Organising Life-cycles in Supply Chains

Linking Environmental Performance to Managerial Designs*

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In recent years increasing attention has been given to continual environmental performance improvement. Although we support the thesis that organisations are able to continuously improve their environmental performance, we state that truly higher levels of environmental care are only reached via fundamental organisational changes. We conclude that, in the literature, attention to a direct link between two important dimensions of corporate environmental improvement—environmental management concepts and environmental performance—lags behind. This linkage is considered to be a critical success factor for the establishment of truly higher environmental performances.

The leading principle is that of environmental care strategies in which environmental targets and organisational activities to reach those targets are linked. Three environmental care strategies are presented. The linkage means that when a company or chain of companies wants to improve on its environmental performance and changes its environmental care strategy, fundamental organisational changes are required.

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THE LIFE-CYCLE METAPHOR PLAYS AN IMPORTANT ROLE IN MANAGEMENT DISCIPLINES. From an environmental perspective, life-cycle assessment (LCA) visualises the environmental 'cradle to grave' performance of products. The organisational counterpart, described in closely related terms as integrated chain management and closed-loop supply chains, presents the row of firms which produce, deliver the products to consumers and start anew with recycled raw materials. Chains are not only presented as a way to enhance sustainable production from the environmental side. Economic interests are also drivers for the development of chains. One of the most significant paradigm shifts of modern business management is that individual businesses no longer compete as solely autonomous entities, but rather as supply chains (Christopher 1998). Strictly speaking, the supply chain is not a chain of businesses with one-to-one,business-to-business relationships, but a network of multiple businesses and relationships. Executives are becoming aware that the successful co-ordination, integration and management of key business processes across members of the supply chain will determine the ultimate success of the single enterprise (Van der Vorst 2000).

Managerial implications of environmental supply chain management (ESCM), as an umbrella concept for the attention to environmental care within supply chains, lags behind the vast literature on LCA. Particularly if continual environmental performance is taken under consideration (see Hagelaar and Van der Vorst 2002), the linkage between chain management concepts and environmental performance is becoming of the utmost importance. In the literature (see Young *et al.* 2001; Ammenberg *et al.* 2002) the necessity to go beyond the mere certificate (e.g. ISO 14001) as a token of good performance is stressed. One should investigate the link between the influence of the company's organisation on continual improvement<not clear what two things the link is between>. Ammenberg *et al.* (2002) and Young *et al.*<and Kielkiewicz-Young?> (2001) state that a certified system does not guarantee an improvement in environmental performance. According to Schaltegger and Synnestvedt (2002), management should not delegate the design of environmental management, but take up this challenge themselves.

In describing the link between 'green' and economic success, Schaltegger and Synnestvedt point at the managerial decision and design process in which environmental management concepts are evaluated in a strategic setting (Schaltegger and Synnestvedt 2002: 344). The targeted environmental and economic performance (which can be indicated by market share, reduction of costs of environmental protection, consumer preferences), the regulatory, institutional environment and the company's internal organisation are the ingredients for a strategic choice of an environmental management concept. To fulfil the environmental and economic performance objectives, managerial efforts have to be directed at designing adequate organisational structures with the corresponding organisational measures to be able to control and manage the environmental effects of the physical process. These two dimensions, targeted performance and the matching managerial concepts, are profoundly linked together by means of the corporate strategy, in this case the environmental care strategy (ECS). Following Schaltegger *et al.* <and Synnestvedt?> (2002) in their line of thought, we propose that each environmental care strategy requires its own type of organisational structures and organisational measures to realise its specific performance objectives.

To be able to continually improve on their environmental performance, supply chains and the embedded, separate companies have to adapt their organisation. The matching between organisational design and the targeted environmental performance is embodied in the environmental care strategy. In order to be able to improve continually on environmental performance, supply chains eventually have to change their environmental care strategy. In changing from one environmental care strategy to another, we state that fundamental organisational changes are required. Changes in the organisational structures, that is, the structure for co-operation and the administrative structure, have to be followed by matching organisational measures.

In this article we state that ongoing improvement of environmental performance can only be achieved by means of radical change within the ESCM. The outline of the paper is as follows. First, we will introduce the concept of supply chain management. This concept is then linked to environmental performance via the instrument life-cycle analysis (LCA). The conclusion from that section is that a strategic choice has to be made about the type of LCA used within the supply chain. To give insight into the strategic choice three environmental care strategies and their implication for the structure of co-operation in the supply chain will be discussed. Next, we will discuss the requirements for the administrative structure and focus on the organisational measures within the chain.

