	364	10	2,75	0,32			880	278	6	2,16	0,32	
	1150	364	9	2,47	0,32			850	277	4	1,44	0,33	
	1100	349	3	0,86	0,32			850	285	37	12,98	0,34	
	1150	361	32	8,86	0,31			850	280	8	2,86	0,33	
	1100	341	6	1,76	0,31			850	262	22	8,40	0,31	
	1150	354	28	7,91	0,31			880	263	20	7,60	0,30	
	1150	348	18	5,17	0,30			880	262	15	5,73	0,30	
	1100	255	14	5,49	0,23								
Mean	1141,18	335,18	23,35	6,97	0,29		Mean	870,63	247,63	13,31	5,38	0,28	
Stdev	19,06	37,42	20,59	6,34	0,03		Stdev	13,91	36,87	9,17	3,37	0,04	

1768	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	306	4	1,31	0,27	0,63		880	246	2	0,81	0,28	0,20
	1100	316	14	4,43	0,29			880	259	6	2,32	0,29	
	1150	379	51	13,46	0,33			880	233	1	0,43	0,26	
	1150	359	34	9,47	0,31			880	191	4	2,09	0,22	
	1150	360	27	7,50	0,31			880	202	4	1,98	0,23	
	1100	354	22	6,21	0,32			880	226	31	13,72	0,26	
	1100	352	56	15,91	0,32			850	226	14	6,19	0,27	
	1150	352	77	21,88	0,31			880	290	33	11,38	0,33	
	1150	354	34	9,60	0,31			850	297	20	6,73	0,35	
	1100	235	9	3,83	0,21			880	262	67	25,57	0,30	
	1150	367	44	11,99	0,32			850	266	27	10,15	0,31	
	1100	265	5	1,89	0,24			880	360	16	4,44	0,41	
	1100	285	19	6,67	0,26			880	292	12	4,11	0,33	
								850	283	34	12,01	0,33	
								880	277	57	20,58	0,31	
Mean	1126,92	329,54	30,46	9,24	0,29		Mean	872,00	260,67	21,87	8,39	0,30	
Stdev	24,93	42,68	21,02	5,65	0,03		Stdev	13,27	41,24	19,27	7,19	0,05	

1769	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1100	307	1	0,33	0,28	0,18		850	227	3	1,32	0,27	0,43
	1150	304	2	0,66	0,26			880	259	27	10,42	0,29	
	1150	274	17	6,20	0,24			880	190	5	2,63	0,22	
	1150	264	25	9,47	0,23			880	233	5	2,15	0,26	
	1150	355	40	11,27	0,31			880	254	12	4,72	0,29	
	1150	356	35	9,83	0,31			880	203	3	1,48	0,23	
	1150	351	32	9,12	0,31			880	281	15	5,34	0,32	
	1150	355	19	5,35	0,31			850	290	29	10,00	0,34	
	1150	355	15	4,23	0,31			880	273	10	3,66	0,31	
	1150	308	48	15,58	0,27			850	265	13	4,91	0,31	
	1100	356	38	10,67	0,32			850	273	1	0,37	0,32	
	1150	371	43	11,59	0,32			850	306	7	2,29	0,36	
	1150	360	27	7,50	0,31			880	192	4	2,08	0,22	
								850	281	24	8,54	0,33	
Mean	1142,31	332,00	26,31	7,92	0,29		Mean	867,14	251,93	11,29	4,48	0,29	
Stdev	18,04	34,39	14,37	4,23	0,03		Stdev	14,85	35,83	9,00	3,15	0,04	

1770	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	346	14	4,05	0,30	0,25		880	313	9	2,88	0,36	-0,17
	1150	349	6	1,72	0,30			880	237	33	13,92	0,27	
	1150	323	7	2,17	0,28			880	252	13	5,16	0,29	
	1150	331	46	13,90	0,29			880	305	31	10,16	0,35	
	1150	269	45	16,73	0,23			850	286	7	2,45	0,34	
	1150	361	140	38,78	0,31			880	306	9	2,94	0,35	
	1150	360	146	40,56	0,31			850	283	21	7,42	0,33	
	1150	357	57	15,97	0,31			850	290	51	17,59	0,34	
	1150	240	41	17,08	0,21			880	296	52	17,57	0,34	
	1150	364	80	21,98	0,32			880	289	51	17,65	0,33	
	1100	378	80	21,16	0,34								
	1150	370	54	14,59	0,32								
	1150	361	168	46,54	0,31								
Mean	1146,15	339,15	68,00	20,05	0,30		Mean	871,00	285,70	27,70	9,70	0,33	
Stdev	13,32	39,23	51,21	13,84	0,04		Stdev	13,75	22,76	17,62	6,13	0,03	

1771	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	355	93	26,20	0,31	0,44		880	280	71	25,36	0,32	0,49
	1100	357	98	27,45	0,32			850	258	18	6,98	0,30	
	1100	366	121	33,06	0,33			850	257	109	42,41	0,30	
	1150	321	76	23,68	0,28			850	244	65	26,64	0,29	
	1150	304	120	39,47	0,26			880	252	116	46,03	0,29	
	1100	369	217	58,81	0,34			880	291	184	63,23	0,33	
	1150	337	99	29,38	0,29			880	268	90	33,58	0,30	
	1150	363	59	16,25	0,32			880	282	101	35,82	0,32	
	1150	365	79	21,64	0,32			880	193	7	3,63	0,22	
	1100	319	106	33,23	0,29			850	266	142	53,38	0,31	
	1150	363	131	36,09	0,32			850	223	19	8,52	0,26	
	1150	323	80	24,77	0,28			880	343	105	30,61	0,39	
	1150	337	40	11,87	0,29			850	276	90	32,61	0,32	
	1150	313	29	9,27	0,27								
	1100	328	48	14,63	0,30								
	1150	315	25	7,94	0,27								
Mean	1134,38	339,69	88,81	26,15	0,30		Mean	866,15	264,08	85,92	32,54	0,30	
Stdev	23,18	21,82	45,86	12,58	0,02		Stdev	14,96	34,04	48,68	17,12	0,04	

