

Towards sustainable production

*The issue of integrating fragmented approaches in policy-
programs and in business firms*

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The paper is based on empirical research projects of the authors:

- Learning processes in government and industry and the introduction of environmental management systems in companies (Funded by the Dutch National Science Foundation).
- Evaluation of pollution prevention projects (Funded by the Ministry of Housing, Physical Planning and Environment).
- Environmentally relevant decision-making in industrial firms (Funded by the Evaluation Committee of the Dutch Directorate-General for the Environment).

Besides their research activities they're also consultants for individual firms and some branches of industry and involved both as an organiser and as a teacher in the postgraduate curricula on environmental management of the CCTEP.

1. The background of the paper

Directives, permit-systems and financial incentives are not enough to reach sustainable production. Many evaluation studies over the past ten years have shown that. The environmental problems and the excessive use of materials and energy make an appeal for self-regulation and creativity inevitable.

Nowadays self-regulation on environmental matters is an important intermediate goal in many countries. In several countries you can see different policy-programs are implemented to stimulate self-regulation. Sometimes several programs are implemented simultaneously. In some cases this leads to fragmented policy programs and to limited results in firms, judged by their contribution to sustainable production.

Of course you can ask what sustainable production is. In this paper we will not try to answer the question what sustainability means for the production of individual firms. Confusion about this question (and its answer) is inevitable. The question if a policy-program is a sufficient or an insufficient approach to direct firms towards *more* sustainable production can and should be answered. This is the central theme of our paper. Policy-programs should be judged on whether the necessary activities within firms are stimulated.

In the next section different kinds of implemented policy programs will be described in a nutshell. Section three answers the question of the contribution of the different kind of policy programs towards a more sustainable production. In this section we describe an integrated approach. Section four deals with the topic of environmental relevant decisionmaking in firms. In section five we specify this for different types of firms.

2. Governmental strategies towards self-regulation in firms

Roughly two kinds of policy programs can be distinguished. Firstly there are programs that aim at organizational learning, adapting environmental values and introducing environmental tasks in the organisation. Secondly there are programs that aim at dealing with concrete environmental issues. These programs are diverse in their appearance. They aim at pollution prevention by dealing with emissions and waste.

We'll shortly introduce these two types of policy-programs. We'll illustrate this by two Dutch examples, but of course similar programs can be found in other countries.

Environmental management

Initiatives to arrive at intra-company environmental care are a response to problems which were signalled in the implementation and enforcement of environmental legislation (see for instance Aalders, 1984). Such initiatives are taken both by industry and by the authorities. The central concept underlying intra-company environmental care is to stimulate the companies' own responsibility and activity. In addition to satisfying (government) regulations, we may expect intra-company environmental care to contribute to preventive goals.

Around mid-1989, the central authorities took a position on the Memorandum on Environmental Care which it sent to Parliament (Ministry of Environment and Public Housing, 1989). This Memorandum indicates what the authorities wish to achieve in the area of intra-company environmental care and which activities it feels are required to do so. The central authorities want to see to it that companies in the Netherlands have a functioning environmental system by 1995. An environmental care system is defined as follows in the Memorandum:

'An environmental care system is a coherent unit of managerial, organizational and administrative measures, aimed at gaining insight into, controlling and wherever possible reducing the effects of company activities on the environment'.

An environmental care system should include the following elements:

- a. an environmental policy statement;
- b. an environmental program;
- c. integration in company activities/environmental coordinator;
- d. measurements and registrations;
- e. internal controls;
- f. internal guidance and education;
- g. internal and external reporting;
- h. auditing of the system.

For over more than forty branches of industry manuals are written. Also more than forty projects have been funded to implement the developed methods in firms in those branches.

Pollution prevention programs.

As part of its waste matter policy, the central government in the Netherlands has followed a policy which aims to stimulate prevention activities in firms. Over the past years this policy resulted in projects which, while being part of a single main concept, vary as to their structure, methods used, executors and form of financing.

A pollution prevention project is a structure in which various participants collaborate. For example, local authorities, branch organizations, environmental advisers and environmental organizations may act as initiators, financiers, executors and supervisors.

