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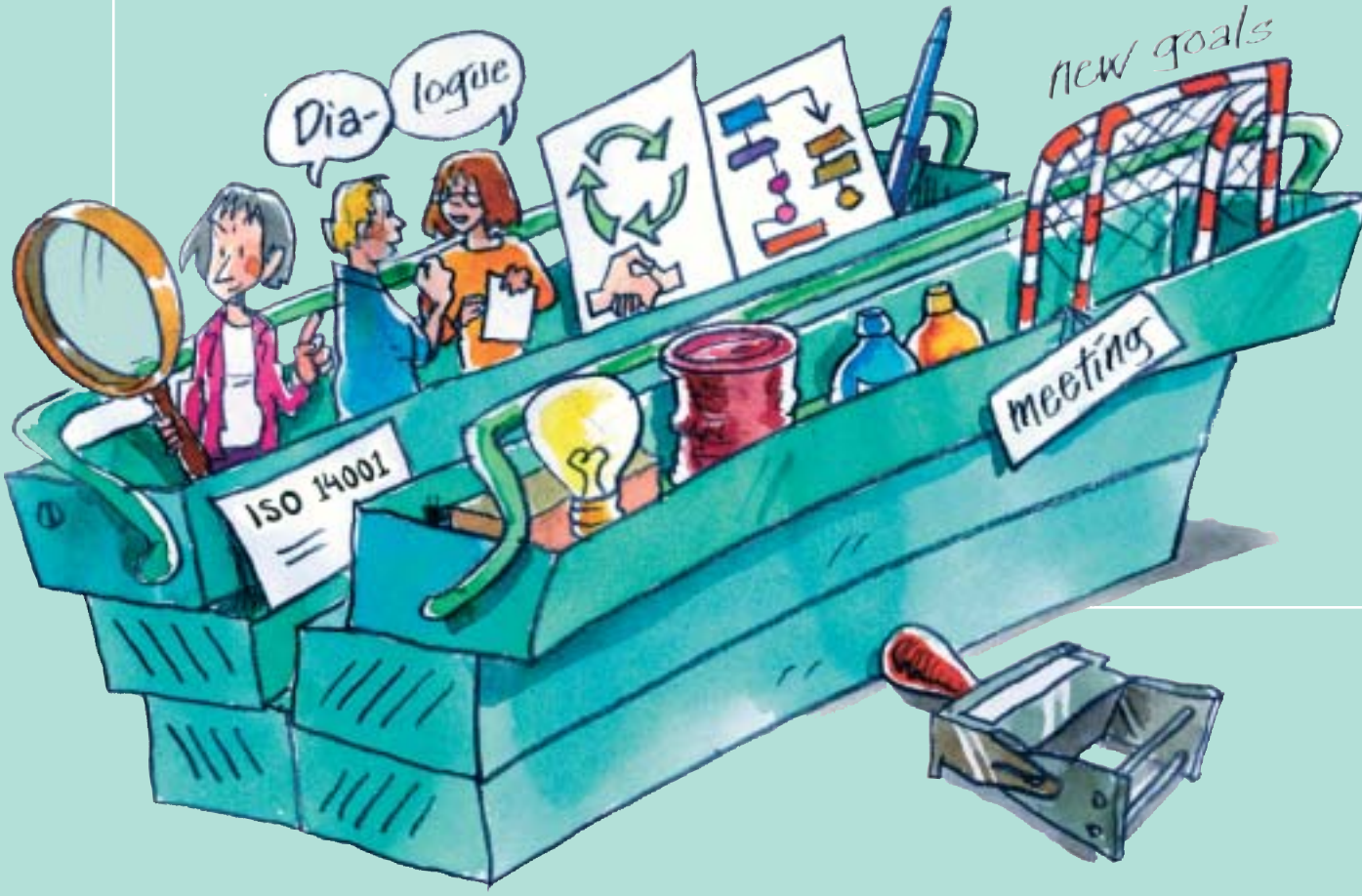
An introduction to Life-Cycle Thinking and Management



Danish Environmental Protection Agency
Danish Ministry of the Environment

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An introduction to Life-Cycle Thinking and Management

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Foreword

In recent years, enterprises taking the forefront in environmental initiatives have increasingly focused on product-oriented initiatives. The Danish Ministry of the Environment and the Environmental Council for Cleaner Products support product-oriented environmental initiatives and have put forward three main goals:

- The environmental characteristics of a product should constitute an aspect of its market competitiveness equal to that of price, function, quality, design, etc.
- Product development should entail improved environmental characteristics throughout the product's life cycle, from cradle to grave.
- That all stakeholders can and will take initiatives to reduce the environmental impacts associated with production, transport, use and disposal of products.

The overall objective is to encourage enterprises to develop cleaner products which may also provide enterprises with competitive advantages in the marketplace.

How does an enterprise get started with product-orientated environmental initiatives? This booklet provides practical ideas, based on a life-cycle perspective, for preventative environmental initiatives.

The booklet is aimed at enterprises, regardless of their sector or size, which are interested in reducing the environmental impact of their products.

The focus is on a straightforward approach to environmental initiatives, where an enterprise begins at a level which matches its ambitions and capabilities. The goal of an environmental initiative is to achieve concrete environmental improvements to products. Enterprises can plan their activities so that the advantages associated with a product-orientated environmental initiative are realised throughout the process.

Development and marketing of cleaner products is not difficult if an enterprise chooses a step-by-step approach where initiatives gradually become more ambitious and far-reaching as the enterprise acquires experience.

This booklet explains how enterprises establish an internal commitment to and readiness for life-cycle-based initiatives, as well as an understanding of how this may gradually be expanded to become a more strategic effort with marketing of cleaner products.

Good luck with your efforts !

Steen Gade,
Director General,
Danish Environmental Protection Agency

Anna Lise Mortensen,
Brdr. Hartmann A/S

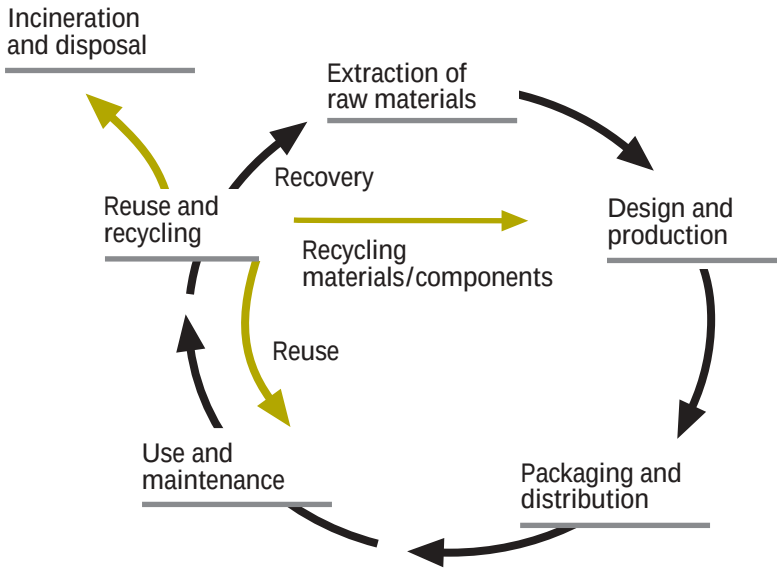
1. Life-cycle-based environmental initiatives

From Cradle to Grave

Life-cycle-based environmental initiatives involve developing products which have improved environmental characteristics throughout the product's life cycle, from cradle to grave.

In the past, enterprises have primarily focused on environmental improvements to the production processes within the enterprise's own perimeter fence. Life-cycle-based environmental initiatives focus on improvements to the product in all phases, from raw material extraction and transport, to production and consumption, to re-use or disposal.

Figure 1.
The life cycle of a product – and closing the resource cycle



A life-cycle-based environmental initiative provides an opportunity to get an overview of the enterprise's situation and to weigh the advantages and disadvantages associated with various choices. For example, would the disadvantages associated with an environmentally problematic material in the production process be counterbalanced by doubling product durability? Composite materials reduce the weight of a car and thereby contribute to decreased fuel consumption in the use-phase of the product. But does this advantage outweigh the disadvantage that recycling of composite materials is often problematic?

A life-cycle assessment provides an opportunity to obtain an overview over the advantages and disadvantages associated with various choices which arise during the various phases in a product's life cycle from cradle to grave. Such an overview also gives the opportunity to develop new initiatives. Is there, for example, a new method to recycle composite materials? Via an environmental / life-cycle assessment it is possible to obtain more detailed knowledge which provides a sound foundation for subsequent decision-making and final choices.

A life-cycle perspective demands more from an enterprise's environmental initiatives, but also provides the possibility for significant advantages, for example: an improved market position compared to the competitors; an improved market image; closer cooperation with suppliers and customers regarding product development and marketing; as well as better relations with environmental and other authorities and with other collaborative partners.

Enterprises begining life-cycle-based environmental initiatives NOW have a greater possibility of realising these advantages than if they wait to see what the competitors are doing.

From cleaner production via environmental management to cleaner products

Over the last decade, Danish enterprises have gradually been taking more responsibility for the environment: *from* environmental optimisation of production, *via* a commitment to make continuous environmental improvements, *to* development and marketing of cleaner products. These represent three different steps in a preventative environmental initiative, which is in itself a step towards sustainable development taking into account economic, social and environmental issues.