1772	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	325	72	22,15	0,28	0,21		880	283	19	6,71	0,32	0,04
	1100	339	83	24,48	0,31			880	224	42	18,75	0,25	
	1150	303	60	19,80	0,26			880	189	42	22,22	0,21	
	1100	211	52	24,64	0,19			850	239	30	12,55	0,28	
	1150	315	116	36,83	0,27			850	260	36	13,85	0,31	
	1150	288	47	16,32	0,25			850	226	28	12,39	0,27	
	1100	305	62	20,33	0,28			850	272	59	21,69	0,32	
	1150	297	100	33,67	0,26			880	225	36	16,00	0,26	
	1150	300	70	23,33	0,26			880	266	41	15,41	0,30	
	1150	298	86	28,86	0,26			850	235	17	7,23	0,28	
	1200	353	150	42,49	0,29			880	259	44	16,99	0,29	
	1150	299	65	21,74	0,26			850	244	55	22,54	0,29	
	1100	243	72	29,63	0,22			850	264	39	14,77	0,31	
	1150	323	101	31,27	0,28			850	185	36	19,46	0,22	
	1150	307	58	18,89	0,27			880	272	139	51,10	0,31	
	1150	355	107	30,14	0,31			850	224	33	14,73	0,26	
	1150	301	42	13,95	0,26			880	242	54	22,31	0,28	
Mean	1141,18	303,65	79,00	26,02	0,27		Mean	864,12	241,71	44,12	18,25	0,28	
Stdev	25,64	34,23	27,41	7,35	0,03		Stdev	14,97	27,08	26,16	9,47	0,03	

1773	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	307	63	20,52	0,27	0,43		850	247	33	13,36	0,29	-0,19
	1100	300	52	17,33	0,27			880	205	40	19,51	0,23	
	1150	264	48	18,18	0,23			850	224	30	13,39	0,26	
	1150	262	79	30,15	0,23			880	266	31	11,65	0,30	
	1150	277	29	10,47	0,24			850	230	11	4,78	0,27	
	1150	211	28	13,27	0,18			850	249	55	22,09	0,29	
	1150	297	14	4,71	0,26			850	280	32	11,43	0,33	
	1150	308	47	15,26	0,27			850	212	9	4,25	0,25	
	1150	323	100	30,96	0,28			850	250	5	2,00	0,29	
	1150	238	20	8,40	0,21			850	262	3	1,15	0,31	
	1200	331	17	5,14	0,28								
	1150	285	42	14,74	0,25								
	1100	343	163	47,52	0,31								
	1150	329	129	39,21	0,29								
	1150	303	1	0,33	0,26								
	1150	347	44	12,68	0,30								
	1100	322	79	24,53	0,29								
	1150	372	104	27,96	0,32								
Mean	1144,44	301,06	58,83	19,54	0,26		Mean	856,00	242,50	24,90	10,27	0,28	
Stdev	22,91	39,03	41,90	12,11	0,04		Stdev	12,00	23,01	16,23	6,82	0,03	

1774	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	366	10	2,73	0,32	-0,07		850	218	12	5,50	0,26	-0,26
	1150	294	22	7,48	0,26			850	211	28	13,27	0,25	
	1150	239	21	8,79	0,21			880	262	15	5,73	0,30	
	1150	301	16	5,32	0,26			880	237	38	16,03	0,27	
	1150	249	2	0,80	0,22			880	245	8	3,27	0,28	
	1150	306	8	2,61	0,27			880	188	2	1,06	0,21	
	1150	299	1	0,33	0,26			850	188	22	11,70	0,22	
	1150	231	9	3,90	0,20			850	249	4	1,61	0,29	
	1150	312	9	2,88	0,27			850	230	2	0,87	0,27	
	1150	353	20	5,67	0,31			850	262	13	4,96	0,31	
	1150	298	11	3,69	0,26			850	259	8	3,09	0,30	
	1150	337	22	6,53	0,29								
	1100	338	4	1,18	0,31								
	1200	259	5	1,93	0,22								
	1150	303	7	2,31	0,26								
Mean	1150,00	299,00	11,13	3,72	0,26		Mean	860,91	231,73	13,82	5,96	0,27	
Stdev	18,26	39,12	7,06	2,43	0,04		Stdev	14,43	26,15	10,88	4,98	0,03	

