Towards an Efficient and Effective Corps of Engineers - Supporting Interactions between Education, Research and Practice

Edwin Dado¹
Almer van der Stoel
Sjoerd Mevissen &
Jody Borgers

Abstract
In order to cope with the increasing demands from society and government for more efficiency and effectiveness, the Corps of Engineers is changing from a rather traditional institute to an innovative institute by adopting new techniques and technologies in the field of management, organisation, manufacturing and information, communication and knowledge technologies. This change poses a true challenge for a traditional educational institute such as the Faculty of Military Sciences [FMS] of the Netherlands Defence Academy [NLDA] in terms of supporting interactions (or bridging the gaps) between education, research and practice.

Keyword: engineering, education, research, practice, interactions

Introduction
Like all other public organisations, the Dutch Defence organisation is continuously forced by society and government to provide more value for money. In fact, they are forced to increase the efficiency and effectiveness (and quality) of the current military processes, services and products in general as well as the operability of the military personnel working under high pressure and ever-changing circumstances during expeditionary operations more specifically. What is true for the Dutch Defence organisation as a whole is also true for the Corps of Engineers. In order to cope with the increasing demands, the Corps of Engineers is (slowly) adopting new techniques and technologies in the field of management, organisation, manufacturing and information, communication and knowledge technologies.² This adoption of techniques and technologies places heavy demands on the competence of the Corps of Engineers and its employees – a new type of competence that is not the same as it used to be. These types of changes require a change in ways of “deciding, doing, acting and responding”, that is, it requires a continuous process of change of the skills and knowledge of employees working in today’s Corps of Engineers but it also requires the transformation of the Corps of Engineers into a learning organisation³ as a whole. This poses a real challenge for the

¹ Corresponding writer: <e.dado@nl.¹>. All authors are at the Civil Engineering Section, Faculty of Military Sciences, Netherlands Defence Academy, the Netherlands.
² Often built upon the developments that can be witnessed in comparable sectors of the non-military Civil Engineering industry.
³ Learning organization is a term used in knowledge management and it refers to an organization which systematically learns from its experience of what does and what does not work. In most of the literature, learning organization is associated with organizational learning and individual learning. Individual learning in this context can be defined as the ability to build knowledge through individual reflection about external stimuli and sources and through the personal re-elaboration of individual knowledge and experience in light of interaction
(academic) educational and research institutes within or associated with the Dutch Defence organisation in terms of supporting interactions (or bridging the gaps) between education, research and practice, that is providing a comprehensive approach which will allow an integration of these elements. This process is shown in Figure 1.

Figure 1. Bridging the gaps between education, research and practice

In the Netherlands, the educational academic programme for Corps of Engineers officers is coordinated and delivered by the Faculty of Military Sciences [FMS] of the Netherlands Defence Academy [NLDA] in cooperation with the Faculty of Civil Engineering of the University of Twente [UT]. Military Civil Engineering research is partly coordinated and conducted by the FMS. In addition, research is also partly coordinated by the Centre of Expertise of the Training Centre for the Corps of Engineers [Dutch: OTCGenie] and also partly conducted by the Netherlands Organisation for Applied Research [TNO]. After successfully completing the educational academic programme, students will apply for their first (operational) job as a Corps of Engineers officer at one of the companies of the 101st Corps of Engineers Battalion, the 11th or 41st Armoured Engineering Battalions or 11th Air Assault Brigade. After they reach the rank of Captain, they can apply for jobs at non-operational or supporting departments such as OTCGenie, Infrastructure Agency Group (Dutch: Dienst Vastgoed Defensie) and Civil Works Department [Dutch: Bureau Geniewerken].

In this study we will mainly focus on the interactions between education and research coordinated and delivered/conducted by FMS and the practice related to the specific Corps Engineers organisational units within the Dutch Defence organisation. In the first part of the study we will give a brief overview of the history of Corps of Engineers in the context of its changing role and tasks to perform. In the second part, an overview of the current Civil Engineering [CE] educational and research programmes at the FMS is given. In the third part of the study we will discuss the main mechanisms for supporting the interactions between education, research and practice which are currently supported or should be supported in the future.