Supply chain management

Lambert and Cooper (2000) detect a growing awareness by executives in their research agenda for supply chain management (SCM). According to them, a top priority in SCM should be research to develop a normative model that can guide managers in their efforts to develop and manage their supply chains. The need for successful linkages holds true especially in food supply chains because of the shelf-life constraints of food products and increased consumer attention to safe, environmentally friendly and animal-friendly production methods (Boehlje *et al.* 1995). One only needs to refer to recent problems concerning BSE, foot-and-mouth disease and swine fever in Europe to picture the numerous interrelationships of actors in these networks.

Over the years, several definitions have been developed to describe chain co-operation. At this stage there seems to be no single, universally accepted definition which generally covers the field of interest (Zuurbier *et al.* 1996; Cooper *et al.* 1997; Beers *et al.* 1998; Migchels 2001). The definitions may differ in many respects as they are designed to limit a particular field of research or to fit a specific situation. However, commonalties can still be found. Key aspects that are included in many of the definitions of chain co-operation are (Migchels 2001): a network of several organisations; processes and transactions; achieve better results; control and co-ordination; vertically organised; consumer-oriented; flexible, non-integrated organisation.

Within the supply chain, relationships may take on a variety of legal forms, including vertical integration, long-term contracts and market transactions. Cooper and Ellram (1993) view SCM as lying between fully vertically integrated systems and those in which each channel member operates completely independently (Fig. 2<Fig. 1?>). In strategic partnerships the emphasis is on co-operation and partnership between the parties, not competition and conflict, as the basis on which a joint competitive advantage is developed. Partnership refers to a relationship that attempts to build interdependence, enhance co-ordination, improve market position focus (by broadening or deepening) or to achieve other shared goals; and that entails sharing benefits and burdens over some agreed time horizon (Cooper and Gardner 1993). A partnership is a tailored business relationship featuring mutual trust, openness, and shared risk and reward that yields strategic competitive advantage (Handsfield<please check spelling; cf. References> and Nichols 1999). Environmental supply chain management presupposes information about all production stages of the product life in order to be more effective from an environmental perspective. It requires data transparency and policy congruence in the supply chain, and therefore openness and trust.

Table 1 combines the findings of literature on partnerships in marketing, contract law, economics and logistics (Cooper and Gardner 1993; Simpson and Long 1998; Lambert *et al.* 1998). It provides an overview of aspects mentioned in the literature that are relevant in determining whether a partnership is appropriate. Because each rela-

Figure 1 TYPOLOGY OF SUPPLY CHAIN PARTNERSHIPS (MIGCHELS 2001)

Drivers for partnerships	Main partnership facilitators	Successful partnership characteristics
▶ Asset-cost efficiencies (cost reduction) ▶ Customer service (e.g. shorter cycle times) ▶ Marketing advantage (e.g. entrance into new markets) ▶ Profit stability/growth	▶ Strategic complementarity ▶ Corporate compatibility (culture and business goals) ▶ Compatibility of managerial philosophy and techniques ▶ Mutuality (joint objectives, sharing of sensitive information) ▶ Symmetry in power	▶ Joint planning ▶ Global SC operating controls ▶ Systematic operational information exchange (rapid and accurate transfer) ▶ Sharing of benefits burdens ▶ Trust and commitment ▶ Extendedness (the relationship will continue into the future) ▶ Corporate culture bridge building

Table 1 CRITICAL SUCCESS FACTORS FOR PARTNERSHIPS

tionship has its own set of motivating factors driving its development as well as its own unique operating environment, the duration, breadth, strength and closeness of the partnership will vary from case to case and over time.

We conclude from this short review of SCM literature that there is variation in the motivations, facilitators and success characteristics needed to develop and maintain supply chains. This differentiation in partnerships must be incorporated in the fine-tuning between the environmental objective to be reached and the management of the supply chain.

ESCM and life-cycle assessment

Recently, more attention has been given to ESCM defined as:

> the set of supply chain management policies held, actions taken, and relationships formed in response to concerns related to the natural environment with regard to the design, acquisition, production, distribution, use, reuse, and disposal of the firm's goods and services (Zsidisin and Siferd 2001).