The common aim of the individual projects concerns efforts to deal with the creation of waste and emissions in firms at the source. Thus, pollution prevention projects are set up to point the way, for one or more firms, to pollution prevention and emission - prevention. The method used by us in our study was inspired on the PRISMA method, which is the best-known and most commonly used pollution prevention method in the Netherlands¹. This method was developed on the basis of a Prevention Manual issued by the American Environmental Protection Agency (Waste Minimization Opportunity Assessment Manual, 1989). The aim was to arrive at a coherent and systematic approach which was suitable within the Dutch context.

The PRISMA method consists of four stages²:

1. *Planning and organization;*
During the first stage a project team is set up which will coordinate the project within the firm. In addition, the areas of attention are determined after a preliminary study.
2. *Assessment;*
After collecting data about the firm, its products and its production processes, prevention options are generated for the problem areas which were found.
3. *Feasibility analysis;*
The options are judged as to their technical and economic feasibility. Also their environmental effects are determined. On this basis a choice can be made as to the best options.
4. *Implementation.*
After analyzing their feasibility, the selected prevention options can be introduced. Attention is also given to the measurement and registration of the effects and the incorporation of prevention activities into the firm.

The pollution prevention projects vary as to the exact implementation of this framework.

¹ PRISMA is the Dutch abbreviation of: PROject Industriële Successen Met Afvalpreventie (Project Industrial Successes With Pollution Prevention). During this project the method in question was developed further and applied.

² See: Hoo, S. de e.a. (red.), *Handleiding voor preventie van afval en emissies [Manual for Prevention of Pollution and Emissions]*, SDU, The Hague, 1990.

Per firm (sometimes non-profit organization) participating in the project, this concept involves at any rate:

1. Inspection of the firm as to:
 - its substance and material flows;
 - the extent of its waste and emission flows;
 - the causes of these inefficiencies.
2. Looking for measures aimed at the reduction of waste and emissions on the basis of:
 - the collected information about waste and emission flows;
 - expertise within the firm and with the team of executors.

Insofar as the projects were successful, this prevention-oriented approach meant that less environmental pollution was caused and less waste had to be processed.

Our primary interest in the paper is how different policy-programs on selfregulation initiate relevant activities in firms. Also we will look for an integrated approach that combines the advantages of both types of policy-programs.

To describe the link between the policy-programs and the relevant activities within firms, we need to draw a simple model.