1775	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	317	2	0,63	0,28	-0,03		850	251	42	16,73	0,30	0,26
	1150	303	6	1,98	0,26			850	247	5	2,02	0,29	
	1150	303	1	0,33	0,26			850	198	7	3,54	0,23	
	1150	316	3	0,95	0,27			880	258	3	1,16	0,29	
	1150	272	12	4,41	0,24			850	249	12	4,82	0,29	
	1150	342	6	1,75	0,30			850	278	9	3,24	0,33	
	1150	234	0	0,00	0,20			880	180	2	1,11	0,20	
	1150	301	17	5,65	0,26			850	230	0	0,00	0,27	
	1150	286	6	2,10	0,25			880	232	10	4,31	0,26	
	1150	342	3	0,88	0,30			850	230	12	5,22	0,27	
	1150	290	0	0,00	0,25			850	271	15	5,54	0,32	
	1150	326	4	1,23	0,28			850	262	3	1,15	0,31	
	1100	309	2	0,65	0,28								
	1150	274	30	10,95	0,24								
	1100	309	47	15,21	0,28								
	Mean	1143,33	301,60	9,27	3,07	0,26		Mean	857,50	240,50	10,00	4,16	0,28
	Stdev	17,00	27,08	12,66	4,26	0,02		Stdev	12,99	27,52	10,62	4,20	0,03

1776	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	293	11	3,75	0,25	-0,31		850	219	5	2,28	0,26	0,49
	1150	293	6	2,05	0,25			850	222	10	4,50	0,26	
	1150	245	34	13,88	0,21			850	224	5	2,23	0,26	
	1150	284	9	3,17	0,25			880	126	0	0,00	0,14	
	1150	307	5	1,63	0,27			850	217	10	4,61	0,26	
	1150	310	3	0,97	0,27			850	186	4	2,15	0,22	
	1150	300	0	0,00	0,26			880	268	40	14,93	0,30	
	1100	231	11	4,76	0,21			850	253	4	1,58	0,30	
	1150	286	0	0,00	0,25			850	217	2	0,92	0,26	
	1150	348	3	0,86	0,30			850	214	1	0,47	0,25	
	1150	331	4	1,21	0,29			850	246	2	0,81	0,29	
	1150	300	11	3,67	0,26			850	195	5	2,56	0,23	
	1100	275	7	2,55	0,25			850	155	0	0,00	0,18	
	1150	209	4	1,91	0,18								
	1150	219	0	0,00	0,19								
	Mean	1143,33	282,07	7,20	2,55	0,25		Mean	854,62	210,92	6,77	3,21	0,25
	Stdev	17,00	38,64	8,09	3,31	0,03		Stdev	10,82	37,12	10,08	3,77	0,04

1777	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	270	5	1,85	0,23	0,44		850	182	0	0,00	0,21	0,12
	1150	296	6	2,03	0,26			850	241	8	3,32	0,28	
	1150	215	1	0,47	0,19			850	257	5	1,95	0,30	
	1150	291	3	1,03	0,25			850	236	1	0,42	0,28	
	1150	287	2	0,70	0,25			880	188	2	1,06	0,21	
	1150	301	12	3,99	0,26			850	233	3	1,29	0,27	
	1150	263	2	0,76	0,23			850	174	4	2,30	0,20	
	1100	227	1	0,44	0,21			850	205	25	12,20	0,24	
	1150	302	0	0,00	0,26			850	154	0	0,00	0,18	
	1150	294	3	1,02	0,26								
	1150	292	8	2,74	0,25								
	1150	273	8	2,93	0,24								
	1150	287	4	1,39	0,25								
	1150	192	2	1,04	0,17								
	1150	206	0	0,00	0,18								
	Mean	1146,67	266,40	3,80	1,43	0,23		Mean	853,33	207,78	5,33	2,57	0,24
	Stdev	12,47	36,20	3,31	1,11	0,03		Stdev	9,43	33,43	7,36	3,58	0,04

1778	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	191	2	1,05	0,17	0,34		850	203	15	7,39	0,24	0,19
	1150	304	7	2,30	0,26			850	217	11	5,07	0,26	
	1150	237	4	1,69	0,21			850	195	8	4,10	0,23	
	1150	289	8	2,77	0,25			850	185	16	8,65	0,22	
	1150	310	8	2,58	0,27			880	212	0	0,00	0,24	
	1200	297	15	5,05	0,25			850	177	11	6,21	0,21	
	1150	299	12	4,01	0,26			850	210	43	20,48	0,25	
	1150	304	3	0,99	0,26								
	1150	270	12	4,44	0,23								
	Mean	1155,56	277,89	7,89	2,84	0,24		Mean	854,29	199,86	14,86	7,43	0,23
	Stdev	15,71	37,44	4,20	1,38	0,03		Stdev	10,50	13,74	12,48	5,92	0,02

1779	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	206	4	1,94	0,18	0,00		850	199	21	10,55	0,23	-0,03
	1150	230	5	2,17	0,20			850	207	3	1,45	0,24	
	1150	167	3	1,80	0,15			850	131	2	1,53	0,15	
	1150	197	2	1,02	0,17			850	182	5	2,75	0,21	
	1150	183	4	2,19	0,16			880	208	21	10,10	0,24	
	1150	205	1	0,49	0,18			850	230	19	8,26	0,27	
	1150	294	2	0,68	0,26			850	224	5	2,23	0,26	
	1100	203	18	8,87	0,18			880	216	23	10,65	0,25	
	1150	314	9	2,87	0,27			850	216	6	2,78	0,25	
	1150	255	4	1,57	0,22			850	201	0	0,00	0,24	
	1150	209	9	4,31	0,18			880	179	3	1,68	0,20	
	1150	300	1	0,33	0,26			850	152	18	11,84	0,18	
	1150	233	1	0,43	0,20			850	225	2	0,89	0,26	
	1150	279	13	4,66	0,24			850	141	7	4,96	0,17	
	1150	279	9	3,23	0,24								
	1150	268	11	4,10	0,23								
	1150	259	8	3,09	0,23								
	1150	135	3	2,22	0,12								
	Mean	1147,22	234,22	5,94	2,54	0,20		Mean	856,43	193,64	9,64	4,98	0,23
	Stdev	11,45	48,37	4,64	2,01	0,04		Stdev	12,31	31,02	8,26	4,15	0,04