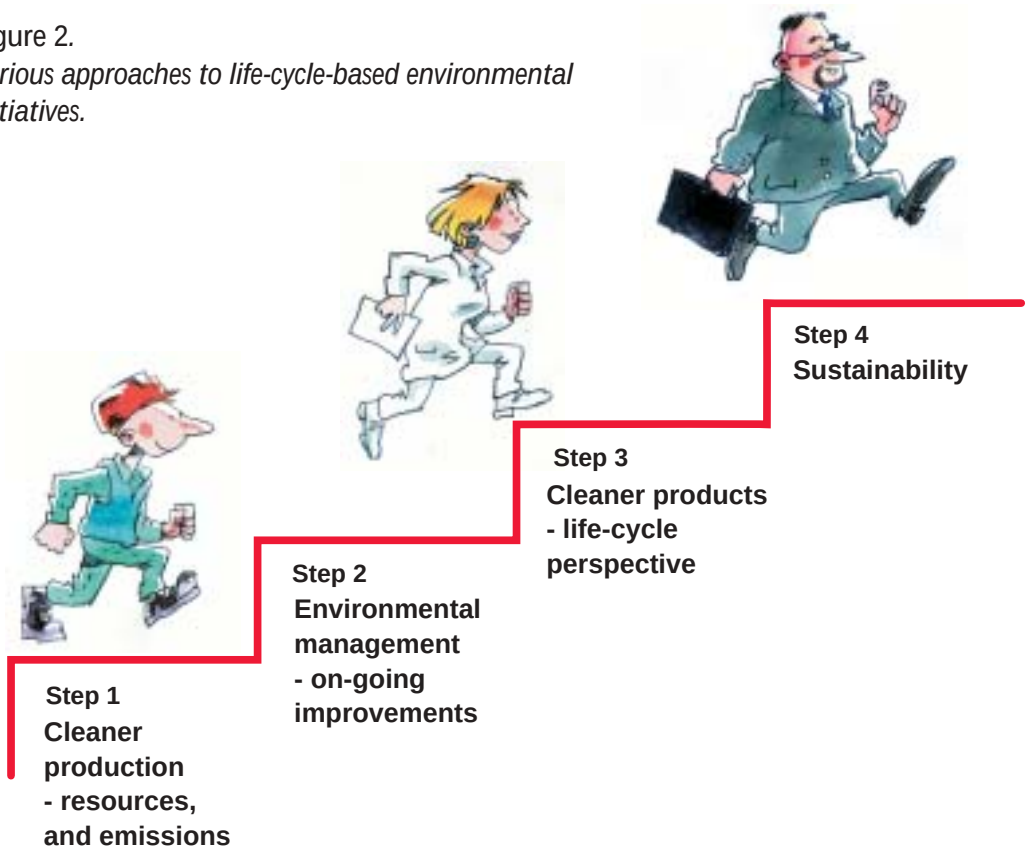
Cleaner production processes

When an enterprise has optimised production by reducing water and energy consumption, by substituting harmful materials, and by introducing the best available technology to reduce discharges and emissions, then an enterprise's products are cleaner, all else being equal. Cleaner production is a first step towards cleaner products.

Environmental management

Environmental management often focuses initiatives on the environmental conditions within the enterprise's own property and makes demands for continuous improvements. With this focus, environmental initiatives can gradually be expanded to include for example, environmentally optimised goods transport, collaboration with suppliers regarding phase-out of harmful substances, information to consumers regarding environmentally friendly product use, etc.

Figure 2.
Various approaches to life-cycle-based environmental initiatives.



Life-cycle-based environmental management is a step further towards cleaner products.

Cleaner products

When an enterprise focuses on improving the environmental characteristics of a product, all departments must contribute including product development, production, sales and marketing, procurement, and transport. Similarly, it requires increased collaboration with suppliers and consumers, regarding environmental improvements and to meet the criteria for the Swan and EU Flower eco-labels.

Cleaner products and eco-labelling make direct use of environmental characteristics as a parameter in market competition.

An enterprise may use all three steps towards producing cleaner products. The enterprise selects the level which best matches its goals and level of ambition, its previous experience, and the resources available.

THREE EXAMPLES FROM DANISH ENTERPRISES

Many Danish enterprises have undertaken extensive environmental initiatives corresponding to one or more of the above "steps". Increasingly, industries are taking their responsibility for the environment seriously which, in accordance with Danish and EU environmental policy, involves preventative action at the source, closure of the raw material cycles, the "polluter pays" principle, and sustainable development.

Printline is a print production company in Odense with 30 employees. In the late 1990's, the enterprise began to make changes to the print production process so that the use of lead and tin was replaced with silver. Printline realised a number of advantages with this new production process: the use of silver represents only one percent of the previous quantity of tin and lead; water and energy consumption have fallen by 80 to 90 percent; the production flow operates four times faster; the work-place climate has improved; the quality of the product has improved, as the surface is now more flat, etc.

Substitution of silver in the place of the undesirable metals has created a cleaner production process, and thus also cleaner printed circuit boards. Together, substitution and cleaner production are steps towards cleaner products.

In 1993, *Phønix Printing* in Århus was the first Danish enterprise to introduce a certified environmental management system. According to the enterprise's environmental accounts, the staff now includes 71 quality and environment managers (= employees). The enterprise has since obtained a licence to use the Swan eco-label on their products. Today, a quarter of the enterprise's trade is in Swan-labelled printed matter and Phønix is working towards increasing this segment via customer guidance, partnerships and general dialogue.

Environmental management can take a product-orientated direction, and thus become a tool, assisting enterprises to develop and market cleaner products. "Green Cotton" is a product concept based on a life-cycle perspective which

the company *Novotex* launched in the late 1980's. The central phases in the life cycle of a cotton product were identified. Then, for each phase, the health and safety and environmental problems were roughly assessed. Based on this information Novotex has had on-going collaboration with its suppliers to reduce the environmental impact of cotton products. At the same time, the enterprise has been working with cleaner technology, introduced an EMAS environmental management system, and eco-labelled some of its textile products.

A cleaner product concept is a good platform from which an enterprise can begin to work with environmental management, eco-labelling, and collaboration with suppliers.

SUPPLY AND DEMAND – WHICH COMES FIRST?

Developments and initiatives in the environmental field have often been driven by demands from authorities. A product-orientated environment policy, also referred to as an integrated product policy (IPP), places some of the responsibility in the hands of the enterprise and the consumer.

Demand for cleaner products on the market must be created: and creating de-

mand is a gamble. On the one hand, an enterprise can, to a certain degree, claim that consumers do not demand cleaner products. On the other hand, consumers may claim that enterprises do not produce and offer cleaner products.

This is a difficult "chicken and egg" situation. But enterprises must take a gamble and make investments in the environment, betting that there will be advantages in the future. The list of possible advantages is long (see chapter 2).

2. Advantages with life-cycle-based environmental initiatives

It is important for an enterprise to predict new trends and possible threats. What one enterprise sees as a threat may be seen as an advantage by another. An enterprise's perspective on environmental change depends to a large degree on the enterprise's own environmental strategy as well as its internal readiness and commitment to undertaking integrated environmental initiatives.

There are a number of good reasons to begin with life-cycle-based environmental initiatives.

INTERNAL DRIVING FORCES

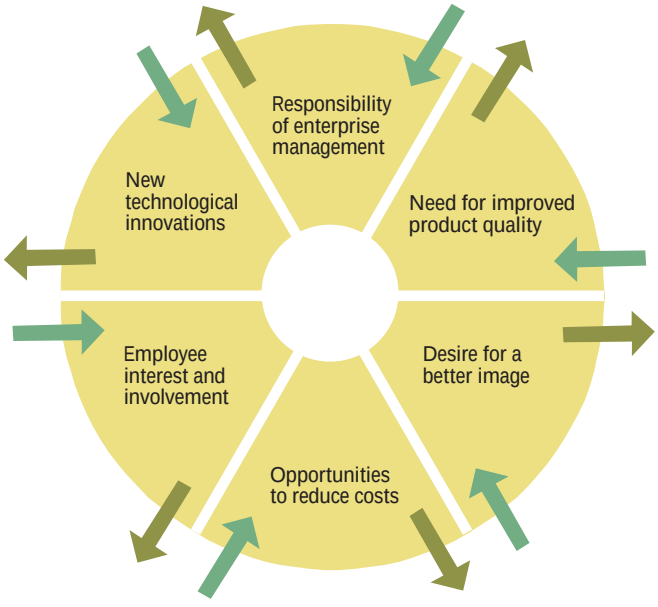
One of the internal driving forces is often an enterprise's desire to be at the forefront of new trends which may be profitable. Inspired by the United Nation's environmental organisation, UNEP, a list of driving forces includes the following (see also Figure 3).

1. The responsibility of management
Management have a responsibility to minimise the environmental impact from products and processes. This responsibility includes the children in the day-care centre 200 metres down the road and extends to the hole in the ozone layer. Management are being urged to act with foresight, to take responsibility for their products, to phase-out environmentally detrimental substances, and to accept their scrap products back from customers, etc.

2. The need for improved product quality
Consideration of the environment in the product development and design stages may give a product new qualities in terms of functionality, durability, ease of maintenance and repair, etc. Thus, the quality of a product may be improved by considering environmental implications from cradle to grave.

3. The desire for a better image
A product and an enterprise's image may be improved by documenting the product's environmental profile in environmental communications, for example, in the enterprise's environmental policy or its green accounts. Thus, an enterprise can market itself, both to its own employees and to external partners, as an enterprise which makes on-going improvements to reduce the environmental impact of its products.

Figure 3.
Internal driving forces and possible advantages



4. An opportunity to reduce costs
Often there are numerous opportunities to reduce costs which become evident during a product-orientated initiative, for example, reduced material costs, less waste, optimised logistics, lower resource consumption, and fewer emissions from each production step.

5. Employee interest and involvement
Employees as well as management must take responsibility for the environment. Employees have an interest in removing harmful substances from production as it will improve their work-place environment. When employees contribute with suggestions regarding environmental improvements, their pride in the product's workmanship increases. A good enterprise and product reputation has a positive effect on employee recruitment.

6. New technological innovations
Technological innovations in the form of new materials or inventions can radically improve a product's environmental profile by increasing its energy efficiency, durability, etc. An explicit environmental profile may lead to breakthroughs into new markets.

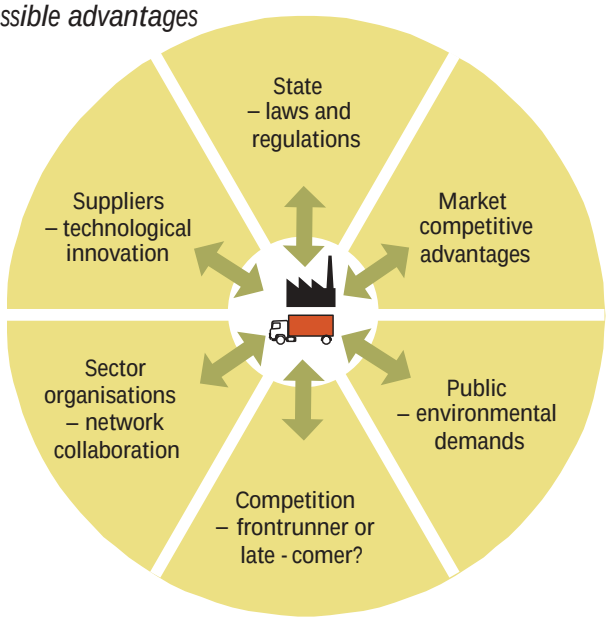
External driving forces

Most enterprises are involved in close collaboration with a number of partners. These relationships may provide opportunities for life-cycle-based environmental initiatives, or demands may be imposed, for example by authorities. Collaboration may also give the opportunity to achieve several advantages (see also Figure 4).

1. Goodwill with the authorities
A front runner environmental initiative creates goodwill with the authorities, as the authorities adjust inspection and supervision of an enterprise according to the enterprise's own level of initiative. At the same time it is expected that enterprises take responsibility for the environmental impacts from their own processes and products.

2. Advantages in market competition
Development of cleaner products and eco-labelling according to the EU Flower and the Nordic Swan criteria may give a strategic advantage on the market in terms of a greater market share and increased sales. A life-cycle-based environmental initiative may give the product an extra quality which may be a contributing factor in a customer's selection of the product rather than a competing product.