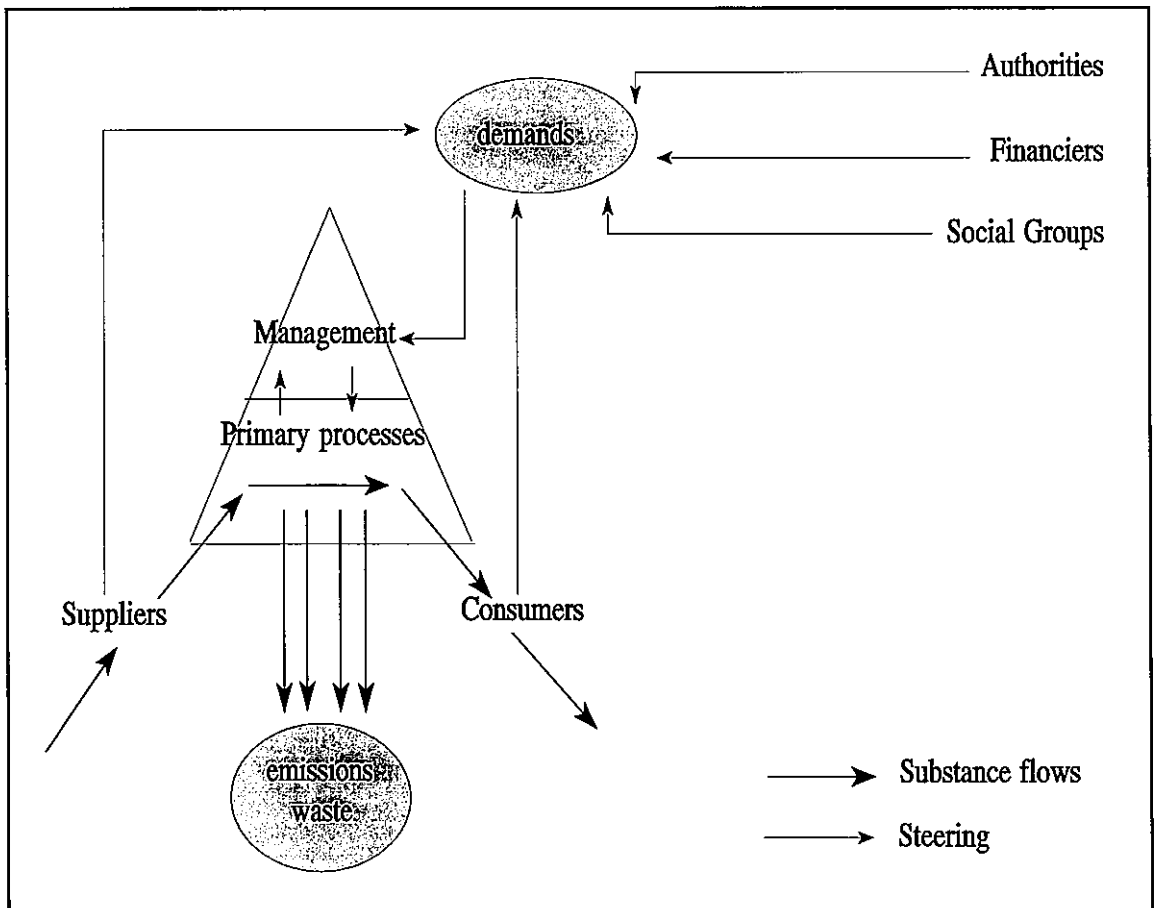


Figure 1: Substance flows, firms and environment

It needs no further explanation that environmental management programs can be described as 'a top-down approach' and pollution-prevention programs as 'a bottom-up approach'. Before writing about the details the biggest problems are:

1. That a top-down approach is implemented without keeping in mind the structure of the firms' management processes *and* without a careful selection of the environmental relevant decision processes.
2. That a bottom-up approach is implemented by external-consultants without learning the organization to prepare itself for future demands.

In a metaphor: In the bottom-up approach some fish is caught but at the same time young-fish is growing. But in order to motivate managers to look for potentially hazardous young-fish, the top-down fishing-course has to fit the needs of the organization.

3. The contribution of policy programs towards sustainable production

The first kind of programs, mainly pollution prevention programs, aim at bottom-up approaches. They aim at reducing inefficiencies in the actual substance and energy-flows. Pollution prevention projects are very often implemented by external consultants. Sometimes these consultants carry out research-activities and make proposals for improvements. Sometimes they only conduct the project management and the actual work is done by the firm itself. A problem in the method, which originated in the USA, is the emphasis on economic feasibility of measures ('Pollution Prevention Pays'). Regulations, policy demands and environmental considerations are underexposed. With that *old* values are used, instead of adapting new values necessary for developing a more sustainable production. It is questionable whether pollution prevention projects are on the long term profitable for sustainable development.

A serious problem however is the emphasis pollution prevention lays on the *actual* production process. Surely big improvements can be found here. But we should realize that these successes are made possible by insufficient attention for environmental matters in the past. Without changing the decisionmaking within the firm, nothing guarantees the absence of the same kind of problems in the future. So, related to sustainable development, the question is whether we are catching small fish or big fish.

The second kind of programs, the environmental management programs, often aims at a more top-down approach. These programs aim at integrating environmental management in the normal decisionmaking and management structure of the firm. A great emphasis is being laid on the organization of environmental matters within the firm. Less attention is paid to reviewing the environmental performance of the firm. Controlling environmental affairs seems more important than improving the performance. A positive exception perhaps is environmental management according to the BS 7750 for this norm asks for 'continuous improvement'. Alas, the members of ISO tend to weaken this demand while negotiating the new 14.000-norm. With this approach one is *potentially* catching big fish.