with others and the environment; see Emily Dickinson, “Learning with Computers”, Web publication (2000); available at: http://hagar.up.ac.za/catts/learner/2000/scheepers_md/projects/loo/theory/theories.html. Most of the educational programmes are developed and designed to help students to develop these abilities - initially delivered as part of their regular educational programmes at higher educational institutes and during working life as part of their lifelong learning programmes. Although individual learning alone is not sufficient for a learning organization, it must be used to create organizational learning; see Jennifer Rowley, “The Library as a Learning Organization”, International Journal of Library Management 18/2 (1997), pp. 88-91.
2. History of the Corps of Engineers

Even in the middle ages the Army had the so-called pioneers, who constructed roads using shovels and pickaxes, as well as the miners, who undermined castles and city-walls. With the arrival of gunpowder the miners started to occupy themselves with destroying constructions and left the digging to the sappers. When in the 16th century the emphasis of warfare turned more and more to conquering fortifications, as a response the emphasis came more on building bridges.

The Dutch Corps of Engineers was officially established in 1748. In the more than 260 years which has passed since then, the Corps of Engineers has known a large number of reorganisations. Despite general cuts in the organisation, often these reorganisations meant a broadening of the scope of activities and the increase in the number of companies. After the Second World War the Corps of Engineers went on a mission abroad in Indonesia (then Dutch-Indies). In contrast to earlier tasks of the Corps of Engineers, where the emphasis was put on thoroughness and sustainability, speed and improvisation now became critical. Later the Corps of Engineers went on a mission abroad for UNIFIL in the South of Lebanon, and it had its first experience with mountainous and impassable areas, which would later be repeated in Afghanistan. These activities were in stark contrast with the tasks of the Corps of Engineers during the Cold War, which focussed on contra-mobility and were characterised by an extremely good knowledge of the environment.

The end of the Cold War, the suspension of national service as well as the many missions outside of the Netherlands together commenced a period of enormous change for the Corps of Engineers. In Bosnia, Cambodia and Angola much specific experience was acquired concerning mine awareness. Also, military operations such as Provide Comfort in Northern Iraq and Desert Storm required a rapid and flexible response, using construction materials and equipment that could be applied under all, and sometimes extreme, circumstances. Instead of waiting for “the Soviets” to come, mobility support had to be granted and the construction task became more and more important. As a result of this development, the four main tasks of the Corps of Engineers can now be summed up as (1) mobility, (2) contra-mobility, (3) protection and (4) general CE tasks.

3. Educational programme

After finishing their basic military education and training programme in the first year, future Corps of Engineers officers will follow a Bachelor of Science [BSc] CE programme. The BSc level, achieved after a first study cycle of three academic years, is a proof that fundamental knowledge and skills have been acquired. This allows the pursuit of most Master of Science [MSc] studies in the field of CE at any university, though for some combinations of specific BSc and MSc programmes small bridging courses may be required. Moreover, the BSc level guarantees that the future Corps of Engineers officers’ skills match the specific traits of the military CE profession. They should be able to undertake theoretical or desk work on an engineering basis in a supervised situation. “Engineering” implies competence in design/synthesis beyond analytical skills. However, a true professional-level qualification for a university-trained engineer is only attained at the MSc level in a particular subject.

---

5 During this basic military education and training programme, future Corps of Engineers officers will follow a number of academic courses that together form the “minor” for the BSc CE programme.
As mentioned earlier, the BSc programme is coordinated and delivered by the FMS of the NLDA in cooperation with the Faculty of CE of the UT. The CE students at the FMS will meet the same qualifications as CE students at the UT, that is, the two versions of the BSc programme are almost identical. The only difference lies in the fact that during the implementation some courses of the BSc programme at the FMS will be added (for instance courses on explosion effects) or slightly modified (for instance design oriented courses) and put into a military context with respect to the main four tasks of the Corps of Engineers the role of its officers after they reach the rank of Captain. Therefore, special attention is given to the ever-changing circumstances during expeditionary operations including peace operations, emergency aid at calamities, natural disasters and war situations. In the context of design, construction, management and maintenance of CE (military) engineering objects or systems, both technical and non-technical (environmental, socio-economic, legal etc.) aspects are of vital importance. Hence, appropriate CE requires high-level knowledge and skills both in the technical (construction) and some non-technical domains. However, within a three-year BSc programme one cannot expect students to attain such a high level of knowledge across the full range from construction skills to multidisciplinary approaches of infrastructural problems. Within the existing BSc programme, clear priorities are laid at construction process management, (military) constructions and water (management). According to these general CE requirements and the specific requirements related to the military context, a three-year BSc programme is offered to the future Corps of Engineers officers. During the first year of the BSc CE programme, most of the education is delivered by lecturers from the FMS. At the end of the first year of the BSc CE programme the students will physically move to the location of the UT in Enschede, where they will continue with the BSc programme. The involvement of lecturers from the FMS is on an ad-hoc basis during the second year. After the second year, students move back to the location of the FMS in Breda, where they finish their BSc CE programme (including a BSc graduation project).