Figure 4.
External driving forces and possible advantages



3. Public demands
Contact with friends, neighbours, the media, etc. creates situations where both management and employees are questioned regarding the enterprise's environmental performance. An environmental communication regarding the enterprise's environmental initiatives provides "the right answers" and a good public image.

4. A frontrunner compared to the competitors
An enterprise which has the internal readiness for, and commitment to, life-cycle-based environmental initiatives has the opportunity to be a frontrunner in the development of cleaner products, rather than just following the competitors. As a trend-setter, an enterprise becomes an attractive and credible supplier.

5. Network collaboration and demands from business associations
Many sectors collaborate via networks or product panels on product-orientated environmental initiatives. A few business associations require member enterprises to introduce a certified environmental management system. Other sectors have developed their own guidelines for "good environmental behaviour".

6. Collaboration among suppliers regarding environmental innovations
Increased collaboration between suppliers may provide advantages in terms of exchange of knowledge and experience, improved supply assurance, flexibility as well as mutual assistance with development of new products and services. Closer cooperation with mutual advantages may lead to partnerships which create new environmental innovations.

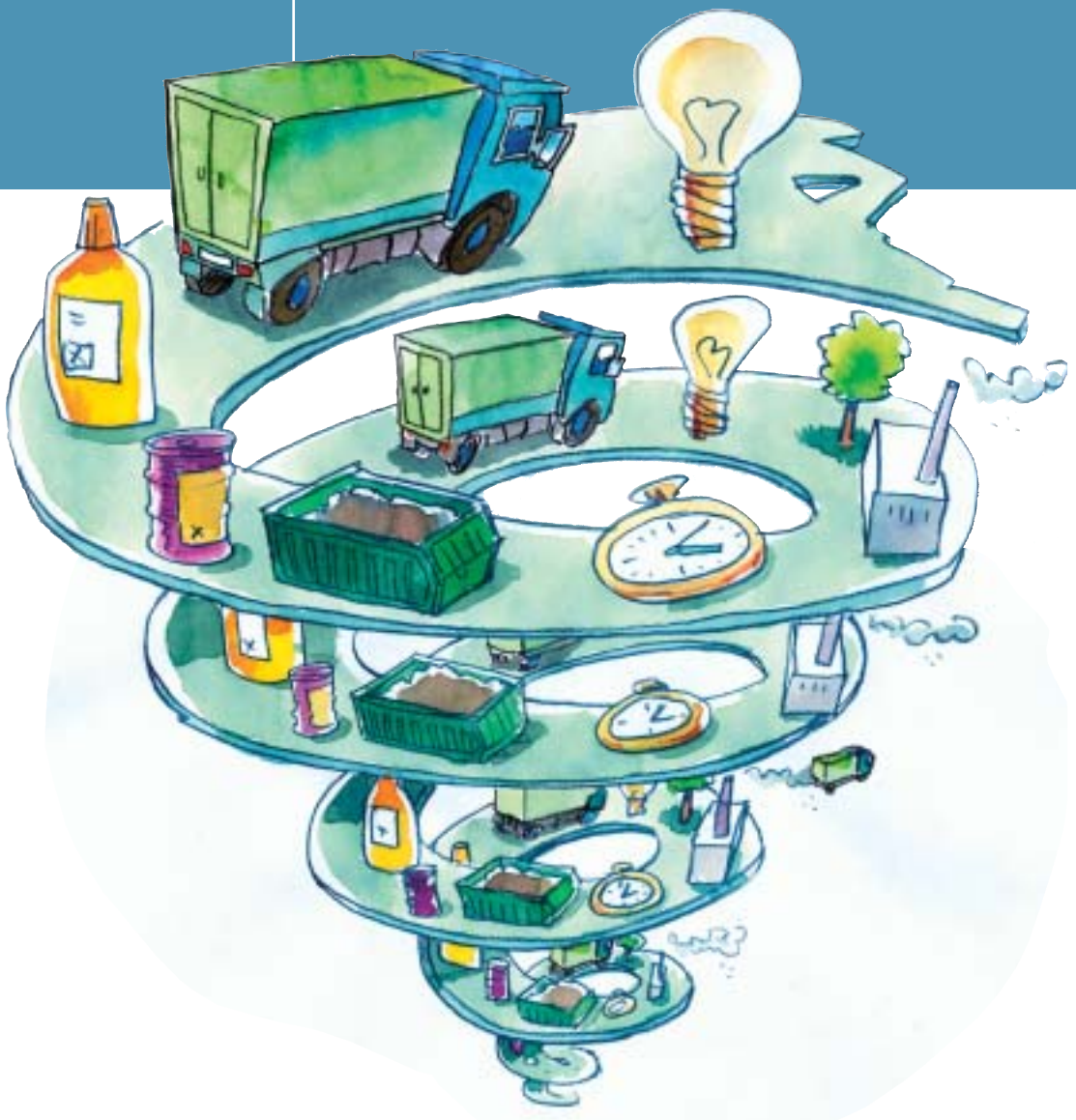
GRAB THE CHANCE

Enterprises are all different. This is also true of the driving forces which influence an individual enterprise. Often enterprises are pictured as maladjusted, surrounded by numerous thick, pointing arrows representing new demands from the market place, the state, etc.

But enterprises are also responsible for their own state of affairs. By focusing on the internal driving forces an enterprise develops knowledge, an environmental commitment, and readiness so it can quickly pick up on new trends and take initiatives when customers, neighbours, authorities or other partners voice new desires or demands.

An enterprise which is well prepared for a life-cycle-based environmental initiative is able to strategically develop and market cleaner products. A proactive environmental strategy means that the enterprise is the leader and can thus play a determining role in the interplay between partners. It is important for an enterprise to discuss the various driving forces when trying to set the ambition level and goal(s) with regard to development and marketing of cleaner products. This subject is discussed in the next chapter.

3. How to begin?



Product-oriented environmental initiatives up until now have focused on the method – a detailed life-cycle assessment, followed by determination of the most significant environmental impacts created during a product's life cycle. These efforts have often ended up dealing with data collection and data issues, rather than concrete strategies concerning how an enterprise can improve the environmental profile of a product.

If an enterprise has not previously investigated a product's environmental impact, then it is a good idea to take a step-by-step approach and begin by focusing on a life-cycle perspective and on concrete possibilities to improve the environmental characteristics of a product.

A STEP BY STEP APPRAOCH

A step-by-step approach may involve the following phases, which are also the same phases an enterprise goes through when introducing an environmental management system (see Figure 5).

1. Policy – setting goals and determining the ambition level

A life-cycle-based environmental policy ought to be visionary and long-range while also being realistic and concrete. An enterprise must therefore, set both long-range objectives and a concrete ambition level. This will avoid confusing signals, both internally and with collaboration partners. There must be no "hotch-potch" between policy and practice: between what an enterprise "says" and what it "does".

Setting goals and determining the level of ambition ensures conformity between policy and actions. There are at least three different ambition levels which can be distinguished.

- Internal readiness and commitment to environmental improvements
- Environmental profile for cleaner products
- Marketing of cleaner products

Distinguishing between these ambition levels allows a step-by-step plan for envi-

Figure 5.
Environmental improvements are the turning point

1. Policy – Set objectives and determine the ambition level
2. Organise – Get management and employees organised
3. Survey – Get an overview over the existing knowledge
4. Goal – Select an area where the efforts will be directed, determine the goal(s), and make an action plan
5. Environmental improvements – Put the plan into action
6. Reporting – Document the effect(s) of the efforts and make the results public
7. Begin again – Evaluate the experience, revise the policy, organisation, etc.
8. Undertake supplementary investigations and obtain further information
9. Specify existing initiative areas and select new areas and goals
10. Etc. Etc. Etc.

ronmental improvements which gradually becomes more ambitious as new knowledge and experience associated with setting plans into action are obtained (see also tools – Chapter 10).

When the environmental policy has been set the enterprise must organise the effort and collect information.

2. Organisation

An organisation of the initiative is, of course, "alpha and omega" to the success of a project, so this step is discussed in greater detail later (see Chapter 4).

3. Survey – get an overview over the existing knowledge

The majority of enterprises have a great deal of knowledge regarding the environmental impacts of their products and processes collected and available, for example, in their environmental approval or green accounts. In general, this information is presented in terms of the production process, rather than in terms of the products. The first challenge is thus to obtain information relating to particular products. This latter information also provides the enterprise with crucial figures for production costs related to product groups or series.

The next challenge is to obtain an overview of the knowledge and experience found in the literature and held by collaboration partners. This type of knowledge survey may be simplified by using the "sparring partners" within the enterprise's network (see also Chapter

Table 1.
The survey:

A. Environmental impacts
- Life-cycle phases – where are the most significant environmental impacts?
- Technology – is there new technology available, or being developed which can reduce the environmental impacts?

B. Market/commercial conditions
- Supply – what is characteristic of the present product's environmental profile?
- Demand – what part does environmental awareness play in the customer's and consumer's product demands?
- Value – what advantages will be achieved by adding positive environmental characteristics as an extra product quality?

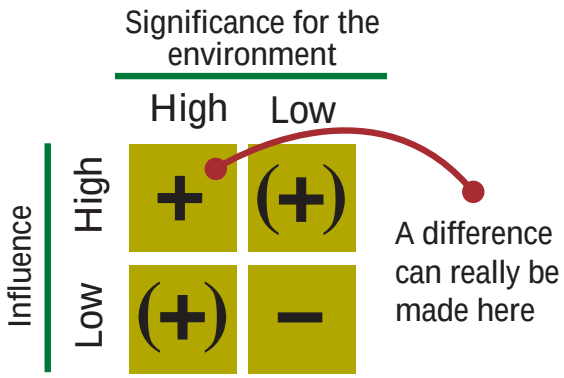
C. Partners
- The product chain – are the suppliers, retail store owners, or others interested in collaboration on environmental initiatives?
- Authorities – what are the demands of authorities – at present and in the future?
- Within the sector – what environmental initiatives are being undertaken by the competitors, or others involved in the sector?
- Knowledge network – what information can consultants, universities, etc. provide?

9). Extending the information survey to suppliers, business associations, authorities, retail shops, scientific institutions, etc. ensures that information is obtained from at least three areas (see also Table 1, above):

Based on the ambition level, the enterprise must limit the information collected to what is necessary and practical. Enterprises which consider too many aspects or potential situations during the data-collection phase risk getting so bogged down in information that the project "dies".

Product-orientated green accounts, six or seven telephone conversations with partners, and some reading are sufficient to obtain the first overview. This overview provides background information which may be drawn upon later if detailed, goal-orientated information collection and investigation are undertaken in conjunction with a raised level of ambition, or new demands.

Figure 6.
Prioritising the effort



4. Select an area where the efforts will be directed, determine goal(s) and make an action plan

Constructive responses to the questions listed above provide a sound basis for selecting an area where environmental improvement would be worth pursuing. In some cases the environmental problems identified by an enterprise may be solved by another's efforts, for example, a new technology is nearly functional or a supplier is phasing out harmful substances.