Sustainable environmental management

In general you can say that proper environmental management (that is environmental management that prepares a firm for sustainable production) should include carefully looking at the production process and incorporating environmental matters in decision-making. Although we are catching big fish this way, there will always be a need for improvements in the actual production ('small fish'). The ultimate goals for sustainable production are not yet given, but this enables firms to fulfill both the actual and the future demands.

Towards an integrated approach

As we've seen both kinds of policy-programs have strong points and weaknesses. Implemented separately however they lead to fragmented results and cause confusion.

On a superficial level environmental management-programs are a success. Our research indicates that a large number of firms implement some form of systematic environmental management (De Bruijn, 1994). On a closer look however a lot of paper is produced and rather less environmental successes. Public and private managers indicate a low priority for the issue 'environmental management' (Coenen and Lulofs, 1993, De Bruijn, 1994). Disappointing experiences with environmental management is our explanation for this. A lot of activities are taken place, a lot of energy is put into it, but somehow the output doesn't seem so relevant and visible. The organization has learned a lot but still not the relevant things to perform.

Pollution-prevention programs lead in practice to rather sufficient results (De Bruijn, Coenen, Lulofs and Marquart, 1995). In general, firms that participated in those programs are happy with the results. A substantial part of the firms continue improving efficiency in substance-flows and energy-flows in the actual production. But nothing in our research on pollution-prevention programs indicates that these firms are paying more attention to environmental concerns during strategic and operational decisionmaking on future production. So the organization has done a lot but hasn't learned to stay out of trouble in the future.

Different programs initiate different parts of the necessary activities. But they do so in a fragmented way. Pollution prevention projects are valuable because of the systematic view they offer on the production processes. But often these projects only result in temporal successes. Environmental management enables firms to incorporate environmental concerns, alas often without a thorough analysis of the actual environmental performance. The general effectiveness of the different policy-programs is less than would be possible in a more integral and simultaneous approach. So there is a need for an integrated approach that combines the best of both.

We propose a two-level approach:

1. A *cause-oriented* approach that aims at influencing decisionmaking processes within firms. This first level tries to prevent environmental burden even before it exists. This results in a division of tasks within the firm, at those places where environmentally relevant and important decisions are being taken. Of course, these places differ for

different types of firms (see section 5);

In *strategic decisionmaking* concerning product and production technology attention is paid to:

- the systematic collecting of information about environmental consequences in the different lifecycle-stages of alternatives;
- the search for alternatives that cause less environmental burden;
- the use of a method to evaluate the environmental consequences amidst other considerations.

In *operational decisionmaking* focused on the starting up and continuation of a production-unit attention is paid to:

- the search for elaborates of strategic decisions that cause less environmental burden;
- the use of a method to evaluate the environmental consequences amidst other considerations.

2 Cause-oriented environmental management

2. A *source-oriented* approach that aims at clearing up the pollution that is not preventively taken care of. This level results in continual processes in which the actual environmental performance is evaluated.

This two-level approach asks for attuning the different policy-programs.

In our view the pollution-prevention program is a good and successful starting-point. But *simultaneously* the organization has to be learned to influence decisionmaking processes to prevent environmental burden even before it exists.

The division of tasks within the firm, at those places where environmentally relevant and important decisionmaking takes place, is a delicate matter. It has to be efficient and include the environmental relevant decisionmaking processes of that *specific* firm.

The short-term successes of pollution-prevention programs create promising conditions. With little effort there will be enough information to deal with this matter. Multiformality and fragmentation are then replaced by an achievement-oriented and plain approach. This will stimulate firms, instead of confusing managers in firms.

In section 4 of this paper we specify the themes of relevant decisionmaking that have to be included in the dividing of tasks.