1780	Charter 1							Charter 2					
	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.		Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.
	1150	154	2	1,30	0,13	0,26		850	191	11	5,76	0,22	-0,09
	1150	128	1	0,78	0,11			880	158	22	13,92	0,18	
	1150	298	48	16,11	0,26			880	194	24	12,37	0,22	
	1150	291	66	22,68	0,25			850	248	19	7,66	0,29	
	1150	312	9	2,88	0,27			880	204	3	1,47	0,23	
	1150	318	4	1,26	0,28			850	200	5	2,50	0,24	
	1150	280	18	6,43	0,24			800	65	1	1,54	0,08	
	1150	315	4	1,27	0,27			850	311	7	2,25	0,37	
	1150	270	2	0,74	0,23			850	188	3	1,60	0,22	
	1150	284	1	0,35	0,25			850	210	4	1,90	0,25	
	Mean	1150,00	265,00	15,50	5,85	0,23		Mean	854,00	196,90	9,90	5,03	0,23
	Stdev	0,00	64,02	21,69	7,35	0,06		Stdev	22,45	59,07	8,19	4,48	0,07

APPENDIX D

This appendix contains all ships that transported extra personnel to the Cape.

EXTRA SHIPS TO THE CAPE											
Year	Tonnage	Crew	Dead	Mortality	Man/Ton	Corr.	Ret. Crew	of which on outward	Net result	Name of ship	Remarks
1771	450	185	55	29,73	0,41	0,65	47	29	101	Zon (1)	
1772	1150	515	190	36,89	0,45		119	92	233	Ouwerkerk	
1772	880	368	103	27,99	0,42		101	83	182	Bartha P	
1772	450	196	41	20,92	0,44		45	45	110	Zon (2)	Crew uncertain
1773	800	258	3	1,16	0,32		29	29	226	Hoop (1)	
1773	850	239	25	10,46	0,28		32	30	184	Noordbeek (1)	
1774	800	245	1	0,41	0,31		31	31	213	Hoop (2)	
1775	750	223	0	0,00	0,30		30	29	194	Katwijk ad Rijn (1)	
1775	850	314	14	4,46	0,37		86	77	223	Huis te Krooswijk	
1775	850	245	92	37,55	0,29		26	5	148	Noordbeek (2)	
1775	800	248	20	8,06	0,31		40	40	188	Hoop (3)	Crew uncertain
1776	750	222	2	0,90	0,30		30	29	191	Katwijk ad Rijn (2)	
1776	450	101	1	0,99	0,22		51	51	49	Jachttrust	Crew uncertain
1778	750	46	0	0,00	0,06		29	27	19	Katwijk ad Rijn (3)	
1778	850	93	2	2,15	0,11		24	8	83	Noordbeek (3)	
1778	600	59	0	0,00	0,10		54	54	5	Herstelder (1)	
1779	600	59	1	1,69	0,10		59	53	5	Herstelder (2)	
1779	750	51	0	0,00	0,07		32	30	21	Katwijk ad Rijn (4)	
1780	750	45 n/a		0,00	0,06		n/a	n/a	n/a	Katwijk ad Rijn (5)	
Sum		3667	550			Sum	865	742	2375		
Mean	743,68	203,72	30,56	9,65	0,258	Mean	48,06	41,22	131,94		
Stdev	168,37	120,10	49,62	13,20	0,13	Stdev	26,63	23,08	80,93		

APPENDIX E

This appendix gives the value per ton for merchandise from Batavia, Ceylon and Canton for the years 1730 until 1795 at five years intervals.

Batavia

Batavia	1730				
		Tonnage	Value	Value/Ton	Name of ship
		580	134808	232,43	Slot Aldegonde
		850	280670	330,20	Wapen van Hoorn
		805	322868	401,08	Jacoba
		528	213589	404,52	Huis de Vlotter
		850	221226	260,27	Kasteel van Woerden
		650	307690	473,37	Pallas
		650	287225	441,88	Schuitwijk
		600	261690	436,15	Herstelling
		800	192972	241,22	Amsterdam
		600	323178	538,63	Anna Catharina
		1100	322525	293,20	Barbestein
		400	96748	241,87	Castor en Pollux
		800	343530	429,41	Cornelia
		1140	336556	295,22	Elisabeth
		630	164283	260,77	Goudriaan
		810	340939	420,91	Ketel
		550	170804	310,55	Petronella Alida
		1150	545250	474,13	Westerdijkshorn
		850	334008	392,95	Adrichem
		600	224956	374,93	Alblasserdam
		850	331742	390,28	Beekvliet
		850	109301	128,59	Everswaart
		800	235442	294,30	Karsenhof
		600	122487	204,15	Susanna
	<i>Mean</i>	<i>751,79</i>	<i>259353,63</i>	<i>344,981</i>	
	<i>Stdev</i>	<i>189,71</i>	<i>99522,40</i>	<i>99,44</i>	