Based on the current situation and knowledge, an enterprise must decide which area will be prioritised with regard to environmental initiatives. This decision may be made based on the following three questions:

- Where are the most significant environmental problems in the product's life cycle? (relevance)
- Where is it possible to achieve environmental improvements? (potential)
- Where can the enterprise make a difference? (influence)

The Danish company Brdr. Hartmann has weighed such questions during the planning of their life-cycle-based environmental initiative. By considering "relevance" and "potential" together in the context of environmental initiatives, they developed the following simple prioritising model, Figure 6.

Remember that an enterprise may have several "shots" at environmental problems. Choose several initiative areas so that an enterprise's various departments, for example, procurement, logistics, etc. also have the opportunity to contribute to minimising the products' environmental impact.

Concrete goals and an action plan must be defined for each initiative area: Who is responsible for doing what and when. An action plan is a good means of explicitly stating the goals, delegating responsibility and setting the time frames, so that the circumstances surrounding the environmental initiative are clear for both management and employees.

5. Make environmental improvements – put the plan into action

Good planning is important, but it is the practical results which create credibility, enthusiasm, and active support for an environmental initiative.

Focusing on the entire life cycle of a product will identify numerous possibilities for obvious environmental improvements – "easy rewards" which will improve a product's profile. Putting focus on a concrete problem will generate ideas for improvements.

Environmental initiatives must also involve new challenges. What if an enterprise were required to take back all its scrap products according to an EU directive that enters into force in one year? Such a demand would, of course, be added to an enterprise's list of initiative area and an action plan would provide explicit details regarding the concrete initiative. The goal of recycling materials and product parts would require a rethinking of the product. Some of the considerations are listed below:

- fewer materials in a product make it easier to recycle
- a product which is easily taken apart is also more easily recycled
- the materials selected for the product are recyclable
- the product is built in modules which facilitate repairs of selected parts
- redesign the product so that parts of the original may be re-used in new products

6. Reporting – document the effects of the efforts and make the results public

With regard to the commitment of management and employees, it is crucial that the effect(s) of the efforts are documented and that the results are made public. Such documentation gives credibility when answering inquiries from customers, suppliers, etc. regarding the enterprise's environmental policy.

The form of documentation is completely dependent upon the ambition level in the enterprise. It is advantageous for enterprises to have some insight into the environmental impacts the enterprise's target group prioritises, so that communication can be aimed at this group.

Green accounts, which already contain details of an enterprise's environmental initiatives, may be redirected to be more product-orientated, thus providing a good forum to document results and make them visible to the public. Product-orientated green accounts may address:

- To what degree has the energy consumption of the product in the user-phase been reduced?
- How much of the product can be recycled?
- To what degree and how has transport been optimised?

Results may also be made visible by calculating some key figures, for example energy consumption during production of the product, which can be made pub-

lic via an environmental folder, eco-labelling, or an environmental product declaration. This is discussed in greater detail in Chapter 8.

7. Keep the process going – evaluate experience and revise policies and organisational structures

After completing the first round of improvements to the environmental profile of an enterprise and a product, it is a good idea to "take a deep breath" and evaluate the experience:

- What went well and not so well?
- How can the effort be improved?
- Should more of the employees be involved in the environmental initiative?
- Should the efforts be focused in a different direction?
- Were the appropriate means and methods used?
- Should more partners be involved?
- Should the level of ambition be raised?
- Etc.

Such an evaluation, conducted once a year, makes an excellent background for adjusting an enterprise's environmental policy so that it is consistent with the actual efforts. After such an evaluation an enterprise may decide to continue at the same ambition level until the internal environmental commitment and readiness to undertake initiatives are well established, or until partners or others voice demands regarding more extensive environmental commitment, and thus a higher ambition level.

Remember – the idea behind a step-by-step approach is ensuring a reciprocal *interaction* between developing knowledge concerning a product's environmental impact, market demands, etc. and implementation of concrete product-oriented environmental improvements.

8. Undertake supplementary investigations and obtain further knowledge

Through the experience from the first round of environmental improvements, an enterprise has likely identified areas where further investigation may be advantageous.

If demands are made requiring an enterprise to supply further documentation regarding the environmental impact of a product, then a simple environmental assessment is appropriate. If it becomes evident that there are significant environmental impacts in the user-phase, then investigation of consumer desires and demands would be an obvious method to obtain ideas for design changes or to develop better instructions for product use. If an enterprise uses chemicals or materials which are on the list of undesirable substances it would be sensible to begin phasing them out.

It is much easier to develop a knowledge-base if there is good cooperation and trust among producers, suppliers, retail store owners, disposal facilities and other stakeholders in the product chain. (See chapter 9, Cooperation in the product chain).

9. Define the environmental initiative area and the goal(s)

On the basis of experience, the initiative area and goal(s) are redefined and a new round of efforts begins with plans, improvements, etc. Focus remains on achieving concrete environmental improvements to the product profile, while realising results during the improvement process.

4. How to organise the efforts?

Of course there are many ways to organise a life-cycle-based environmental initiative. Clearly, the size of an enterprise and its previous experience with preventative environmental activities will influence how an initiative is organised, as will the enterprise's ambition level.

Integration of environmental efforts into all aspects of an enterprise may be accomplished in part by:

- High priority from management
- Internal communication
- Involvement of all the relevant departments / functions
- An environmental coordination group
- Coordination with other initiatives and projects within the enterprise.

High priority from management

The benefits an enterprise achieves from a life-cycle-based environmental initiative depend upon whether the "environmentally active" employees have the full support of management. In practise this support may be expressed in the following ways:

- The necessary resources have been set aside for the environmental initiative – particularly time and educational resources.
- Management actively participates in setting the strategic goals.
- There is explicit internal communication throughout the enterprise regarding the ambition level and goals.
- The employees involved in the environmental initiative feel that their ideas and suggestions are taken seriously.

Internal communication and visibility within the enterprise

Internal communication ensures that both focus areas and results of life-cycle-based environmental initiatives are common knowledge among employees. The greater the number of employees, the more demanding this task. The visibility of the efforts and the results is an important precondition for support and involvement.

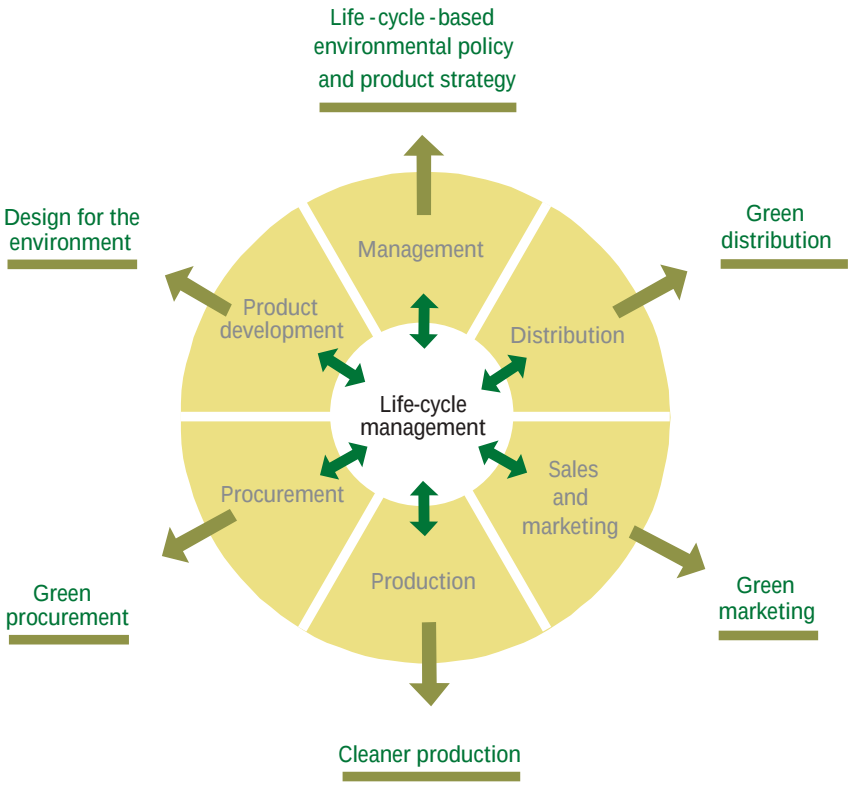
It should be "in neon lights" that a particular initiative is not a single effort, but rather a part of an on-going environmental improvement plan where all employees can contribute with ideas for new initiatives or improvements. Internal communication also ensures that the various departments can see the reason for the initiatives and thus do not work against each other due to lack of information and understanding.

Involvement of all relevant departments

A life-cycle-based environmental initiative affects all functions and departments of an enterprise. For example, a decision to change the material composition of a product not only affects the quality, price and environmental profile of a product, but also raises questions regarding procurement of the new material, potential markets for the new product, consequences to the production process, new logistical demands, etc.

All departments must therefore participate with ideas for environmental initiatives and solutions, based on their particular expertise. This will ensure a range of ideas, as well as creating a realism in relation to the situation in the various departments. The smaller the enterprise, the smaller the number of people who

Figur 7.
Various departments' contribution to a product-oriented environmental initiative (from the firm, Brdr. Hartmann A/S).



must be involved to ensure participation of all departmental functions.

Each department within an enterprise operates to some degree inside "its own universe" – with its own projects, interests and priorities. A challenge for management and the environmental coordination group is "putting the environment in the spotlight" in every department and creating a friendly competition between departments regarding life-cycle-based environmental initiatives.

Environmental coordination group

A life-cycle-based environmental initiative is so extensive that one person, regardless of his competence, cannot sit alone with daily responsibility for such a project, as depicted in Figure 7. Responsibility ought to lie with an environmental coordination group with a central key person. This coordinator is responsible for ensuring that the group functions, meetings are arranged, minutes taken etc. The coordination group members may take turns doing many of the practical tasks.

The members of the coordination group ought to be selected so that all departments / functions within the enterprise are represented, including management, product development, production, procurement, logistics and sales. The actual number of people who will participate in a coordination group depends upon the size of the enterprise. It is also important

that the division of labour and responsibility are clear for each project.

Participation of a range of employees ensures that the environmental initiatives will be deeply rooted in the enterprise and that the focus will be on concrete improvements to a product's environmental profile, rather than mere talk and data collection. Furthermore, broad participation ensures that an environmental project doesn't "die" if a key employee involved in the project leaves the enterprise.

Coordination with other initiatives and projects within the enterprise

Often the various departments within an enterprise have their own "pet projects". This situation can lead to mixed signals and employee complaints that, "We've got our fingers in too many pies!" "A project isn't even finished before a new one is started!"