Life-cycle assessment can be seen as an often-used instrument of ESCM; it is a technique for gathering data on environmental care issues in order to locate environmental hot spots. The results of a LCA can be viewed as indicators of the process within the supply chain and used as a basis for decision-making about interventions from an environmental perspective. In general, the steps to be taken to implement LCA are well described
(ISO 1997). However, when one develops a LCA from different perspectives and with different goals, different results are obtained; LCA is therefore a context-dependent tool.

Life-cycle assessment is an instrument with which the environmental effects of a product during its life-cycle can be integrally assessed. Integral means that all the processes in the supply chain that contribute to the overall environmental burden are

incorporated in the assessment; from the use of raw material to the use, re-use and disposal of the product. Unfortunately, there is no standard way of executing a LCA, and there are many varying definitions (Van Koppen 2000). The most authoritative definition of LCA at the moment is the ISO 14040 definition (ISO 1997). In this ISO 'code of practice', the LCA is divided into the following four main steps: (1) goal definition and determination of the scope; (2) inventory analysis; (3) impact assessment; and (4) interpretation.

This seems to be a clear-cut approach to gathering environmental data, but in the literature we can find quite a few problems and ambiguous moments of choice in the execution of LCAs (Bras-Klapwijk 1999). Examples of such problems can be labelled as problems in the realm of representativeness and legitimacy (Van der Kolk 1995), specific usefulness (Fraanje and Lindeijer 1993), cost-effectiveness (Schaltegger 1996) and comprehension and transparency (see Schuster 1998).

From a managerial perspective, we can conclude that the application of the LCA instrument is not without its puzzles. Choices have to be made about the amount of resources one intends to invest in the execution of an LCA, about the required information to make far-reaching decisions including implementation, about the required information to satisfy stakeholders and, finally, about the public character of information. These are all questions that have to be answered in order to be able to use the LCA instrument in the company or the chain. A strategic choice has to be made in terms of how to apply LCA. Strategic because there has to be a trade-off between the process layout, the co-operation intensity with suppliers and buyers, and the relationships with customers and other stakeholders.

Environmental care strategies, types of LCA and supply chains

Conclusions from the previous sections picture a differentiation in supply chains and in the way to execute LCAs. Supply chains can have different goals which are reflected in the way companies co-operate in the chains, and the execution of LCA is subjected to strategic choice. These findings direct attention to environmental care strategies of chains in which organisational structure is matched with environmental performance. Differentiation is then accounted for. But what environmental care strategies are possible? A literature research resulted in the following ideal typical typology of environmental care strategies applicable to individual companies and supply chains (e.g. Spliethoff *et al.*<and van der Kolk?> 1991; Vermaak 1995; Van Koppen and Hagelaar 1998):

- **Crises-oriented** strategy: aimed at reduction of environmental effects that endanger minimal compliance with rules and regulation, before the effects are released to the surroundings. End-of-pipe techniques are instrumental to this strategy
- **Process-oriented** strategy: a more proactive approach based on the internal driver of pollution prevention pays (a better return) under the condition of compliance with rules and regulations. The focus is on reduction of the use of raw materials and prevention of waste within the separate steps in the production process. Examples of process-oriented techniques are new technologies to save water or other raw materials or a process redesign to produce less waste during the production process
- **Market-oriented** strategy: again a more proactive approach which focuses on the environmental demands on the product as a whole, by consumers. This strategy aims at the combination of the reduction of the environmental burden caused by the design of the product and the achievement of competitive advantage. In this

stage of environmental care the R&D department incorporates the environmental aspects into the design process

In a supply chain, strategic choices have to be made concerning the chain's environmental goals. This implies that, whenever the goals vary, the information needed to take decisions will vary as well. Therefore, the goals serve as selection criteria for the LCA data needed. Based on this assumption, we want to differentiate between the following types of LCA and data required:

- Crises-oriented LCA: end-of-pipe data (emissions, etc.)
- Process-oriented LCA: end-of-pipe, process steps and transport data
- Market-oriented LCA: end-of-pipe, process steps, transport, nature and quantity of raw materials and disposal data

When the environmental care strategy becomes more ambitious, the LCA has to generate more and more detailed information. The information gathering tends to progress from the outskirts of the organisation (crises), into the factory (processes) and, finally, into the product (market). Then, it is possible to compare the environmental burden of a product with that of a competitor. The market-oriented strategy presupposes detailed information on the environmental burden of the different stages in the production process throughout the chain. To be able to gather such detailed information in a reliable and efficient way, increasing demands are placed on the co-operation of the companies involved in the supply chain.