Batavia	1735				
		Tonnage	Value	Value/Ton	Name of ship
		450	172359	383,02	Coxhoorn
		630	213488	338,87	Goudriaan
		800	272896	341,12	Cornelia
		450	75102	166,89	Duifje
		850	258556	304,18	Everswaard
		850	347080	408,33	Goidschalxoord
		650	208017	320,03	Maria Adriana
		1140	155996	136,84	Oostrust
		550	210538	382,80	Petronella Alida
		650	226547	348,53	Rust en Werk
		650	233639	359,44	Venenburg
		1100	378975	344,52	Zoetelingskerke
		650	232242	357,30	Zorgwijk
		1150	408129	354,89	Berkenrode
		705	87305	123,84	Klarabeek
		650	159266	245,02	Hofwegen
		850	121192	142,58	Landskroon
		850	433070	509,49	Nieuwland
		810	111657	137,85	Patmos
		850	127392	149,87	Huis te Rensburg
		500	126356	252,71	Binnenwijzend
	Mean	751,67	217133,43	288,869	
	Stdev	199,95	101062,18	106,83	

Batavia	1740				
		Tonnage	Value	Value/Ton	Name of ship
		600	226024	376,71	s Heer Arendskerke
		600	216321	360,54	Delfland
		450	195137	433,64	Duifje
		810	329599	406,91	Patmos
		850	319232	375,57	Popkensburg
		650	166414	256,02	Hartenlust
		850	157884	185,75	Langewijk
		850	392299	461,53	Beukestijn
		850	166985	196,45	Everswaard
		850	391787	460,93	Goidschalxoord
		650	118966	183,02	Hofwegen
		540	357873	662,73	Ouwerkerk
		650	173502	266,93	Rijnhuizen
		1100	473329	430,30	Sara Jacoba
		650	274849	422,84	Vreeland
		850	131765	155,02	Hilversbeek
		850	130537	153,57	Nieuw Walcheren
	Mean	744,12	248382,53	333,795	
	Stdev	156,17	106252,30	136,18	

Batavia	1745				
		Tonnage	Value	Value/Ton	Name of ship
		525	134411	256,02	Batavier
		850	308220	362,61	Hoop
		650	151405	232,93	Heuvel
		850	395914	465,78	Oplettendheid
		850	401058	471,83	Toevalligheid
		850	242303	285,06	Hogersmilde
		1150	307552	267,44	Leiden
		850	281539	331,22	Reigersdaal
		850	185694	218,46	Spanderswoud
		850	160623	188,97	Brouwer
		850	232944	274,05	Duinhof
		850	191878	225,74	Huis te Persijn
		850	356390	419,28	Voorzichtigheid
	<i>Mean</i>	<i>832,69</i>	<i>257687,00</i>	<i>309,462</i>	
	<i>Stdev</i>	<i>133,51</i>	<i>88269,78</i>	<i>91,25</i>	

Batavia	1750				
		Tonnage	Value	Value/Ton	Name of ship
		1150	436510	379,57	Eendracht
		1150	571846	497,26	Hof d'Uno
		850	349290	410,93	Waakzaamheid
		850	399385	469,86	Hoop
		850	184953	217,59	Bevalligheid
		850	204578	240,68	Vosmaar
		850	213160	250,78	Immagonda
		1150	348987	303,47	Liefde
		1150	267954	233,00	Akerendam
		850	237945	279,94	Jager
		1150	273029	237,42	Kievitsheuvel
		1150	287653	250,13	Sloterdijk
		1150	213566	185,71	Herstelder
	<i>Mean</i>	<i>1011,54</i>	<i>306835,08</i>	<i>303,335</i>	
	<i>Stdev</i>	<i>149,56</i>	<i>107326,01</i>	<i>97,37</i>	

Batavia	1755				
		Tonnage	Value	Value/Ton	Name of ship
		880	236533	268,79	Oranjezaal
		880	255256	290,06	Noord Nieuwland
		1150	395735	344,12	Ruiteveld
		850	88234	103,80	Standvastigheid
		850	79743	93,82	Delft
		850	105163	123,72	Langewijk
		850	149967	176,43	Huis te Manpad
		1150	231603	201,39	Stadwijk
		1150	196982	171,29	Torenvliet
	Mean	956,67	193246,22	202,000	
	Stdev	137,19	95305,45	82,50	

Batavia	1760				
		Tonnage	Value	Value/Ton	Name of ship
		1150	324290	281,99	Amelisweert
		880	249607	283,64	Huis te Boede
		850	220876	259,85	Immagonda
		880	366523	416,50	Blijdorp
		880	175328	199,24	Noord Nieuwland
		1150	190319	165,49	Barbara Theodora
		850	108097	127,17	Overschie
		880	144314	163,99	Vrouwe Petronella
		1150	184261	160,23	Radermacher
		1150	261595	227,47	Sloten
		880	160116	181,95	Lekkerlust
		1150	254752	221,52	Eendracht
	Mean	987,50	220006,50	222,791	
	Stdev	137,73	71967,09	75,35	

Batavia	1765				
		Tonnage	Value	Value/Ton	Name of ship
		850	296593	348,93	Vosmaar
		880	304364	345,87	Jerusalem
		880	93799	106,59	Westfriesland
		880	174553	198,36	Lycochton
		850	165164	194,31	Baarzande
		850	179793	211,52	Vrouwe Elisabeth
		880	169622	192,75	s-Gravenzande
		1150	312027	271,33	Keukenhof
		1150	348717	303,23	Lapienenburg
		1150	263356	229,01	Admiraal de Ruyter
		1150	323010	280,88	Tulpenburg
		1100	276725	251,57	Zuid-Beveland
		880	242492	275,56	Blijdorp
		880	251749	286,08	Schoonzicht
	Mean	966,43	242997,43	251,439	
	Stdev	130,42	72206,32	63,65	