4 Environmentally relevant decision-making processes

In designing our model of business decision-making we have used a cone-shaped model. This cone is characterized by the fact that when going down in the cone, the temporal distance between decision-making and the realization of the decisions that were taken (i.e. the realization of the primary processes) diminishes, while the amount of detail is

1. Preparing

- establish the needed workforms
- preparing environmental statement
- creating bearing surface

2. Analysing the environmental performance

- making an inventory of environmental demands and standards of authorities, financiers, suppliers, consumers and social groups
- analysing inefficiencies in energy- and substanceflows

3. Generating measures and establishing a program of activities

- developing alternative preventive measures
- choosing measures on the basis of environmental, legal and technical urgency

4. Implementing the program

- implementing the chosen measures
- informing and educating

5. Controlling and reporting

- measuring and registrating
- implementing internal controls
- preparing internal and external reports
- feedback to previous processes

3 Source-oriented environmental management

increasing. In such a cone model, therefore, strategic decision-making is located close to the top of the cone, while operational decision-making is located near the bottom (viz. Paine and Anderson, 1983, and Anderson, 1990).

Strategic business decisions are aimed at long-term continuity and concern choices with regard to products, production technology and firm sites. Operational decision-making concerns the initiation, coordination and control of the primary processes. Both strategic and operational decisions are environmentally relevant insofar as they entail *potential* environmental pollution when implemented. This makes environmentally relevant decision-making a part of the 'normal' decision-making process within a firm.

In the case of *environmentally relevant strategic decision-making* the issue is future environmental pollution as a result of decisions regarding:

- * the product: i.e. the composition of the product and its use as laid down in the design of the product;
- * production technology: i.e. the intended production process, the equipment to be used, machinery-resources;
- * location: i.e. the physical location where the firm is managed.

In the case of *environmentally relevant operational decision-making* the issue is future environmental pollution due to the starting-up, maintaining and changing of production.

Environmentally relevant decisions concern the following in particular:

- * the choice of raw materials and resources;
- * the choice of equipment, machines and installations;
- * the planned use of substances and equipment, including:
 - the purchase, installation, maintenance and exploitation of tools, machines and installations;
 - the ordering and use of raw materials and resources;
- * the planned delivery, storage and transport of:
 - raw materials and resources;
 - working supplies of raw materials and resources;
- * the planned transport, storage and delivery of:
 - the products;
 - any secondary products;
 - waste matter.

Summarizing, there are good reasons to devote attention to *all* environmentally relevant business processes in trying to accomplish a considerable reduction of the environmental pollution by firms. The question of which processes are environmentally relevant can now be answered briefly as follows: both (a) the primary processes (where the sources of environmental pollution are located) and (b) strategic and operational decision-making (which caused the sources) insofar as this concerns the environmentally relevant aspects of business management.

So the issues for dividing tasks are known. Policy-programs that aim at environmental management, more specific organizational learning, adapting environmental values and introducing environmental tasks in the organisation, are bounced to fail without linking up to the main forms of management. Otherwise environmental management will stay a 'fremdkörper' in the organisation and will be rejected. In the last section we will present a conceptual framework for this.

5. Main forms of management

To be able to operate successfully, a firm is dependent on its environment. In addition to the generally dominant market and competition considerations, other environmental factors may also affect business management. Here we may think of specific demands imposed on the production process (i.e. by the license-granting authorities) or demands concerning the firm's socio-economic policy (imposed by authorities and trade unions). It is the task of the management to weigh the various requirements in shaping the primary processes. These primary processes do not consist only of production itself but also of essential functions such as the purchase of raw materials and resources and the sale of products. Thus it is the primary processes themselves that lead to the substance and energy flows that are so important to environmental management.

Changing market and competition relations must lead to adjustments in the primary

processes³. Choices are determined largely by market dynamics. Generally speaking, business management has to respond to market dynamics. Dynamic markets require a form of management which can deal with rapidly changing demands from consumers. Less dynamic markets mainly call for a form of management that is able to keep the cost price low. Thus firms can be characterized on the basis of their form of business management. This specific form of management, i.e. the *production method*, is characterized by:

1. The *products* manufactured by the firm:

If the market(s) is/are very dynamic, i.e. if consumer preferences change rapidly, the product will be revised very frequently (indicated as 'High Innovation Frequency' in Figure 4) and be closely adapted to the client's wishes ('High Product Specificity' in Figure 4). The order precedes production and there is little distance between the producer and the individual client.