Management must therefore consider the connection between initiatives and how to create synergy in the projects. The priority of various projects must be clear to all employees. Furthermore, it is a good idea if each department has its own environmental project (see Figure 7) so that the unity and connection in the environmental effort is visible. Management must ensure, already in the planning phase, that the resources required are available among all categories of employees so that the prioritised projects can be completed.

Good coordination of an individual environmental initiative with other initiatives reduces administrative problems and extra work associated with the day-to-day functioning of the various projects.

For enterprises with a certified quality- and / or environmental management system, the new version of the ISO 9000 standard from 2000 has provided good opportunities for creating synergy between customer-based quality management and product-oriented environmental management (see Chapter 9).

Finally, it is necessary to check all policies, procedures and instructions to ensure that they reflect a life-cycle perspective and an integrated product policy. These internal documents must explicitly state which departments are responsible for which tasks (see the following chapter).

"Little Enterprise Ltd.", a fictive example, is a small enterprise which produces thermoses. The enterprise has not previously worked in a goal-oriented way with environmental issues, but it is a point of honour that the enterprise has "its house in order". Furthermore, the enterprise puts an emphasis on a good working environment.

Little Enterprise Ltd. is beginning to receive environment-related questions from their customers, and in order to avoid any unpleasant surprises regarding the environmental impacts associated with their product, the company has decided to improve the product's environmental characteristics using a life-cycle perspective.

In practice, the day-to-day management of the company is undertaken by three people. Hansen is the director of Little Enterprise Ltd. and is responsible for management and sales. Kirsten is the secretary and is also responsible for procurement and logistics. Niels is the head of production with responsibility for production and product development. He is also the central coordinator for life-cycle-based environmental initiative.

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5. Management and the environmental employee

Management is responsible for life-cycle-based environmental initiatives including coordination with other initiatives and priorities within the enterprise. Thus, it is obvious to appoint an environmental leader / central environmental coordinator as the day-to-day "anchor person"

MANAGEMENT HAS OVERALL RESPONSIBILITY

Overall responsibility for a preventative environmental initiative belongs, by definition, to the director of the enterprise. This responsibility becomes even more important when the focus shifts to developing and marketing cleaner products.

Management must ensure that all employees understand, and live up to, the intentions behind the environmental initiative. Rather than a list of empty phrases, an enterprise's environmental policy must be relevant and clearly state the following:

- The long-term objectives and ambition level
- The areas where the efforts will be directed and the concrete environmental goals
- The enterprise's strategy for the product and product service in a life-cycle perspective.

A product-orientated environmental policy must be integrated into the enterprise's other strategies and plans, as well as functioning as a guide in the daily work. The environmental policy may be used in communication with partners as well as evidence of the enterprise's own ambition level. Furthermore, it may be used as an explanation for the demands to suppliers and other partners.

The long-term goals plot a course and indicate the direction of an enterprise's environmental efforts. An environmental policy may be both visionary with long-term objectives, while also being realistic by selecting manageable short-term goals. A step-by-step approach gives the possibility of being both visionary and realistic at the same time. Furthermore, a step-by-step approach means that experience and knowledge are gained throughout the process, and these are building blocks for the next steps.

The environmental policy ought to be put into action in the initiative areas by means of concrete environmental goals which employees can work towards in their daily tasks.
Examples of initiative areas and goals are some of the following:

The Danish company Grundfos has developed the following environmental goal for product-development projects which states that "Under normal circumstances the following minimum conditions must be met:

- minimum five percent reduction in product energy consumption in the use-phase
- minimum three percent reduction in the raw-materials procurement-phase
- development of disposal instructions for the product

The project manager may, after consultation with the technical manager, dispense with one or more of these requirements if it appears that the goals cannot be achieved within an economically and technically justifiable framework."

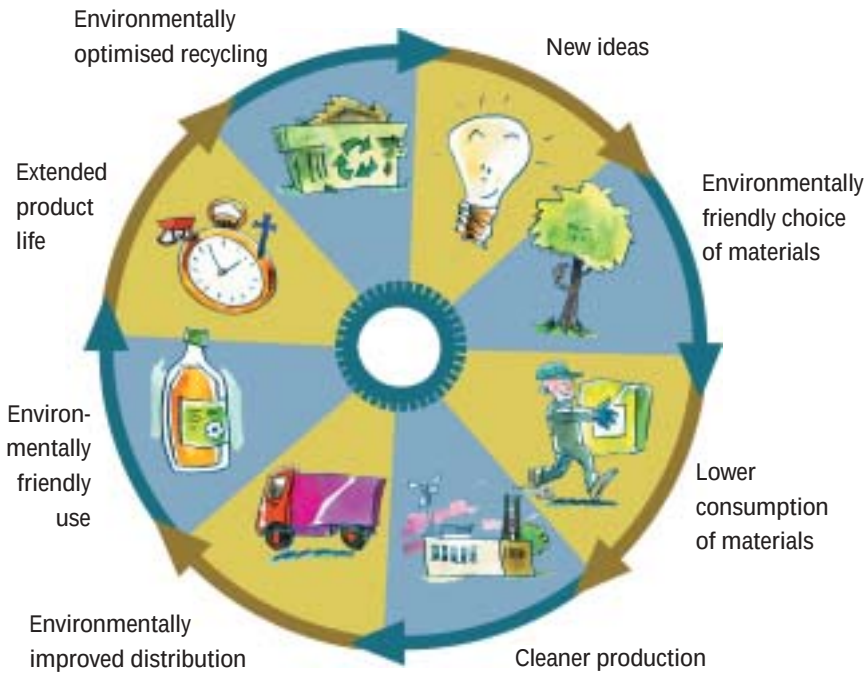
- Chemicals – phasing out and substitution of chemicals and materials which are on the list of undesirable substances
- Transport – reduce CO_2 emissions from the enterprise's goods transport by ten percent
- Product – develop instructions regarding environmentally friendly use and disposal of the product
- Recycling – 85 percent of the materials in the product can be recycled
- Resource consumption – reduce water and energy consumption by eight and five percent, respectively

Selection of an initiative area and measurable goals motivates employees and makes it obvious that environmental improvement efforts are being taken seriously. Thus, it is a good idea if employees participate actively in this selection process.

One way of specifying an initiative area involves setting environmental goals for each phase of a product's life cycle. This can be actualised by a product strategy which explicitly states that an enterprise will consider the environmental implications of a product's various phases, and via this improve the product's environmental profile. Tools which may help in identifying environmental implications are a "spider-web" or a "strategy wheel". These can be drafted in such a way that the difference between a product's existing and improved environmental profile may be illustrated graphically (see Chapter 10 regarding tools).

Expressing the environmental policy both as concrete goals and a product strategy demonstrates, in practise, that management takes life-cycle-based envi-

Figure 8.
Identifying initiative areas and determining a product strategy



Niels draws a diagram of the environmental impacts associated with production of a thermos; Little Enterprise's most sold product. Hansen and Kirsten contribute their knowledge regarding impacts before and after the product leaves the factory.

Using the diagram, they discuss the goals for a new, environmentally improved product which they hope will capture a greater market share. Their biggest competitor's product marketing is based on product materials alone. Furthermore, Little Enterprise believes that there are possibilities for optimising energy consumption during production. Thus, they have identified two initiative areas - at first.

These initiative areas do not require extensive background research. Instead, "Little Enterprise Ltd." will concentrate on getting an overview. In addition to Hansen, Kirsten and Niels, a few others are involved in the information collection phase. The general overview may also illuminate areas were more information should be obtained from outside sources. The group agrees to inform about their efforts at a common breakfast meeting the following Friday.

Both dedicated enthusiasts and book keepers are needed in a life-cycle-based environmental initiative!

ronmental initiatives seriously, and that management will be leaders in the process. Similarly, management must signal that life-cycle-based initiatives require cooperation between all departments at all levels. Larger enterprises in particular require a coordinator who has day-to-day responsibility for the initiatives.

ENVIRONMNTAL COORDINATOR AS ANCHOR PERSON

The central environmental coordinator, or the anchor person with daily responsibility for the initiatives will find that the tasks involved expand.

In cooperation with the environmental coordination group, the daily coordinator must assume the following roles:

- Coordinator for all the activities in the various departments
- Source of inspiration ensuring motivation and availability of simple tools
- Motivator including making the ongoing results of the initiatives visible.
- Ambassador for the environmental initiatives to partners in the product chain
- Contact person for the knowledge network and relevant authorities
- Data processor during environmental assessments or detailed life-cycle assessments
- Organiser / coordinator for collection and analysis of market information
- Collector of suggestions for environmental improvements from internal departments and collaboration partners.
- Etc.

Whether the environmental coordinator is an environmental manager, a product developer, or a sales associate is, in principle, unimportant. It is important that the person is dedicated and enthusiastic about the plans, as well as being good at motivating and delegating. Furthermore, the person must be capable of acting as a coordinator for the entire enterprise. Specialised environmental expertise can, if necessary, be obtained outside the enterprise.

A life-cycle-based environmental initiative also requires the presence of analysts and data processors within the enterprise. This is yet another argument for an environmental coordination group with broad representation from within the enterprise.

6. Product development and production

Up until now, people involved in the production have had a main role in connection with environmental improvements in the production process and also with the introduction of environmental management systems. Similarly, designers and product developers have an important role in the development of cleaner products.

THE ROLE OF DESIGNERS AND PRODUCT DEVELOPERS

Clearly, product development is key to a life-cycle-based environmental initiative. The earlier environmental considerations are integrated into product development, the easier it is to prevent harmful environmental impacts in a product's life cycle.

Designers and product developers must therefore have an understanding of the factors which determine the environmental impact of a product. Only in rare cases will product developers need to analyse environmental data, for example a life-cycle assessment. Rather, access to straightforward guidelines and assessments conducted by environmental specialists is required.

How radically a designer or a product developer changes a product will reflect the level of ambition and the product strategy which management has set. Generating ideas and developing concepts are central elements if the framework is relatively loose. Is there any demand for this type of product in the future? Will this product be replaced by a service? Or integrated into a main product? The telephone answering machine is an example of a product which is disappearing as a specific product, as the same function is integrated into many telephones or may be procured as a service from telephone companies. In most cases, product development involves small steps – gradual adjustments and incremental improvements to a product. There are many aspects of a product which may be addressed, but the environmental profile of a product may be a good place to begin.

Technical aspects, economy, design, quality, etc. are still crucial to the development of a product, but these aspects may often be combined so that environmental considerations are given more weight, for example:

- make the existing product cleaner, for example by replacing an environmentally harmful substance with a less harmful substance,
- move environmental considerations higher up on the design criteria list - for example by putting equal weight on price and energy consumption in the use-phase,
- develop a new, cleaner product with the starting point being consideration of environmental impacts - for example a new clothes collection based on ecological cotton,
- shift from producing a product to supplying a service - the sale of linen products shifts to a clean linen delivery service.