LCA implementation requirements

Multiple decisions concerning the scope of measures that reduce the environmental burden are possible. The LCA can trigger individual companies to implement such measures; it can also result in a joint effort in a specific place in the supply chain; it can even result in a joint decision for a changed product design (see van Sonsbeek *et al.* 1997).
It is clear that in order to make such joint decisions, some form of chain co-operation is required.

A chain is organised according to the collective targets of the participating companies and the conditions they agreed on (Zuurbier and Hagelaar 2000). In talking about multi-actor supply chains, we should keep in mind that not all chains are identical; external and internal demands on chains can differ and it is within this environment that chains are designed. In order to typify a supply chain, we will distinguish between three interrelated components of a supply chain that are specifically designed to meet those internal and external demands: institution, process and performance (see Mintzberg 1983; Trienekens 1999). **Institution** refers to the companies in the supply chain and the relations between them. The **process** refers to the sequence of activities of the parties involved. Finally, **performance** refers to the common objective of the chain (Trienekens 1999).

In this article, as stated, performance refers primarily to environmental performance. To fulfil the environmental performance objectives, the management process should be designed in a specific way. Therefore, it follows that each type of LCA requires its own type of process, which is consistently embedded in an institutional environment, which is aimed at fulfilling its specific performance objectives (Table 2).

We will discuss the two opposite types of LCA. The crises-oriented type of LCA is directed towards the individual links in the chain. Every specific party in the chain has

	Types of LCA		
Components SC	Crises-oriented	Process-oriented	Market-oriented
Process	Black box: identification of outside effects (emissions, etc.)	Nucleus: identification of internal effects and causes	Sublimation: identification of contributions to the meta-result of the process, i.e. the product
Institution	Fragmented	Negotiation	Communal
Performance	Compilation of results of individual end-of-pipe measures	Compilation of results of end-of-pipe measures and realised process improvements	Compilation of results of end-of-pipe measures, process and product design improvements

Table 2 SUPPLY CHAIN REQUIREMENTS OF LCA TYPES

to comply with rules and regulations that define a basic norm, which should not be surpassed. The process is not important in this type of LCA; it remains a black box because the attention is directed towards emissions and so on. The chain is a fragmented organisation since each company should individually comply with the (governmental) demands directed specifically at it. The chain environmental performance in the crises case is measured in the compilation of all individual performances.

The market-oriented type of LCA is the mirror image of the former. The environmental performance is the result of the joint effort to design and produce a product. This requires a chain structure in which the individual links work intensively together to open new markets. Integration and common goals are key aspects. The ultimate result of the well-coordinated process steps in this kind of chain structure is the integral level of analysis.

We can conclude that, as the ambition level for the use of LCA, and with that the ambition level of the environmental performance increases, the chain requirements also increase in order to fulfil the higher environmental performance objectives. Within the supply chain the extent of exchange and sharing of (possibly delicate) environmental information and the level of co-operation will be greater when the environmental ambition level rises.

Environmental performance and supply chain co-operation structures

To be able to meet these rising demands for co-operation and information exchange, the structure of co-operation in the supply chain has to be adjusted. First, chain co-operation structures are explored and then these structures will be adopted<adapted?> to the three ECSs.

We distinguish between four types of supply chain co-operation based on two dimensions (Fig. 2):

1. The extent of *complexity* of the supply chain partnership, as defined by the number of functions (logistics, marketing, etc.) that are included in the partnership
2. The *differentiation* of the structural linkage between the partners in the supply chain, defined as the number of consult structures<would it be helpful to define 'consult structures'?> between partners which influence the decision-making process.