If consumers preferences do not change or change only slowly, we see little market dynamics and far less product adaptations ('Low Innovation Frequency' and 'Low Produkt Specificity' in Figure 4). The orders are preceded by production (programming), and there is a large distance between the firm and the individual customer.

2. The *technology* used by the firm:

Low market dynamics result in relatively high investments being made in productivity-enhancing equipment and automation. After all, the low product specificity makes the price a major competitive factor. However, this does affect the flexibility of the production arrangement, leading to a situation which is characterized by product-specific mechanization and automation of the production arrangement to keep the cost price as low as possible.

Vice versa, a dynamic market leads to more process-specific mechanization and automation with a higher flexibility where the range of products is concerned.

On the basis of these two characteristics we may distinguish production methods on the basis of continuous, series and piecemeal production.

In the case of *continuous production* the products are put on the market indirectly in large numbers through importers, wholesalers and trade enterprises. Often production is based not on orders but on supplies, and only a small number of products are manufactured at a production site. The life cycle of a product from development up to the moment it is 'taken off the market' is a long one, and the frequency of product innovation is low. The price/quality ratio is a major competitive factor. The economic and technical life of the tools, machines and installations together with the large amount of invested capital makes far-reaching changes a long-term matter.

We see standard finished products, semi-manufactured products which are processed by

³ Although in our elaboration we devote extra attention to environmentally relevant characteristics of the organizational and decision-making structures, this is an approach with a broad base of support (Skinner, 1969; Mintzberg, 1979; Hayes and Wheelwright, 1979 a and b, and 1985; Wheelwright 1985; Lammers, 1987; Botter, 1988; Fisscher c.s., 1991 and De Bruijn and Lulofs, 1992).

a large number of purchasers, or means of production which can be used in a general way. Examples of such products are foodstuffs such as bread, semi-manufactured products such as building wood, basic chemicals such as chlorine, and basic metals such as steel. Examples of standard means of production are wheelbarrows and storage racks.

In series production we should distinguish between the production of consumer goods and the production of semi-manufactured products.

In the case of *series production of consumer goods*, just as with continuous production, market sales take place through intermediate trade, so that we see an indirect interaction between producer and consumer. However, consumer preferences with regard to the products change more rapidly than in the case of continuous production. Here the product is not tailor-made to the demands of the individual consumers, but to the idea the producer has of the preferences of (part of) the consumers. So we see considerable amounts of a standardized product which was developed with a specific group of consumers in mind. However, due to changing consumer preferences product innovation takes place regularly. Thus the life cycle of the often durable consumer goods is considerably less than in the case of continuous production. Examples of such products are audio and video equipment, household equipment, cars, bicycles, (office) furniture and clothing. The life cycle of these products varies from some six months to around four years.

In the case of *series production of semi-manufactured products* for the production of consumer goods in series production, we see direct interaction between the producer and the consumer. This means that the product to be supplied is tailored to the requirements of the individual consumers. Examples are the subcontractors that work in many branches of industry, e.g. a firm that supplies synthetic parts for the automobile industry. The means of subsistence of such subcontractors are usually closely linked to a limited number of consumers. The products they supply are large amounts of semi-manufactured products, made to order according to customer specifications. As far as the frequency of product innovation is concerned, the manufacturers of these products are forced to follow the wishes of their customers.

Regarding the production technology to be used, in series production choices need to be made between some basically conflicting considerations. On the one hand, mechanization and automation of the production arrangement can reduce cost price and strengthen the firm's competitiveness. At the same time regular product innovations force the entrepreneur make any large investments in mechanization and automation flexible enough so that he will not be faced with forced depreciations each time.

In the case of *piecemeal production* there is direct interaction between the producer and the consumer. The consumer informs the producer directly of his wishes regarding product specifications. Orders precede production. Product sales are determined by the extent to which it is possible to produce the desired product in the desired quality. However, this does not imply that a whole new product is made for every consumer; rather, the entrepreneur's general basic concept will be respecified every time on the basis of consumer requirements. Within certain limits, the range of products is infinite. These limits are determined by the product technology available. Examples of such products are made-to-order production equipment and luxury yachts.