"Little Enterprise Ltd." decides to make their existing products cleaner by using a more environmentally friendly material in the plastic parts of the thermos.

THE PRODUCT DEVELOPER'S TOOL

Product developers and designers require practical tools when they are challenged to include environmental considerations in product development. A number of international guidelines and rules of thumb which reflect the environmental considerations for numerous sectors are available, also on the Internet (see the tool box in Chapter 10).

Many of these rules of thumb are built upon the same principles referred to as the "6 RE philosophy":

- Re-think – rethink the product and its functions
- Re-duce – reduce energy and material consumption throughout a product's life cycle
- Re-place – replace environmentally harmful substances with more environmentally friendly alternatives
- Re-cycle – select materials which can be recycled
- Re-use – design the product so that its parts can be reused
- Re-pair – design the product so that it is easily repaired

Products with motors and electrical plugs have always in the use-phase energy consumption which gives rise to significant environmental impacts.

If there are no guidelines for an enterprise's specific product, it is a good idea to investigate the existing knowledge concerning the product group / family, as there may be guidelines for environmentally friendly design and product development for related products. Inspiration for rethinking many types of products may be found via the tool referred to as a strategy wheel or a spider web (see Chapter 10). Rules of thumb and guidelines are valuable tools for generating new ideas for environmental improvements to products. After these ideas have been analysed and prioritised, the environmental profile of the new product may be visualised using a spider web diagram which illustrates graphically the anticipated results of the product development.

In practise, there may be contradictory considerations, for example between a long product life and the use of a harmful substance in production. In such cases an environmental assessment or a detailed life-cycle assessment is necessary.

INTEGRATED PRODUCT DEVELOPMENT

Poor coordination between product development, production and sales departments is often a problem for larger enterprises. Consequently, many large enterprises have introduced "integrated product development", where coordination

KNOWLEDGE ABOUT CLEANER TECHNOLOGIES AND ENVIRONMENTAL MANAGEMENT

- contact business associations

Most business associations have written material and guidelines regarding cleaner technology and environmental improvements to production. Furthermore, many business associations have compiled sector-specific manuals to assist in introducing environmental management systems. A few of these manuals assist with life-cycle-based environmental initiatives.

of the various considerations is integrated into a system.

This involves formulating a procedure for when and how environmental considerations are incorporated into the product development process. For example: when product specifications are available, then a simple environmental assessment is to be undertaken. When a product prototype is completed, it is sent to a local scrap dealer for comments regarding the ease with which the product can be taken apart and recycled.

Enterprises such as Grundfos have environmental considerations as an inherent part of the enterprise's integrated product development procedure.

THE ROLE OF PRODUCTION EMPLOYEES

Employees in the production department have a big role to play in addressing the environmental impacts associated with production processes and thus, may actively contribute to reducing resource consumption and emissions. Enterprises which have not previously considered cleaner technology and environmental management find that there are many possibilities for improvements and savings.

Production employees may contribute with good ideas for concrete product improvements, as well as finding and supplying data which specifically relate to a particular product. In addition, employees have practical experience regarding what is possible in the production process, while avoiding too much backwards and forwards.

Environmental management systems up until now have sufficed with figures regarding the resource consumption for the entire enterprise and for the primary sub-processes. Most green accounts and environmental reports are formulated this way. Now, however, with focus on cleaner products, figures concerning resource consumption and emissions during production of each product are of interest. It may be necessary to change measurement points as well as documentation statements and procedures to obtain such figures.

Common product figures are a good frame of reference for on-going environmental improvements of products. Individual figures for a specific product may be difficult to calculate if the enterprise has a broad range of products, because a distribution factor must be determined which "allocates" the resource consumption among the various product groups. In such cases a rough estimate, which may be further refined at a later date, is sufficient to begin an assessment.

AN EXERCISE FOR ALL EMPLOYEES

Try assembling eight to ten interested employees one day with one to two hours available to discuss the following:

ENVIRONMENTAL PROBLEMS

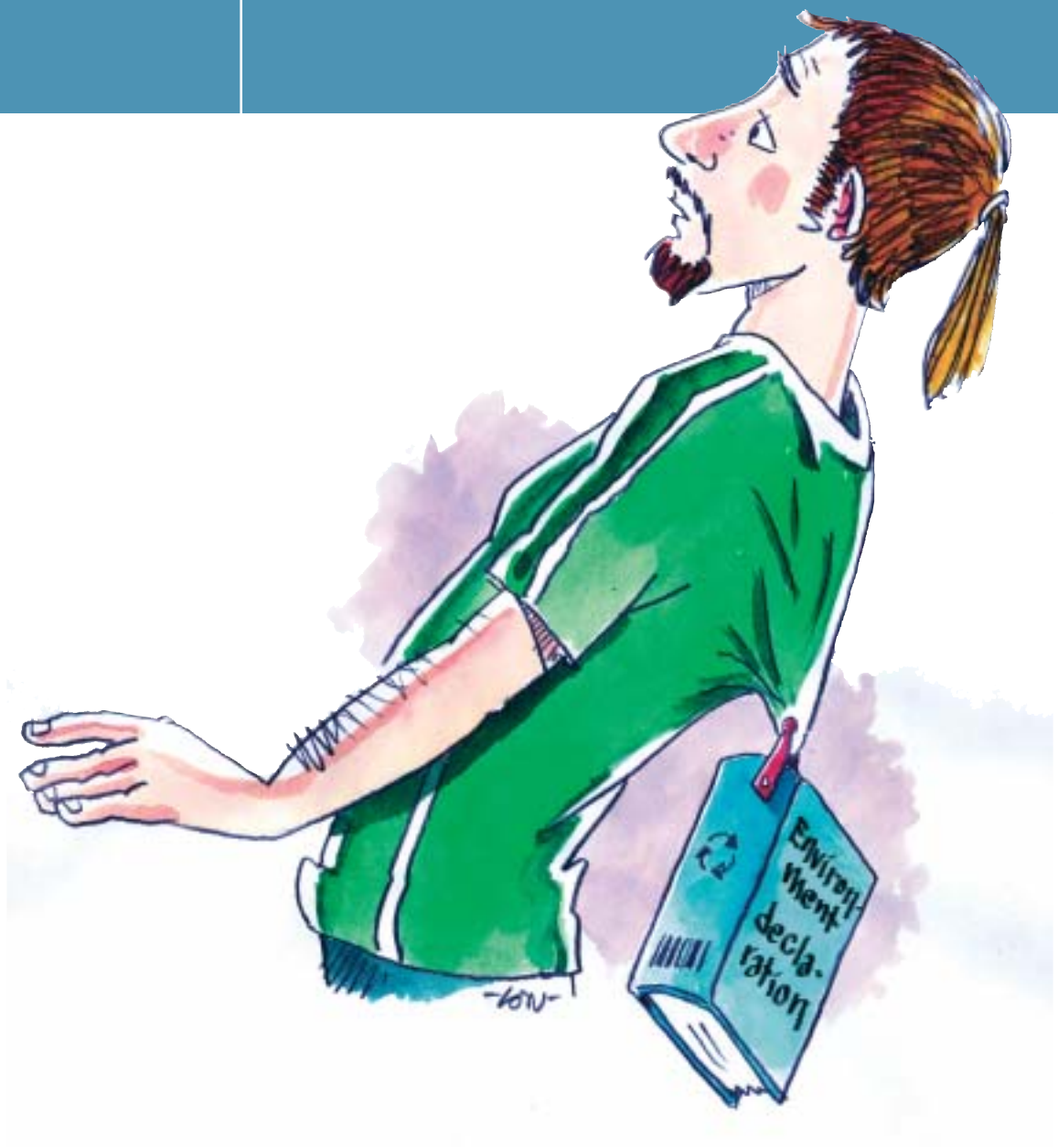
- brainstorm about where the environmental problems are found in the product's life cycle
- record all the environmental problems
- discuss which problems ought to be and can be addressed
- develop a top-10 problem list where each person has three votes

POSSIBLE SOLUTIONS

- brainstorm again about possible solutions and suggestions for envi ronmental improvements
- record all ideas for improvements
- make an action plan which includes who will be responsible for what and when

There may be environmental problems and possible solutions which require further investigation. Include them in the action plan.
Based on the discussions a so-called SWOT-outline can be drawn up which straightforwardly identifies strengths, weakness, opportunities and threats to the project.

7. Procurement, transport and sales



All departments within an enterprise have an important role to play in a life-cycle perspective. Procurement, transport and sales employees have central tasks with developing and marketing cleaner products (see Figure 7).

Procurement

The buyer has an important role in selecting the raw materials. Consequently, a buyer requires some tools which integrate environmental considerations together with other factors such as price, quality, functionality, etc.

Buyers are able to encourage environmental considerations at their suppliers via questions and demands. A buyer may request the following information:

- overview of the supplier's general environmental initiatives and the supplier's environmental policy
- documentation of the environmental impacts from the previous life-cycle phases
- specific environmental data regarding raw materials, secondary (passive) materials, etc.

THE BUYERS TOOL BOX:

- Overview: what are the most significant environmental factors / impacts in the product chain
- Criteria for selection of main supplier(s) (evaluation procedure for selection of suppliers)
- Questionnaire regarding suppliers' environmental initiatives
- Guidelines for environmental dialogue and collaboration regarding product improvements
- Procurement guidelines for environmentally friendly procurement
- Criteria for eco-labelling for relevant product areas
- Environmental declarations
- List of undesirable substances

Communication may be broadened to include dialogue and collaboration where the enterprise contributes ideas and constructive criticism regarding environmental improvements at the supplier's end. The buyer may take on the role of the critical, environmentally conscious customer who makes numerous demands, or the role of a collaboration partner working toward mutual advantages associated with the development of cleaner products.

Kirsten of "Little Enterprise Ltd." makes enquiries at the supplier about whether the steel can be recycled. She also enquires whether the supplier has an overall environmental policy and if so, what this involves.

Transport and logistics

Transport is the common link between all phases of a product's life cycle. Energy consumption connected to transport of raw materials, as well as transport of finished products, is generally a minor component of an enterprise's total energy consumption. Similarly, transport is seldom identified as one of the significant areas of environmental impact in a life-cycle assessment.

Nevertheless, a number of conditions within an enterprise may support transport-related initiatives. These may include the following: interest on the part of the people responsible for transport, transport as an obvious initiative area, desire to influence the transporter to undertake more extensive environmental initiatives, etc. Furthermore, environmental impacts associated with transport

TOOLS FOR ENVIRONMENTAL OPTIMISATION OF GOODS TRANSPORT:

- Accounting scheme which documents quantity and volume of goods, as well as transport distance
- Goals for degree of capacity utilisation (load factor)
- Comparative information schemes regarding the environmental impacts of various forms of transportation, trucks, trains and ship
- Demand that the transporter use cleaner technology and an environmental management system
- Distribution concept whereby weight, volume and distance determine the type of transport selected
- Guidelines for improved logistical planning, route optimisation, etc.
- Optimisation of packaging to reduce transport needs

are in general a growing problem, where many hitherto initiatives have fallen short.