The **round table structure** is the most basic. There are few consult structures between partners influencing the decision-making processes focused on only one business

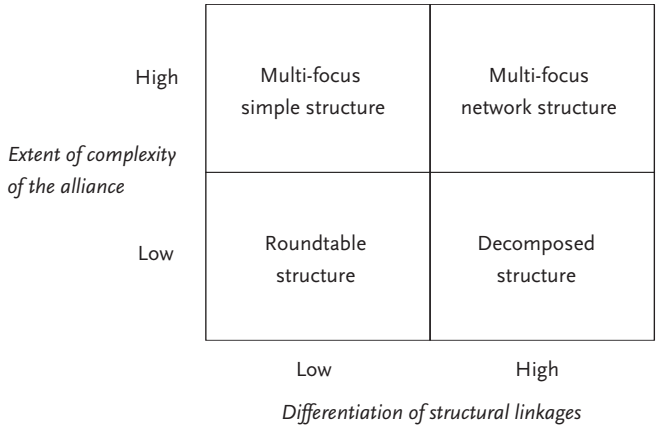

Figure 2 TYPOLOGY OF SUPPLY CHAIN STRUCTURES
Source: Zuurbier and Hagelaar 2000

function (e.g. transportation). All the other business functions and management functions are dealt with by each individual partner separately.

The **multi-focus simple structure** suggests that few consult structures between partners participate jointly in the decision-making processes on several functions. Within each firm, the decision-making is attuned to joint decision-making.

The **decomposed structure** is characterised by just a limited number of functions to be included in the partnership. However, the nature of those functions requires a highly differentiated consult structure of co-ordination and fine-tuning among the partners, horizontally and vertically. This situation occurs, for example, in highly technologically advanced alliances.

The last structure, the **multi-focus network structure**, fits situations in which the partnership deals with many functions and the decision-making process is highly differentiated both vertically and horizontally. Mechanisms that are installed in these structures comprise: joint teams for individual functions, shared facilities, inter-functional and cross-functional interfaces, steering mechanisms for overall management of the alliance or supply chain, and centralised and decentralised decision-making based on decomposition of problems (see Zuurbier and Hagelaar 2000). In short, this is chain co-operation in *optima forma*.

On the basis of the theoretical description of chain co-operation structures we can conclude that, as complexity and differentiation in consulting structures increase, tighter partnerships are required. The implementation of more ambitious goals puts higher demands on the co-operation of supply chain partners. Of course, this is logical since more information is exchanged on processes and products, requiring an ever-more open and trustworthy co-operation model. It can even be the case in this form of co-operation that companies invest in other companies within the chain to improve the overall environmental performance, following the supply chain management line of thought. When we link these findings to the different types of LCA, we find the overview depicted in Figure 3.

The complexity of co-operation increases in line with rising ambition levels. In order that the co-operation structures, and with those the aims, can be assured, the co-operation structure has to be embedded in the administrative structure of the involved chain. The administrative structure of a chain can be typified by two dimensions (see Luning *et al*. 2002): centralisation–decentralisation and formalisation–flexibility. In Figure 4, administrative structures are developed according to the two dimensions.

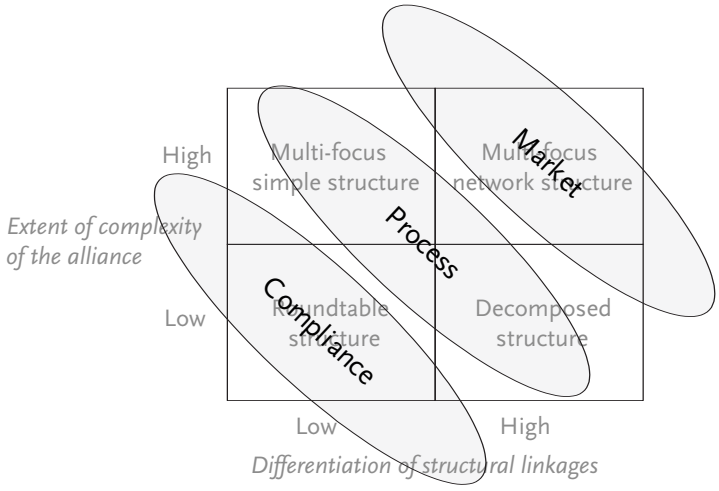

Figure 3 CHAIN CO-OPERATION STRUCTURES AND TYPES OF LCA

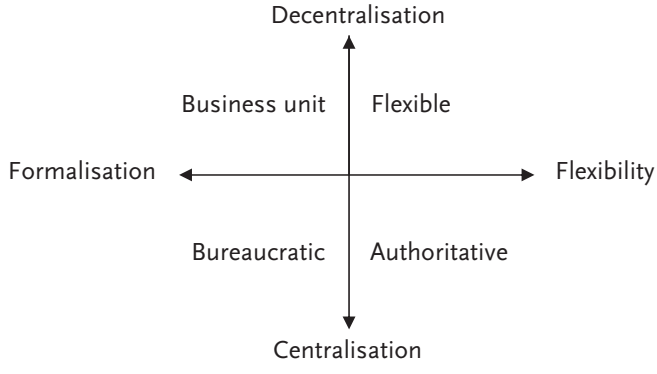

Figure 4 ADMINISTRATIVE STRUCTURES (LUNING *ET AL.* 2002)