4. Research programme

The main objective of the research programme, which is partly coordinated and conducted by the Civil Engineering section of the FMS, is to provide solutions for the aforementioned increasing demands from society and government for more efficiency, effectiveness and quality of the current CE processes, services and products in general and the operability of military civil engineers working under high pressure and ever-changing circumstances during expeditionary operations more specifically. In order to reach this objective, solutions, provided by the civil CE practice and research, will be made applicable for the Dutch Defence organisation by adapting and modifying these solutions to the specific needs and characteristics of the Dutch Defence organisation. If needed, new techniques, methods, concepts and much more will be developed instead of existing solutions. The research programme basically consists of three main research topics:

1. Military (underground) construction. This subject mainly focuses on different aspects of military underground construction, including guidelines for ground investigation techniques to optimise compound design, improvement of bridge foundation design for ad hoc bridge constructions, ground improvement techniques for runway construction and maintenance, underground ammunition storage and command centres and possibilities of pile foundations in out of area construction.

---

7 University of Twente, Civil Engineering Bachelor Study Guide (2008); available at http://www.cit.utwente.nl.
8 More details about the BSc CE programme can be found on: http://www.cit.utwente.nl/ or http://tgbd_nts32/ (restricted access).
2. **Increased protection of personnel and structures.** This subject focuses on technical, organisational, and strategic solutions to increase the protection of people, equipment, and structures against external threats like war related violence, terrorist attacks, and natural disasters. Current research includes mass-evacuations in dike ring areas, safety concrete to reduce the effects of spalling, shock wave prediction model and shock tube blast testing facility and computational modelling of damage development in heterogeneous materials under plane impact load.

3. **Process and system innovation (including ICKT).** This subject mainly focuses on the adaptation and modification of solutions for process and system innovation provided by The Process and System Innovation in Building [PSIBouw] and to some extent by other CE national and international reform programmes. PSIBouw is an initiative by the non-military CE industry to fundamentally reform the Dutch CE industry through process and system innovation. The PSIBouw programme is built upon five relevant research themes, each of which covers a large number of research subjects including: (1) client orientation (2) strategic procurement, (3) assessment models, (4) tendering law and (5) integrity and transparency. In addition to this, the research theme also focuses on the application of advanced information, communication and knowledge technologies [ICKT] (and management) applied in the context of the five relevant research themes of PSIBouw (that is, ICKT serves as an enabler).

Due to the relatively small number of researchers currently working in the CE section of the FMS, only a limited number of research projects are currently conducted, obviously mostly according to the specific expertise of the individual researchers. Example 1 gives a short description of an ongoing PhD project on ‘mass-evacuation in dike ring areas’.

---

**Example 1. PhD project ‘mass-evacuation in dike ring areas’.

The role of the Dutch Defence organisation within national security (other than war) must change from a ‘safety net’ to an active partner with civil emergency organisations, as put forward in the interdepartmental project ‘intensifying civil-military cooperation’ [ICMS]. The subject of this research project is vulnerability of the road network for mass-evacuation during flooding. Besides the development of a method to measure this vulnerability, strategic and operational solutions to decrease the vulnerability will be examined. The possibilities of the Dutch Defence organisation in general and the Corps of Engineers more specifically, to provide personnel, equipment and knowledge to implement the solutions, will form the concluding piece of the research.

---

5. **Supporting interaction between education and research**

As a consequence of the requirements for university degree courses set by the Quality Assurance Netherlands Universities [QANU] organisation and the evaluation criteria set by the Accreditation Organisation of the Netherlands and Flanders [NVAO], most higher educational institutes have established a connection between education and research in their bachelor and master programmes. This connection is mostly established by the teaching staff, most of whom are active in research. Although many of the theory courses in the first year of the CE programme are an introduction to the new discipline, new theories or insights are introduced during the lectures and/or delivered to the students as part of their mandatory reading list. In addition, many theory courses are supported by guest lecturers and they make

---

10 According to the QANU-protocol (F12: Requirements for University) most of the teaching should be provided by researchers who contribute to the development of the subject area.
use of relevant real-life cases and excursions. The main goals of these theory courses are twofold. On the one hand, students become familiar with existing scientific knowledge in relevant engineering disciplines and have the competence to increase and develop this through study. On the other hand, it adds to students’ scientific mindset and systematic approach characterized by the development and use of theories, models and coherent interpretations, critical attitude, and insight into the nature of science and technology.