At hospitals, consulting companies, and similar enterprises, transport of personnel between home and the workplace, as well as work-related transport, represent a significant environmental impact. An initiative in this area may begin by investigating the following questions. Can employees get to work on time using public transport? Is there potential for car-pooling? Should the enterprise procure electric cars for city driving? Are facilities for bicyclists adequate?

Kirsten has discovered that with a little better planning and a longer product life, some of the transport can be saved – an advantage economically and environmentally.

Environmental improvements involve many small initiatives which together have a large effect. Furthermore, it is a good idea to find initiative areas which are visible to all employees and which have an important symbolic value. Similarly, small problems can impede larger initiatives – "When the enterprise won't even build a proper bicycle shed why should I bother to get involved…?"

SALES AND MARKETING

It would be a waste of enterprise resources to develop a cleaner product if it is not in demand or cannot be sold. Thus, the employees responsible for sales and marketing have an important role in a life-cycle-based environmental initiative, because they must ensure good information both to and from the customer.

Information *from* the customer provides sales personnel with detailed knowledge about consumer preferences, weight given to environmental considerations and how the product is used.

An investigation of consumers' use of a product may reveal inappropriate aspects of product use, thus giving product developers new knowledge and inspiration for future environmental improvements. For example, an Australian investigation revealed that 15 percent of the electrical consumption associated with an electrical kettle was unnecessary. It was found that kettle-users often reboiled the water because some small

task, which begun while waiting for the water to boil, took longer than the actual boiling time. A whistle, a temperature indicator or better insulation of the kettle are three possible solutions.

Knowledge regarding consumer behaviour and preferences is crucial to developing and marketing cleaner products. Consumer and market surveys provide accurate information regarding consumer preferences and priority given to environmental considerations. There is, however, always a dilemma in market surveys as there is a difference between what a consumer says and how, in fact, the consumer acts.

Although "Little Enterprise Ltd." only has a small customer base, their behaviour and preferences are well known. Hansen enquires within the enterprise if any employee has received environment-related questions from customers. He also makes enquiries regarding what environmental aspects their customers prioritise, as well as what customers would like to see prioritised in future environmental initiatives.

"Little Enterprise Ltd." has expanded its product-use directions to include information regarding the following: environmentally friendly cleaning; where spare parts for the thermos may be purchased; and how the thermos may be disposed of in an environmentally appropriate manner.

TOOLS FOR SALES EMPLOYEES:

- Consumer and market surveys
- Analysis of the competition and consumer trends
- Environmental profile for the product / an environmental information fact sheet
- Strategy for environmental marketing
- Directions for environmentally friendly use of the product
- Information and courses regarding repair, environmentally friendly operation, maintenance and disposal

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Information *to* the customers provides the enterprise with an opportunity to increase awareness about a product's environmental impacts. Sales employees must have enough environmental knowledge to be capable of advising customers regarding environmentally friendly use and disposal of the product.

The textile company, Gabriel, provides their customers with guidelines for cleaning of residential and industrial textiles to ensure that the cleaning method is environmentally friendly. Thus, Gabriel has assumed some of the use-phase responsibility for the product and wants to contribute in reducing the use of environmentally harmful dry-cleaning and cleaning agents.

Product misuse may be extremely detrimental to a product's total environmental life-cycle impact. Excessive quantities of laundry detergent are an example of product misuse. Similarly, information regarding product disposal may improve recycling of selected materials or the entire product. The trend is towards making the producer responsible for disposal of its own products.

Sales and marketing departments must have enough environmental knowledge that they can profile their enterprise's products above the competitors. This requires that sales employees are familiar with the criteria for eco-labelling, public procurement guidelines, the consumer ombudsman's criteria for environmental marketing, etc. (see Chapters 8 and 9).

There are lots of places for a sales employee to begin, and further ideas in the next chapter.

8. Marketing and environmental communication

When an enterprise improves a product's environmental profile, the product is given an extra quality. This is often a "hidden quality" because it is not always obvious to consumers that a particular product has fewer environmental impacts than an apparently similar product.

The enterprise must therefore consider the following questions:

- How can a cleaner product be marketed?
- How can the product's environmental qualities be made known?

MARKETING CLEANER PRODUCTS

Increasingly, the environment is a parameter which enterprises use in the competition together with price, functionality, design, quality, etc. Enterprises may use a product's environmental characteristics to market the product in three different ways:

1. Eco-labelling

In Denmark there are two officially approved eco-labels, the Scandinavian Swan label and the EU Flower label. Eco-labels are aimed primarily at consumers and cover a wide range of common and consumer goods (but not food products). An enterprise must document that a product meets a list of previously determined criteria in order to obtain an eco-label. It is not necessary, however, to conduct a detailed life-cycle assessment.

2. Environmental characteristics

In this case, marketing is based on one particular aspect of the product's environmental profile, for example, that the petrol is lead-free, or that a laundry detergent is easily degradable. The enterprise must be able to document its claim(s).

3. Environmental products declaration

An environmental declaration is aimed primarily at professional buyers and makes it possible to compare the characteristics of several similar products. There are no official guidelines for environmental declarations in Denmark, although there are in Sweden.

An environmental declaration must be based on a life-cycle assessment and have common or uniform content and formulation. The degree of detail required in the life-cycle assessment has not yet been determined.

There are ISO standards for all three types (type I, II and III). Furthermore, it is necessary to know the marketing laws and the consumer ombudsman's guidelines for environmental marketing. The guidelines stress that marketing claims regarding the environmental characteristics of a product must be possible to document, must be significant and relevant, and must not be misleading.

REMEMBER that knowledge about the market is just as important as knowledge about a product's environmental impacts. The following questions are relevant for an enterprise to consider in conjunction with marketing of a cleaner product:

- What do my customers demand, and how do they weigh various considerations?
- What do my customers consider to be the most important environmental problems which ought to and can be addressed?
- What do collaboration partners, for

example, neighbours, financial institutions, etc. consider to be important areas for environmental improvements of the product?

Environmental information and communication

There are other, more informal ways to make a product's environmental characteristics or an enterprise's environmental initiatives more visible. Some examples are listed below:

- Figures for environmental impacts during production of a particular product
- Conversations with customers
- Electronic news letters about environmental initiatives
- Fact sheets about the environmental impacts of a product
- Manuals for environmentally friendly use and disposal of the product
- Lectures, and presentations at conferences
- Contact with the media and articles in trade journals
- Publication of the enterprise's environmental policy, goals and action plans, as well as the green accounts
- Open house event

"Little Enterprise Ltd." has calculated figures for the energy consumption required to produce one thermos, so this information is available if and when a customer makes enquiries. In addition, the enterprise's new product-use directions give instructions regarding environmentally friendly cleaning and disposal of the thermos.

It is important to make a clear distinction between information and communication.

Information is uni-directional, such as a newsletter, directions for use, or green accounts. In contrast, communication is multi-directional and functions as a dialogue between two or more partners, for example, a customer visit, an employee meeting, etc. Therefore, the following must be considered:

- Who is the target group for the environmental initiative(s), and how is this group best reached with our message?
- Who are our environmental communication partners and in what areas is there collaboration?

Selection of a method to make a product's environmental profile and an enterprise's environmental initiatives visible will depend upon the responses to these questions.

A number of enterprises were disappointed that there was not greater public interest in green accounts. Green accounts are an example of environmental information, but there is also a need for environmental communication if an enterprise wants an active dialogue with customers and partners.

When an enterprise is putting together environmental communication it must consider which messages and which methods are best suited to which audiences. For one customer group, problems associated with waste may be important. Another customer group may emphasise obtaining comprehensive information concerning environmental impacts throughout a product's life cycle.

The better an enterprise knows the various consumer groups and collaboration partners, the bigger the effect of goal-oriented environmental communication. This knowledge is obtained from dialogue and cooperation. It is also necessary to evaluate the effect of an enterprise's environmental information and communication so that experience can be put to use in future initiatives.

When an enterprise has taken the step from information to active environmental communication, then the next step is cooperation with the enterprise's partners.

9. Environmental cooperation in the product chain – using the enterprise's network

9. Environmental cooperation in the product chain – using the enterprise's network

A challenge in a life-cycle-based initiative is establishing cooperation and collaboration among the relevant partners in the product chain as well as with other interested partners.

SUPPLY CHAIN + VALUE CHAIN
+ COOPERATION = PRODUCT CHAIN

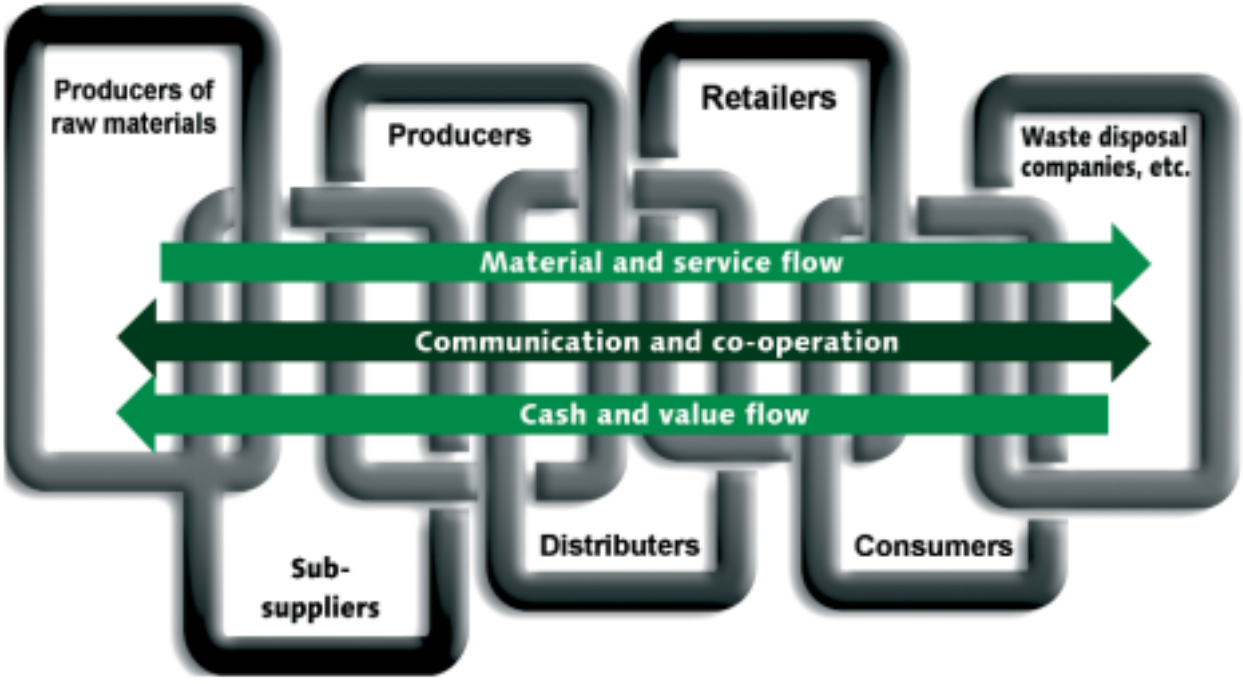
With a product-orientated environmental initiative the focus shifts from within the enterprise's fence to the entire product chain. The product chain includes the following:

- *a flow of materials* from acquisition of raw materials to production, to use, to disposal
- *a value and cash flow* from the consumer to the producer
- *communication and cooperation* in the form of mutual exchange of knowledge and experience.