Following this line of thought, we can link the co-operation structures and, in line with those, the three ECSs, to the administrative structures as follows:

1. Round table structure/crises-oriented strategy: authoritative administrative structure

There are few consulting structures and one business function is at stake (i.e. compliance). The environment (dominated by governmental authorities) is rather stable. The administrative structure is authoritative.

2. Multi-focus simple structure and decomposed structure/process-oriented strategy: bureaucratic or business unit administrative structure

The two co-operation structures are relatively more complex compared with the above-mentioned structure: the one co-operation structure because of the high structural linkages (many environmental issues are dealt with), the other structure because of the high extent of complexity of the alliance (the environmental measures taken are critical for other quality standards as well, such as safety in the aviation industry). Both sources of complexity demand a fitting administrative answer to assure the co-operation structure. One way of coping with the complexity is by introducing the procedure-driven administrative structure (bureaucratic structure) to be used in a rather static environ-

ment. The other way of dealing with the rising complexity is giving freedom to units to execute the strategy; they can handle environmental issues in their own way (business units).

3. Multi-focus network structure/market-oriented strategy: flexible administrative structure

This co-operation structure scores high on both dimensions; the chain is faced with the utmost complexity. High demands are placed on the partnership because of the many functions incorporated and the large number of consult structures; in other words, an intensive partnership designed for fast response to market demands. This requires speedy and content-driven decisions (decentralisation and flexibility).

Measures

We stated above that each environmental care strategy has its own ideal typical combination of co-operation structure and administrative structure. To execute these structures and realise the targeted performance, the appropriate organisational measures have to be taken. The organisational measures have to be consistent with the co-operation structure and the administrative structure to achieve the goals. Three types of organisational measure are presented (see Luning *et al.* 2002):

- Technology oriented: what kind of technology is required?
- Procedure oriented: how formal and dynamic should the organisation function be?
- Human oriented: what are the required competences and skills of the employees?

Technology measures

Chains which have a certain strategic ambition should plan the type of technology they need to enable them to reach the targets. Luning *et al.* (2002) stress the importance of creating strategic technology plans in which the desired technology is chosen. To be able to keep up with competitors, they discerned three types of technology. They differentiated between incremental (using existing techniques, proven technology), radical (new technology for a specific business object) and fundamental technology (new for the company and probably for the world). The choice between these three types of technology is a trade-off between risks and rewards pending their<?> strategy.

Procedure measures

Ultimately employees have to execute certain actions to reduce environmental burden. To direct the employees, different ways of steering are at the disposal of a manager. These different ways of steering vary from procedure-driven to flexible and from centralised to decentralised.

Human measures

To achieve the desired environmental performance the skills and knowledge of employees are essential. People management can take place in three modes: vertical, horizontal and inter-organisational.

ECS / Components	Crises	Process	Market
Performance	Compilation of end-of-pipe measures	The same plus process improvements	The same plus product design improvements
Structures			
Co-operation structures	Roundtable	Multi-focus or decomposed	Flexible
Administrative structure	Authoritative	Bureaucratic or business unit	Flexible
Measures			
Technology	Standardised	Radical	Fundamental
Procedure	Authoritative, procedure-driven	Decentralised, procedure-driven	Decentralised, flexible
Human	Vertical	Horizontal	Chain

Table 3 OVERVIEW OF THREE IDEAL TYPICAL CONSTELLATIONS

With the vertical mode, the strict execution is meant by employees of tasks within an organisation<Please check sense>. Communication and description of tasks and control measures are part of this mode. Within the horizontal mode attention is paid to employees forming a workgroup within one unit or across functional or staff units. The specification of clear targets for such a group, creating the organisational bedding within the existing organisation and empowering employees, are measures taken in such a human-oriented type of measure (see Luning *et al.* 2002: 289).

The inter-organisational mode encompasses groups of employees belonging to different partners in the supply chain. Organisational measures concerning specific training on relevant subjects on an inter-organisational level (new modes of communication, joint marketing, joint R&D, collaboration), empowering and training strategic skills, and stimulation of learning about partners (encourage participation in chain activities and internalisation of chain goals) are part of this mode. Special attention should be given to the inter-organisational bedding of these groups.