In the following figure gives the characteristics discussed above are summarized on the basis of production method.

Production method	Product - <i>specificity</i> - <i>innovation frequency</i>	Technology - <i>mechanization</i> - <i>automation</i> - <i>flexibility</i>
<i>continuous finished and semi-manufactured products</i>	- low specificity - low innovation frequency	- product-specific mechanization - produkt-specific automation - low flexibility
<i>series finished products</i>	- average specificity - average innovation frequency	- process-specific mechanization - process-specific automation - average flexibility
<i>semi-manufactured products</i>	- high specificity - average innovation frequency	
<i>piecemeal finished and semi-manufactured products</i>	- high specificity - high innovation frequency	- process-specific mechanization - process-specific automation - high flexibility

Figure 4: Production Method, Product and Technology

Meanwhile it has become clear that any turbulence in the environment will affect the features of products and technology. Realizing these features requires the right kind of internal organization of the firm. Here we are faced with a third and fourth feature of production methods, i.e. the organizational structure and the decision-making structure.

The organizational structure is the way in which tasks, powers and responsibilities are allocated to persons and departments and the way in which persons and departments are related to one another (Heijnsdijk, 1992). In the organizational structure we first distinguish the horizontal allocation of tasks, which may be either functional or product-oriented. Next we distinguish the vertical allocation of tasks, which concerns the number of organizational levels and relations between line and staff positions.

The decision-making structure concerns the positions in the organizational structure where the contents of decision-making is actually being prepared, the temporal horizon of decision-making, the allocation of formal decision-making powers and the extent to which decision-making is governed by certain fixed rules.

The following section explains how environmentally relevant decision-making takes

place per production method on the basis of the forms in which organizational and decision-making structures occur in production methods.

In anticipation, Figure 5 gives a survey of the various forms of organizational and decision-making structures per production method.

Production method	Organizational structure - <i>horizontal task allocation</i> - <i>vertical task allocation</i>	Decision-making structure - <i>centralization</i> - <i>formalization</i> - <i>target/contents</i>
<i>continuous finished and semi-manufactured products</i>	- strong, centralized hierarchy - preparatory staff important ⁴ - staff and line strictly separate	- strongly centralized decision-making power - strongly formalized procedures - aimed at process improvements
<i>series finished products</i>	- strong, centralized hierarchy - preparatory staff important, also for product variation - staff and line separate	- centralized decision-making power - strongly formalized procedures - aimed at both process and product improvements
<i>semi-manufactured products</i>	- centralized hierarchy - preparatory staff important, particularly in case of product variation - staff and line not strictly separate	- decision-making power lies with the management, preparatory staff and medium-level executives - formalized procedures - aimed at product improvements
<i>piecemeal finished and semi-manufactured products</i>	- weak, decentralized hierarchy - no boundary between staff and line	- strongly decentralized decision-making power - few formalized procedures - aimed at product improvement

Figure 5: Production Method, Organizational and Decision-Making Structures

As mentioned above, the possibilities for deviating from this typology are limited. For instance, a firm that does piecemeal production using a technology, organizational structure and decision-making structure that belongs with continuous production, cannot compete or has difficulty competing: flexibility is too low, the distance to the customer too great and the invested capital too high. It should be noted, however, that a firm can consist of elements which have different types of business management. An example is the 'special products' department of a series-production firm.

The extent to which the organization pays attention to other demands than market demands (see Figure 1) likewise depends on the production method. If certain requirements are considered sufficiently important, the organizational structure will provide

⁴ This preparatory staff consists of planners, controllers and process developers, among others (Mintzberg, 1979).

tasks which have to ensure the translation of these requirements into relevant decision-making situations within the firm.

An important element of environmental management is the allocation of tasks to those places where environmentally relevant decision-making is taking place. The performance of these tasks should ensure the introduction of environmental considerations into strategic and operational decision-making. In short, the performance of these tasks means that all environmentally relevant decisions within the firm are subjected to an environmental test.

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