As consequence of the characteristics of the (civil) engineering discipline many courses are design-driven in stead of research-driven. In the context of CE, designing is a synthetic activity aimed at the realisation of new or modified artefacts or systems with the intention of creating value in accordance with predefined requirements and desires. This type of courses (that is project based courses) refers to the academic competence of students to be familiar with existing scientific knowledge and to be able to increase and develop this through study and research. The latter refers to students’ ability to acquire new scientific knowledge through research. We define research as “the development of new knowledge and new insights in a purposeful and methodical way”. In terms of design competences, it also refers to students’ ability to reformulate ill-structured design problems, to have creativity and synthetic skills with respect to design problems, to be able (with supervision) to produce and execute design plans, to be able to work at different levels of abstraction and to understand, where necessary, the importance of other disciplines and to be aware of the changeability of the design process through external circumstances or advancing insights but also with the skill to take design decisions and to justify and evaluate these in a temporal and social context.\textsuperscript{11}

During the course ‘Designing a Research Project’, students get insights and skills in doing scientific research. These skills are, in particular, how to formulate a research aim, to derive research questions and (sub) questions from this aim and to translate the research questions into a research plan for their individual research graduation project. Special attention is given to find the most optimal research design to fit the objectives of their BSc graduation project, to reduce the project to a feasible size (i.e. work plan) and to some extent to critically analyze existing scientific literature. During the BSc graduation project, the student must apply herself in a creative manner, through a scientific way of working, to the solution (or design) of the problem(s), all based and/or extending the expertise and skills acquired so far. During the graduation phase there must be a number of interim meetings with the examination committee to gauge the progress being made. Before a presentation date is agreed to for the graduation work the student must send (or present) a draft report to the committee and wait for the approval. After the student has received the approval of the examination committee\textsuperscript{12}, he or she must then arrange a presentation date. When it comes to the task of assessing the graduation work, the final result will, to a large degree, be determined by the work content and process but the reporting style and public presentation will also play a part. Example 2 gives a short description of a recently finished BSc graduation project on an EU strategy against terrorist explosive devices.


\textsuperscript{12} The examination committee is composed of at least three members: chairman (full professor), vice chairman (assistant of associate professor) and member(s) that is/are preferable the ‘owner(s)’ of the problem.
6. Supporting interaction between education and practice

It is generally known that the CE practice relies heavily on the interactions between civil engineers and other disciplines. As discussed in the previous section, project based courses are meant to develop competences to understand the importance of other disciplines and to enable operations in the context of a multidisciplinary team (and to act as a project leader). The key to this approach is to work on realistic problems (case studies) in project groups. This project-based and problem-based learning (PBL) approach has been described as one of the most significant developments in professional education in the last few decades. At the time of the introduction PBL, it brought a fundamental shift from a focus on teaching by means of traditional lecturing to a focus on self-learning. The advantage of this shift becomes clear if we take a closer look at the Learning Pyramid of Bales (Table 1).

<table>
<thead>
<tr>
<th>Method of learning</th>
<th>Average retention (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional lectures</td>
<td>5</td>
</tr>
<tr>
<td>Reading</td>
<td>10</td>
</tr>
<tr>
<td>Audio-visual</td>
<td>20</td>
</tr>
<tr>
<td>Demonstration</td>
<td>30</td>
</tr>
<tr>
<td>Discussion group</td>
<td>50</td>
</tr>
<tr>
<td>Exercise</td>
<td>75</td>
</tr>
<tr>
<td>Self-learning</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 1. Pyramid of Bales

---

13 In most education literature the terms “project-based learning” and “problem-based learning” are used separately from one another. Part of the difficulty is the range of forms that both project-based and problem-based learning can take. Problem-based learning can make use of projects, but does not have to. Project-based learning can make use of problems but does not have to. Both can be group-based, but neither has to be. In civil engineering the similarities between the two approaches may well be greater than in some other disciplines. Engineering projects will typically address a real world problem; this may not be true of projects elsewhere. In this context, case studies are a particular form of PBL, and modelling lectures and assignments around actual, real-world projects can be an effective bridge to the practice; see Ban Seng Choo (Ed), PBLE: Project Based Learning in Engineering, Web publication (2003); available at http://www.pble.ac.uk/guide-final.html.