By considering these types of measure, which represent three different fields of intervention within an organisation, one can get a deeper insight into the desired organisational requirements. The types of organisational measure are presented below <in Table 3?> in line with performance and the organisational structures as discussed above. We consider this elaboration as a preliminary exercise based on arguments and various empirical insights from student based research.

The types of measure will also be explained in accordance with the ECS.

Technology-oriented measures and ECS

As stated above, the environmental performance of a crises-oriented strategy is directed towards complying with governmental rules and regulations. Risks are deduced from those governmental demands. Rewards are in terms of meeting minimum standards, which eventually has some pay-off such as no penalties and the creation of some goodwill with the local or regional authority. End-of-pipe technology is designed to meet governmental demand and earn the rewards. Therefore, incremental technology is in such cases an appropriate means to meet the performance objectives.

The environmental performance of a process-oriented strategy is a compilation of results of end-of-pipe measures and of process innovations. The strategy is directed at reduction of environmental burden and at cost saving. Risks are limited. The strategy

is deduced from the corporate environmental policy and indirectly from the market (market share by price competition). Rewards are in line with this; that is, meeting corporate policy and enlarging market share. Incremental technology and possibly (when a particular sector is characterised by a severe price competition) radical technology are in line with what is at stake in process strategy and the same applies for environmental performance.

The environmental performance of market-oriented strategy is the compilation of effects of end-of-pipe-, process and product design measures. The strategy is directed at meeting market preferred environmental challenges. Innovative technology can be seen as a means to achieve a competitive edge. Risks and rewards can be located in the market. Radical and fundamental technology is in line with such an environmental target.

Procedure-oriented measures and ECS

As we gathered from the previous sections, environmental actions are, with respect to the different ECSs, located in different parts of the organisation. In the case of the crises-oriented strategy, the technology and maintenance unit is the unit in which appropriate actions are likely to be concentrated. Such a unit strives, with the help of end-of-pipe technology, for compliance with more or less static governmental norms. In other words, these actions can be centralised and can be strictly procedure driven.

To reach process-oriented environmental performance, the location of environmental actions becomes more spread over the supply chain. Economic, financial departments, line-units such as production units and possibly a specific co-ordinating unit (environmental co-ordinator) take action. Possibly the units receive some freedom to reach environmental and financial targets in their own manner. In other words, tasks are decentralised and are in a certain limited degree dynamic. From the top to the units there are no procedures but targets. Within the unit, procedures can be used to manage the actions.

The location of environmental actions for the market-oriented strategy is more diffuse than in the latter strategy. Besides the units already mentioned, the units of product design, sales and marketing, function actively within such a strategy. Dynamic adaptation is the key concept within such a supply chain. Decentralisation and flexibility are the key words to manage the environmental actions.

Human-oriented measures and ECS

In the execution of the crises-oriented strategy the vertical mode of taking measures is dominant. As we saw in the discussions above on the other types of measure (technology and procedure), standardisation and centralisation are the key words for reaching compliance directed goals. It is important that employees in such a context know, understand and execute their isolated, environmental action(s) within the organisation.

In reaching environmental performance based on a process-oriented strategy, employees should become more knowledgeable about the process within the company. As units can have freedom in choosing methods to reach goals, employees will be more committed to the environmental performance. The horizontal mode of human-oriented measures becomes relevant to implementation.

The market-oriented strategy with its specific environmental performance is reached by intensive co-operation within a chain. The process of product design and dynamic adaptation to changing preferences of consumers make decentralisation and flexibility important features of the organisation of the chain. Human-oriented measures in the

inter-organisational mode can contribute to these features by linking the companies intensively, exchanging information and building trust.

Consequences of continual improvement

In the previous section we derived certain mixtures of organisational measures required to execute the organisational structures successfully. In order to implement the organisational structures, the appropriate measures are required.<delete?> We can conclude that changing ECSs requires a fundamental and consistent organisational change which boils down to changing:

- The partnerships within the chain and the relations between units within the constituting companies
- The personal attitudes towards the role of the environmental issue for the continuity of the chain
- The processing of the material flow through the chain

More specifically, we can point to different aspects of a chain in which changes have to be implemented:

Information gathering

Changing ECS means changing the information infrastructure. Measurement of end-of-pipe solutions has to change to measurement of process steps and one step beyond that, measurement of half fabricates. Exchanging information between partners, thus adapting the information structure within the chain, becomes highly necessary to be able to design more environmentally friendly products.