Batavia	1770				
		Tonnage	Value	Value/Ton	Name of ship
		880	134795	153,18	Vrouwe Margaretha Maria
		880	209299	237,84	Vrouwe Maria Jakoba
		1150	228752	198,91	Vrouwe Petronella Maria
		1150	217172	188,85	Vredelust
		880	74510	84,67	Westfriesland
		850	157075	184,79	Vrouwe Kornelia Hillegonda
		1100	163627	148,75	Kronenburg
		1150	164164	142,75	Nieuw Rhoon
		880	156727	178,10	Vrouwe Anthoinetta Koenardina
		1150	220767	191,97	Jonge Lieve
		1150	231742	201,51	Huis ter Meyen
		880	192440	218,68	Jonge Samuel
		1100	186092	169,17	Duinenburg
		850	154317	181,55	Ridderkerk
		880	159059	180,75	Vlissingen
		1150	210874	183,37	Woestduin
	Mean	1005,00	178838,25	177,949	
	Stdev	133,70	40261,19	33,67	

Batavia	1775				
		Tonnage	Value	Value/Ton	Name of ship
		1150	99731	86,72	Honkoop
		1150	101754	88,48	Willem de Vijfde
		850	81538	95,93	Mercuur
		880	113629	129,12	Bartha Petronella
		1150	149671	130,15	t Loo
		1150	159702	138,87	Huis Om
		1150	181226	157,59	Woestduin
		1150	293773	255,45	Patriot
		880	117612	133,65	Jonge Samuel
		850	116333	136,86	Abbekerk
		850	118479	139,39	Ridderkerk
		1150	186150	161,87	Hof ter Linden
		880	151559	172,23	Ritthem
		1150	171508	149,14	Jonge Lieve
	Mean	1027,86	145904,64	141,950	
	Stdev	141,38	51628,88	40,47	

Batavia	1780				
		Tonnage	Value	Value/Ton	Name of ship
		850	98706	116,12	Vrouwe Everhardina
		1150	160397	139,48	Zeepaard
		880	111795	127,04	Vrouwe Anthoinetta Koenrardina
		1150	153524	133,50	Behemoth
		1150	169465	147,36	Concordia
		1150	167291	145,47	Oud Haarlem
		850	125934	148,16	Vreeburg
		850	141019	165,90	Beekvliet
	Mean	1003,75	141016,38	140,490	
	Stdev	146,54	24756,98	14,15	

Batavia	1785						
		Tonnage	Value	Value/Ton	Name of ship		
		508	68208	134,27	Vrouwe Wijnanda Luberta		
					Le Castries	?	108790
		790	114305	144,69	Vrijheid		
		620	119644	192,97	Les Quatres Frères		
					La (Bonne) Resolution	?	93914
		884	116922	132,26	Eensgezindheid		
		898	119799	133,41	Dordrecht		
		574	87847	153,04	Eik en Linde		
		560	69842	124,72	Mentor		
		175	20672	118,13	Hoop		
		525	69082	131,58	Elisabeth et Sophie		
					Le Nepthune	?	142664
		356	47169	132,50	Willem en Jan		
		648	120302	185,65	Jonge Jakob		
		444	93117	209,72	Vrouwe Johanna Jakoba		
		892	120446	135,03	Eikenwoud		
		484	72880	150,58	Vlugge Trekvogel		
	Mean	597,00	88588,21	148,389			
	Stdev	204,89	30667,17	26,80			

Batavia	1791				
		Tonnage	Value	Value/Ton	Name of ship
		136	7121	52,36	Vlijt
		1150	308892	268,60	Beverwijk
		1150	120743	104,99	Phoenicier
		768	95528	124,39	Surseance
		136	789	5,80	Luchtbol
		880	109783	124,75	Schoonderloo
		780	96548	123,78	Texelstroom
		650	107331	165,12	Oostzaandam
		1150	134499	116,96	Zwaan
		600	79382	132,30	Eenparigheid
		136	8849	65,07	Kraai
		898	129221	143,90	Dordrecht
		880	81217	92,29	Hoornweg
		560	74441	132,93	Mentor
		708	69494	98,16	Standvastigheid
		880	81582	92,71	Horssen
		1150	112921	98,19	Vredenburg
	<i>Mean</i>	<i>741,88</i>	<i>95196,53</i>	<i>128,318</i>	
	<i>Stdev</i>	<i>335,55</i>	<i>66662,05</i>	<i>53,05</i>	

Batavia	1795				
		Tonnage	Value	Value/Ton	Name of ship
		900	105616	117,35	Ceylon
		1150	124126	107,94	Makassar
		894	108272	121,11	Noord-Holland
		708	91988	129,93	Standvastigheid
		136	7226	53,13	Vlijt
	<i>Mean</i>	<i>757,60</i>	<i>87445,60</i>	<i>115,424</i>	
	<i>Stdev</i>	<i>341,09</i>	<i>41388,82</i>	<i>27,31</i>	

Canton

Canton	1730				
		Tonnage	Value	Value/Ton	Name of ship
		450	273961	608,80	Coxhoorn
	Mean	450,00	273961,00	608,802	
	Stdev	0,00	0,00	0,00	

Canton	1735				
		Tonnage	Value	Value/Ton	Name of ship
		650	304450	468,38	Noordwolfsbergen
	Mean	650,00	304450,00	468,385	
	Stdev	0,00	0,00	0,00	