14 Note that current trends in education such as ‘action learning’ and ‘task based learning’ are forms of PBL.

The Learning Pyramid of Bales indicates the average retention of knowledge with respect to several methods of transferring knowledge and learning modes. Bales has revealed that the traditional lecture as mode of learning provides the least retention of knowledge. This is a rather passive way of learning; its usefulness decreases in particular as the number of students increase and as dialogues are replaced by monologues. This has always been partly compensated for by the incorporation of other modes of learning such as reading, audio/visual/live demonstrations, discussions and exercises. PBL is unique in that it fosters collaboration among students, stresses the development of problem solving skills within the context of the professional practice, promotes effective reasoning and self-learning, and is aimed at increasing motivation for life-long learning. Central to this concept is the importance of students developing their problem-solving abilities from an early stage so that they are capable of enhancing their knowledge as their studies progress. To facilitate this, students have to be exposed to an assessment strategy that not only carefully considers the interrelationship between the educational programme at each level, but also explores mechanisms for promoting this so that students become increasingly aware of course (subject) integration [8]. In the CE programme at FMS this strategy is implemented as a number of interrelated design courses, consisting of both theory and project-based and problem-based courses, form a so-called "design line" together. The design line has been programmed in such a way that students can apply knowledge which has been acquired in other (engineering) courses. In the first year when student still lack engineering knowledge, the emphasis is laid on the feasibility and early design phases. Students use reference material of different kinds. In the second year when students possess basic engineering knowledge, the design process is completed.16 In the third year when students master engineering knowledge at a relative high level, special attention is given to the final design phase and problem-solving and decision-making processes in multidisciplinary design teams. Example 3 gives a short description of the third year B3 design project.

**Example 3. B3 design project.**

An example of design project carried out by third year students is the B3 project. In their third year, the engineer cadets carry out a design project over five intensive weeks. Within a military context and environment they have to find a solution for a multi-disciplinary design problem. The project environment is mostly situated in a mission area like Afghanistan. The most important goals of the project are: (1) working in a team, (2) managing a complex environment and (3) managing conflicting interests. The problem is mostly derived from a recent real-life situation. Sometimes a problem is provided by one of the Engineer battalions. In that case, the cadets are in fact working out a solution for an actual or future problem. In the first two weeks they are provided with a lot of information and restrictions given in a mixture of lectures, role plays, literature and meetings with experts. With this information, which reflects different and conflicting point of views and interests, the cadets go through a design and military decision process simultaneously. At the end of the five weeks they have to present a report, a program of requirements, and a construction plan.

As stated in the introduction section of this study, the change in ways of “deciding, doing, acting and responding” requires a continuous process of changing the skills and knowledge of officers working in today’s Corps of Engineers. It poses a true challenge for a traditional educational institution such as the FMS in terms of education delivery. Instead of delivering very static (and traditional) educational programmes, the FMS need to adapt their academic programmes dynamically to the demands arising from the new developments within both

---

16 In CE the design process is divided in five successive design phases: (1) initiative, (2) feasibility, (3) preliminary design, (4) final design and (5) detailed design.
military and civil CE and to the specific needs of individual officers as part of their lifelong educational programmes. Lifelong learning or continuous learning has become a very popular topic at the FMS recently. Like other higher educational institutions in the Netherlands, the FMS is slowly transforming itself from a traditional learning institution into a lifelong learning institution. The application of e-learning and e-training, that is, an all-encompassing term generally used to refer to computer-enhanced learning or training, is seen as one of the key enablers for this transformation process. In order to overcome the most important weakness of the current e-learning and e-training approaches, that is, the reduction of face-to-face contact with lecturers and trainers, higher educational institutes started to embrace the concept of blended modes of learning and training.\(^\text{17}\)

### 7. Supporting interaction between research and practice

As discussed earlier, the main objective of the CE research programme at the FMS is to provide solutions for the increasing demands from society and government for more efficiency, effectiveness and quality of the current CE processes, services and products in general and the operability of military civil engineers during expeditionary operations more specifically. In research we distinguish between two types of research approaches: (1) demand-driven and (2) development-oriented research. The demand-driven research approach is focused on short-term and mid-term solutions for problems arising from the daily activities of military civil engineers. In this research approach, most of the knowledge gained is directly shared with the problem ‘owners’. This process of knowledge sharing between research and practice is well supported at the FMS, for example through BSc and MSc graduation projects as discussed earlier. The development-oriented research approach is more focused on long-term solutions for fundamental CE system problems. In addition, this type of research also focuses on the exploration of new technologies and concepts which leads to innovations instead of solutions for identified problems. However, knowledge sharing in this context is currently inadequately supported at the FMS for two main reasons.\(^\text{18}\)