Commitment and trust

Changing ECS means changing commitment and trust between the companies involved. In the crises-oriented strategy environmentally oriented actions take place in isolated units throughout the chain. Each company has its own responsibility. In the other two strategies people have to co-operate more and more, exchange information, discuss results and change their actions because of joint decisions. Borders of units within a company and between companies have to be crossed to be able to reach jointly agreed goals. Evidently, commitment to environmental chain goals and trust in partners becomes more and more important. Crossing organisational borders implies changes in commitment and trust.

Leadership and assessing success criteria

Organisational structures have to change when changing ECS. This implies a change in leadership: from direct, short line control to controlling the execution of procedures, to controlling the achievement of targets, to inspiring self-steering teams. In line with the style of leadership, the assessment of success criteria has to change as well, from complying with minimum standards to assessing economic and environmental benefits criteria, to market-oriented criteria.

Technology

Technology changes with changes in ECS. This means that new knowledge has to be gathered both within the chain and externally. Not only knowledge changes about new machines and the use and maintenance of these machines, but also knowledge about the assessment of the performance of the technology and knowledge about product design have to be (continuously) developed.

Skills and capabilities

Besides gathering new technical knowledge, more and more attention is paid to social and strategic skills. Having the skills and capabilities to co-operate with people from their own company and with employees from chain partners, becomes essential for reaching environmental targets. Also the capacity for drawing conclusions and taking joint decisions within their own 'jurisdiction' becomes more important. The innovativeness of (groups of) employees is another skill which has to be stimulated in order to develop a market orientation successfully.

Attitude

To successfully change ECS, the attitude of employees has to change as well: for example, the attitude towards environmental care as an element of corporate strategy. The attitude within a crises-oriented strategy is viewing environmental care as an external issue which has to be dealt with: environmental care as a burden. In the process-oriented strategy, the attitude changes to an internal issue in which economic benefits can be reached by way of reducing the environmental effect: pollution prevention pays attitude. In the market-oriented strategy the environmental issue becomes externally oriented, this time towards the customer. Environmental care becomes vitally important for the chain: market attitude.

Another change in attitude has to do with the change in administrative structure. In changing from one ECS to another ECS, switches in administrative attitudes can be detected: from following orders to following procedures, to taking own responsibility, to target orientation, to flexible adaptation towards the market. An important condition for realising all the changes mentioned, is an open mind for change.

Epilogue

In this article we presented a line of thought which shows that continual environmental improvement needs to be organised. Strategic decisions have to be made in order to design environmental management concepts which can realise the desired environmental and economic performance. We illustrated this by linking the environmental performance, expressed in LCA results, to organisational and administrative structures of supply chains and deepening these insights by pinpointing matching measures. Although we consider this line of thought as a preliminary exercise, we would like to draw the following conclusions:

1. Environmental performance is bounded to an environmental management concept.

In this article we approached environmental performance improvement as a bond between environmental performance and the organisational management concept. This bond resulted in three ideal typical constellations of environmental performance, co-operation structures, administrative structures and types of measure.

2. Radical improvement of environmental performance can only be reached by changing the ECS within a supply chain.

To improve the environmental performance, a chain can choose to optimise the possibilities within one management concept. This is more or less bounded continuous improvement. Optimising has its borders and when reaching those borders, a chain is faced with the strategic weighing of changing the environmental care strategy.

3. Effectuating an ECS has a radical impact on the environmental management concept of the supply chain.

Continual environmental improvement by effectuating another ECS not only means a fundamental chain-internal change. Implementing another ECS also includes changing its relation with the external stakeholders such as the government, competitors and customers. In searching for new possibilities for continual environmental improvement, new boundaries have to be overcome. From this perspective, changing the environmental performance directly affects choices which have to be made concerning the internal and external chain organisation.

Schaltegger and Synnestvedt (2002) talked about a challenge for managers to design new environmental management concepts. We truly perceive this design effort as a challenge for management science as well, in close co-operation with environmental science (LCA). The design should be aimed at the development of normative models for ESCM (see Lambert and Cooper 2000). A basic requirement for the design effort is empirical research in the fields of effective and efficient environmental management concepts to realise the targeted environmental goals.

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