Canton	1740				
		Tonnage	Value	Value/Ton	Name of ship
		850	543565	639,49	Bethlehem
		850	540436	635,81	Scheijbeek
	Mean	850,00	542000,50	637,648	
	Stdev	0,00	1564,50	1,84	

Canton	1745				
		Tonnage	Value	Value/Ton	Name of ship
		1150	593069	515,71	Overnes
		650	402219	618,80	Bosbeek
	Mean	900,00	497644,00	552,938	
	Stdev	250,00	95425,00	51,54	

Canton	1750				
		Tonnage	Value	Value/Ton	Name of ship
		1150	629675	547,54	Overnes
		1150	723277	628,94	Nieuwvijvervreugd
	Mean	1150,00	676476,00	588,240	
	Stdev	0,00	46801,00	40,70	

Canton	1755				
		Tonnage	Value	Value/Ton	Name of ship
		850	342119	402,49	Overschie
		1150	691770	601,54	Amstelveen
		1150	707522	615,24	Haarlem
		1150	596686	518,86	Admiraal de Ruyter
		1150	783591	681,38	Nieuw Nieuwerkerk
	<i>Mean</i>	<i>1090,00</i>	<i>624337,60</i>	<i>572,787</i>	
	<i>Stdev</i>	<i>120,00</i>	<i>153127,64</i>	<i>95,85</i>	

Canton	1760				
		Tonnage	Value	Value/Ton	Name of ship
		1100	641542	583,22	Vrouwe Geertruida
		1100	637033	579,12	Kronenburg
		1100	632338	574,85	Vrouwe Petronella Maria
	<i>Mean</i>	<i>1100,00</i>	<i>636971,00</i>	<i>579,065</i>	
	<i>Stdev</i>	<i>0,00</i>	<i>3757,77</i>	<i>3,42</i>	

Canton	1765					
		Tonnage	Value	Value/Ton	Name of ship	
		1150	901924	784,28	Huis Om	
		1150	869433	756,03	Aschat	
		880	707978	804,52	s Lands Welvaren	
		1150	88531	76,98	Ruiteveld	???
	<i>Mean</i>	<i>1082,50</i>	<i>641966,50</i>	<i>593,041</i>		
	<i>Stdev</i>	<i>116,91</i>	<i>327859,45</i>	<i>305,60</i>		

Canton	1770				
		Tonnage	Value	Value/Ton	Name of ship
		1150	636118	553,15	Bot
		850	478377	562,80	Jonge Hellingman
		1150	638646	555,34	Prinses van Oranje
		1150	649086	564,42	Willem de Vijfde
	<i>Mean</i>	<i>1075,00</i>	<i>600556,75</i>	<i>558,657</i>	
	<i>Stdev</i>	<i>129,90</i>	<i>70707,80</i>	<i>4,78</i>	

Canton	1775				
		Tonnage	Value	Value/Ton	Name of ship
		1150	581994	506,08	Ceres
		850	481500	566,47	Beemster Welvaren
		1150	571295	496,78	Vrijheid
		1150	622947	541,69	Oostkapelle
		1150	577632	502,29	Indiaan
		850	444196	522,58	Jonge Hugo
	Mean	1050,00	546594,00	520,566	
	Stdev	141,42	62421,97	24,64	

Canton	1780				
		Tonnage	Value	Value/Ton	Name of ship
		850	508582	598,33	Java
		1150	687992	598,25	Voorberg
	Mean	1000,00	598287,00	598,287	
	Stdev	150,00	89705,00	0,04	

Canton	1785				
		Tonnage	Value	Value/Ton	Name of ship
		1150	802928	698,20	Brederode
		1150	777036	675,68	Draak
		1150	680504	591,74	Voorschoten
		1150	793801	690,26	Berkhout
	Mean	1150,00	763567,25	663,972	
	Stdev	0,00	48847,36	42,48	

Canton	1791				
		Tonnage	Value	Value/Ton	Name of ship
		1150	739545	643,08	Alblasserdam
	Mean	1150,00	739545,00	643,083	
	Stdev	0,00	0,00	0,00	

Canton	1795				
		Tonnage	Value	Value/Ton	Name of ship
		880	550442	625,50	Siam
		1150	698006	606,96	Washington
		1150	716139	622,73	Zeelelie
		1150	714079	620,94	Zwaan
	Mean	1082,50	669666,50	618,630	
	Stdev	116,91	69191,35	7,16	

Ceylon

Ceylon	1730				
		Tonnage	Value	Value/Ton	Name of ship
		1150	147135	127,94	Gaasperdam
		850	133175	156,68	Slot ter Hoge
		810	123697	152,71	Kommerrust
		1180	182524	154,68	Meijenburg
	<i>Mean</i>	<i>997,50</i>	<i>146632,75</i>	<i>147,000</i>	
	<i>Stdev</i>	<i>168,43</i>	<i>22336,03</i>	<i>11,67</i>	

In 1735 no ships left Ceylon for the Republic.