1. **Cultural differences between military civil engineers and FMS researchers.** Cultural differences between research and practice have been reported by a large number of authors. The main factors standing in the way of effective partnership between research and practice might be roughly categorised as institutional, communicative and philosophical differences. Significant institutional differences exist in the manner by which the two types of institutions work towards achieving their goals and in terms of the intended beneficiaries which these efforts target. Significant communicative differences exist in the manner in which research results are articulated and communicated (i.e. in terms of differences in the targeted audience and readership). The need for researchers to publish in academic journals to gain academic credentials makes it less attractive for them to spend their time and energy in (re-)articulating their ideas for practitioners. Significant philosophical differences are primarily related to the interpretation of the question “what is knowledge”.\(^\text{19}\)

2. **The lack of adequate knowledge management.** Since the late 1990’s, knowledge management [KM] has become an important issue within the Dutch Defence organisation.

\(^{17}\) Blended learning and training, in the strictest sense, are the combination of e-learning and e-training with traditional face-to-face learning and training.

\(^{18}\) Other reasons are related to the differences in mindset between researchers and responsible Corps of Engineers officers (i.e. short-term versus long-term mindset) as a consequence of the job rotation scheme of military personnel or related to the typical organizational structure of the Dutch Defence organisation.

and thus has lead to a number of KM initiatives, each with their own goals, motivations and approaches. As a result of this, the current state of KM within the Dutch Defence organization can be characterized as fragmented, redundant and overlapping, not clear about its effectiveness as well as suboptimalising. An integral KM approach is a prerequisite for the transformation of the Corps of Engineers into a learning organisation and the knowledge transfer or sharing between research and practice. In fact, the development of an integral KM approach is itself a good example of a development-oriented research project in terms of solving fundamental system problems. Example 4 gives a short description of a research proposal in this area submitted by a member of the CE section of the FMS.

Example 4. Research proposal “A Holistic model for effective KM within CE departments of the Dutch Defence organisation”.

The main objective of this research proposal is to develop the theoretical basis for a holistic model for effective KM within the CE departments of the Dutch defence organisation. From this objective the following four subordinate research questions arise:
1. Is it possible to develop a theoretical model that integrates the different conceptual approaches to KM from different scientific disciplines into a single, holistic model?
2. Is it possible to “parameterize” the holistic model into a set of “value” parameters that provide a basis for valuing the performance of KM initiatives?
3. Is it possible to develop a general method for valuing the performance of KM initiatives?
4. How can we use the results of this research for effective KM within the CE departments of the Dutch Ministry of Defence?

At the time of writing, the research project has been proposed and is awaiting approval.

8. Conclusions

In this paper we discussed the existing interactions between CE education, research and practice in order to bridge the gaps between these. As a consequence of the requirements for university degree courses set by the QANU organisation and the evaluation criteria set by the NVAO, the interaction between education and research is currently adequately supported. This is not the case with the interaction between education and practice. The change in ways of “deciding, doing, acting and responding” requires a continuous process of changing the skills and knowledge of officers working in today’s Corps of Engineers. It poses a true challenge for a traditional educational institution such as the FMS in terms of education delivery and the academic competences of future officers. In this respect, solutions such as PBL, e-learning, blended learning and lifelong learning programmes have been discussed in this paper. Regarding the interaction between research and practice, we distinguish between two types of research approaches: (1) demand-driven and (2) development-oriented research. In the case of the demand-driven approach (that is, finding short-term solutions for daily problems) there are currently adequate mechanisms for the knowledge transfer between research and practice. In the case of the development-oriented approach (that is, finding long-term solutions for system problems or technological innovations) knowledge transfer between research and practice is hampered by cultural differences between military civil engineers and mostly civil FMS researchers and the lack of adequate KM within the Dutch defence organisation.

20 The cause of this lies partly in the scientific approach of KM. The scientific interpretation of KM is characterized by a strong multi-disciplinary conceptual approach which hardly gives any attention to the way an approach must be implemented in the organisation and the measurement of its effectiveness or how it adds to the aims and objectives of the organisation.