Ceylon	1740				
		Tonnage	Value	Value/Ton	Name of ship
		650	107213	164,94	Loverendaal
		850	126370	148,67	Huis te Marquette
	<i>Mean</i>	<i>750,00</i>	<i>116791,50</i>	<i>155,722</i>	
	<i>Stdev</i>	<i>100,00</i>	<i>9578,50</i>	<i>8,14</i>	

Ceylon	1745				
		Tonnage	Value	Value/Ton	Name of ship
		850	287827	338,62	Kerkwijk
		650	138179	212,58	Knappenhof
		850	208821	245,67	Nieuw Walcheren
	<i>Mean</i>	<i>783,33</i>	<i>211609,00</i>	<i>270,139</i>	
	<i>Stdev</i>	<i>94,28</i>	<i>61125,34</i>	<i>53,35</i>	

Ceylon	1750				
		Tonnage	Value	Value/Ton	Name of ship
		875	415413	474,76	Huis te Donk
		650	312032	480,05	Huis te Rensburg
		850	281457	331,13	Wapen van Hoorn
		830	309697	373,13	Krabbendijke
	<i>Mean</i>	<i>801,25</i>	<i>329649,75</i>	<i>411,419</i>	
	<i>Stdev</i>	<i>88,77</i>	<i>50956,78</i>	<i>64,40</i>	

Ceylon	1755				
		Tonnage	Value	Value/Ton	Name of ship
		1150	331779	288,50	Oudkarspel
		1150	366768	318,93	Zuiderburg
		1150	268542	233,51	Overnes
		1150	313990	273,03	Spaarzaamheid
	<i>Mean</i>	<i>1150,00</i>	<i>320269,75</i>	<i>278,495</i>	
	<i>Stdev</i>	<i>0,00</i>	<i>35389,78</i>	<i>30,77</i>	

Ceylon	1760				
		Tonnage	Value	Value/Ton	Name of ship
		1150	314390	273,38	Liefde
		1150	300433	261,25	Vrijburg
		1150	249424	216,89	Giessenburg
		1150	296123	257,50	Walcheren
	<i>Mean</i>	<i>1150,00</i>	<i>290092,50</i>	<i>252,254</i>	
	<i>Stdev</i>	<i>0,00</i>	<i>24431,48</i>	<i>21,24</i>	

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Ceylon	1765				
		Tonnage	Value	Value/Ton	Name of ship
		1150	365662	317,97	Eendracht
		1150	379491	329,99	Luxemburg
		1150	334326	290,72	Overnes
		1150	349686	304,07	Barbara Theodora
	<i>Mean</i>	<i>1150,00</i>	<i>357291,25</i>	<i>310,688</i>	
	<i>Stdev</i>	<i>0,00</i>	<i>16942,11</i>	<i>14,73</i>	

Ceylon	1770				
		Tonnage	Value	Value/Ton	Name of ship
		1150	260643	226,65	Velsen
		1100	269785	245,26	Zuid Beveland
		1100	154549	140,50	Geinwens
	<i>Mean</i>	<i>1116,67</i>	<i>228325,67</i>	<i>204,471</i>	
	<i>Stdev</i>	<i>23,57</i>	<i>52301,32</i>	<i>45,63</i>	

Ceylon	1775				
		Tonnage	Value	Value/Ton	Name of ship
		1150	320755	278,92	Veldhoen
		1100	304118	276,47	Zuid Beveland
		1150	293773	255,45	Nieuw Rhoon
		3400	918646	270,00	
	<i>Mean</i>	<i>1133,33</i>	<i>306215,33</i>	<i>270,190</i>	
	<i>Stdev</i>	<i>23,57</i>	<i>11114,74</i>	<i>10,53</i>	

Ceylon	1780				
		Tonnage	Value	Value/Ton	Name of ship
		1150	344476	299,54	Prinses van Oranje
		1150	313946	273,00	Huis Om
		1150	329334	286,38	Ganges
		1150	299917	260,80	t Loo
	<i>Mean</i>	<i>1150,00</i>	<i>321918,25</i>	<i>279,929</i>	
	<i>Stdev</i>	<i>0,00</i>	<i>16669,26</i>	<i>14,50</i>	

Ceylon	1785				
		Tonnage	Value	Value/Ton	Name of ship
		1150	277883	241,64	Doggersbank
		1150	276614	240,53	Triton
		723	186186	257,52	Huisduinen
	<i>Mean</i>	<i>1007,67</i>	<i>246894,33</i>	<i>245,016</i>	
	<i>Stdev</i>	<i>201,29</i>	<i>42930,40</i>	<i>7,76</i>	

Ceylon	1791				
		Tonnage	Value	Value/Ton	Name of ship
		1150	241684	210,16	Berkhout
		1150	240504	209,13	Leviathan
		1150	153204	133,22	Draak
	<i>Mean</i>	<i>1150,00</i>	<i>211797,33</i>	<i>184,172</i>	
	<i>Stdev</i>	<i>0,00</i>	<i>41434,54</i>	<i>36,03</i>	

In **1795** no ships left Ceylon for the Republic.

For almost two centuries, the ships and the crews of the VOC navigated their way between the Dutch Republic and Asia. This could not have been achieved without the technology of ship design and ship building, the technology involved with keeping the crew healthy, and the technology of charting a route. This dissertation shows that the “success” or “failure” of these technologies could never be taken for granted. The introduction, use, development, improvement or rejection of technologies had to be negotiated over and over again. Therefore, the VOC itself had to navigate its way through new, existing and disappearing technologies. Using insights from Science and Technology Studies, it becomes clear that not only humans took part in these negotiations but also non-humans like contagious diseases, typhoons, profitable trade, and the ships themselves.

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Cover image:
“Dekzicht van een VOC-schip naar de grote mast”
(drawing by Jan Brandes, between 1778 and 1787)
Rijksmuseum NG-1985-7-1-144

Photo of the author:
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