In an environmental context, interest up to now has been directed towards the flow of materials, for example, in a life-cycle assessment. In a life-cycle environmental initiative it is just as important to focus on the value flow. What expectations does the consumer have concerning the product's environmental characteristics? How do consumers rate environmental considerations relative to other product aspects such as price, quality, functionality, design, etc.?

For enterprises, the challenge is to connect the links in the product chain in such a way that there is focus on both environmental optimisation of the material flow in the supplier chain; and on the customer's expectations regarding environmental considerations in the value chain. Communication and cooperation between all the partners involved will build connections between the supplier

Figure 9.
Communication and cooperation in the product chain



chain and the value chain. This is illustrated in Figure 9.

Development of a cleaner product which never makes it to the market is a waste
Thus, knowledge concerning environmental impacts must be balanced against what consumers truly demand, particularly in terms of the environmental characteristics of a product.

The platform for undertaking concrete environmental improvements of a product are described in Figure 9 and listed below:

- knowledge about the product's environmental impacts and possible improvements,
- knowledge about markets' and consumers' priorities regarding environmental considerations,
- knowledge about the demands of other collaboration partners.

A combination of knowledge from all three areas is the best basis for a life-cycle-based environmental initiative. An enterprise must decide how knowledge concerning both the material and the value flow can be continuously updated concurrent with the latest changes in consumer preferences, new technological advances, etc.

A possible means is to couple *customer-based* quality management with *product-oriented* environmental management. The latest version of the ISO 9000 standard requires that quality management be customer-based in a much more overt way than just registering complaints. For example: What are consumer demands regarding quality and environmental considerations? How can the enterprise accommodate these demands? The combination of knowledge regarding the chain of values together with an enterprise's control over quality and environmental parameters in the supplier chain means that the enterprise is in a good position to reap the strategic advantages associated with a cleaner product, tailored to the consumer.

When establishing product chain cooperation it is wise to contact the sector organisations, as they are acquainted with the existing knowledge and can assist with advice and guidance. For example, environmental assessments of particular product groups / families are available, thus making it easier to tap into existing knowledge across enterprises within a particular sector (see Chapter 10).

Informal cooperation and partnerships in the product chain

A life-cycle-based environmental initiative requires the establishment of close *cooperation* between suppliers and consumers which will allow for an exchange of knowledge and experience regarding the product chain. This cooperation aims at creating concrete advantages for all partners. A close producer-consumer relationship provides a good platform for technological innovation, including integrating environmental considerations into product development.

For some enterprises, *informal* cooperation, where information is exchanged and new initiatives are planned ad hoc, is sufficient. Informal cooperation often occurs with direct contact between employees in the enterprises involved. Other enterprises are involved in *formal* cooperation or even partnerships to ensure

integration of environmental considerations into product development.

For example, Henkel-Ecolab has, in collaboration with Berendsen, introduced a dosing and service system which reduces the consumption of laundry detergent. There are other examples of enterprises which advise customers on the environmental impacts associated with various choices, for example, in relation to choice of colour on packaging and printed matter.

Cooperation in the product chain may be formalised by establishing a working group which will coordinate collection of information concerning both a product's most significant environmental impacts, and the preferences and demands of consumers and retailers. Then, ideas for concrete environmental improvements to the product may be assembled by the working group. Formal cooperation has the advantage that the partners are mutually obligated to exchange information and experience.

Cooperation on environmental improvements in the product chain may also result in advantages in areas not directly related to the environment, for example:

- Supplier – certainty regarding the orders and a tailored solution
- Consumer – certainty that the product will sell, a good image and a solution tailored to the consumer
- Authorities – supervision adjusted to the enterprise, improved goodwill, opportunity to influence the agenda.

The company Brdr. Hartmann has, for example, experience that a tailored solution developed in collaboration with the customer provides a greater degree of certainty that the customer will also select the product in the future.

"Little Enterprise Ltd." decides that Niels ought to participate in informal cooperation with a network group involved in product-oriented environmental work so he can update his knowledge of this field. The informal cooperation group turns out to be a good source of inspiration and provides him with a network of resource people to whom he can turn when he has a question or problem concerning the environment.

Experience Exchange Groups

Business associations and municipalities have had success with using experience exchange groups to introduce environmental management to groups of enterprises in the same field, or in the same geographic area.

Experience exchange groups also provide a good forum for introducing a life-cycle-based environmental initiative to a group of enterprises. With product-chain cooperation there are mutual obligations concerning, among other things, data exchange. In an experience exchange group the focus is on updating the level of knowledge within a certain field, exchange of experience, and mutual inspiration via discussion of concrete ideas for environmental improvements. Such groups lead to the development of networks where members are able to help one another with solutions to specific environmental problems.

In many enterprises, a single employee is responsible for environmental issues, including data collection and analysis, as well as specific initiatives regarding improvements to a product. This environmental responsible employee will often need to discuss environmental questions with colleagues in similar situations employed at other enterprises. Furthermore, such groups help to maintain employee's enthusiasm for environmental initiatives.

It is a good idea if several employees from the same enterprise are involved in this collaboration. The employee with responsibility for environmental issues should invite other employees to selected meetings. For example, employees involved in product development may be invited to a theme day about environmental considerations in design and product development. This will strengthen internal interest and cooperation within an enterprise, which will, in turn, contribute to the organisational integration of the efforts and finally contribute to the results from the product-oriented environmental initiative.

COOPERATION WITH AUTHORITIES AND A KNOWLEDGE NETWORK

Authorities and a number of other institutions more or less closely tied to an enterprise may provide assistance with life-cycle-based environmental initiatives focusing on developing and marketing cleaner products.

Various authorities have an in-depth knowledge of requirements for production processes and products. These requirements are constantly changing, and in recent years, the majority are EU requirements.

A recurrent dialogue with authorities provides insight into these requirements, so an enterprise is not "caught sleeping". Local authorities have knowledge about where an enterprise may obtain informa-

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GOOD PLACES TO GET HELP – ON THE NET AND IN PERSON:

- *Cleaner products:* see www.mst.dk, the Danish Environmental Protection Agency's website, under "products & industry". At this site there are project reports, references to product panels, information regarding subsidies under the Program for Cleaner Products.
- *Energy:* see www.energioplysningen.dk, the National Danish Energy Information Centre (Energi Oplysningen).
- *Waste:* see www.affaldsinfo.dk, Waste Centre Denmark (Videnscenter for Affald).
- *Transport:* see www.transit.dk, transIT – provides information to the transport trade.
- *Chemicals:* see www.dtc.dk, Danish Toxicology Centre (Dansk Toksikologi Center).
- *Undesirable substances:* check the "list of undesirable substances" at www.mst.dk.
- *Environmental marketing:* see www.fs.dk, the Danish National Consumer Agency's (Forbrugerstyrelsen) website under "consumer law".
- *Business associations*: see for example www.di.dk, the Confederation of Danish Industries' (Dansk Industri) website.

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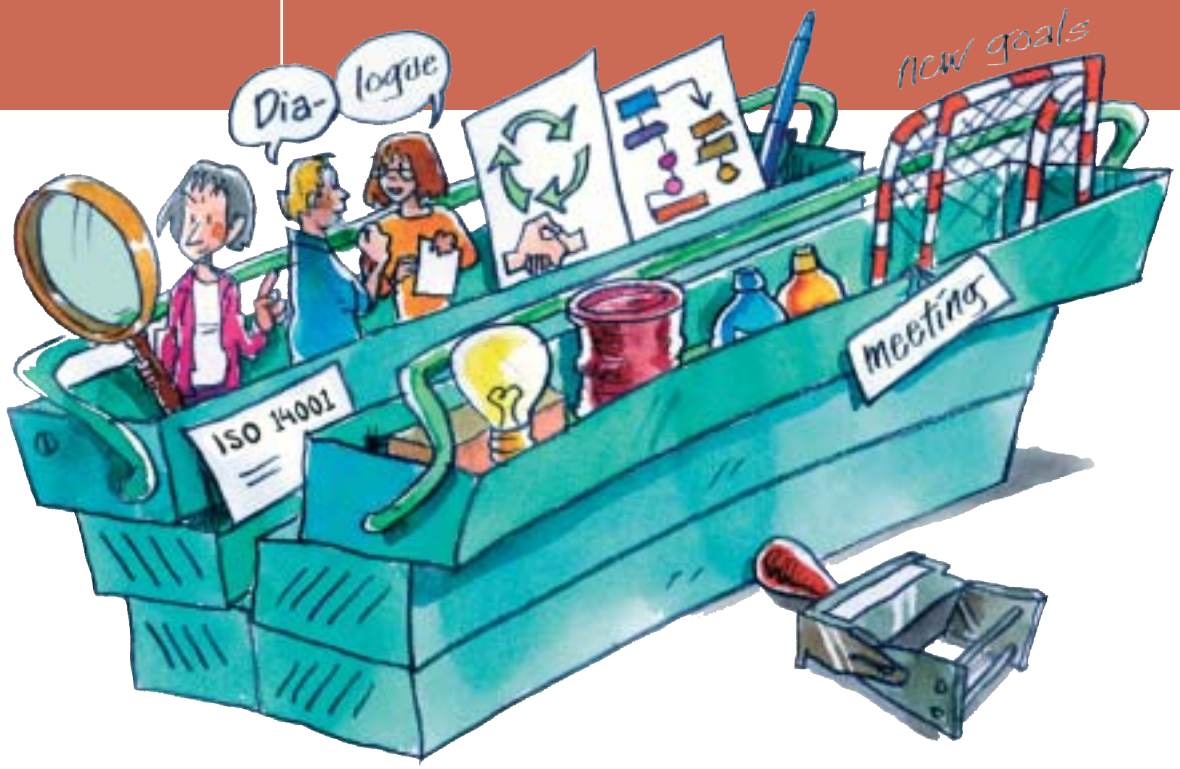
tion regarding energy, waste, subsidy programmes, etc.

An enterprise's knowledge network includes various types of consulting firms, Technological Information Centres, universities and research institutions, the occupational health service, sector organisations, approved technological service institutes, for example "dk-teknik" and "Teknologisk Institut", local / regional energy and waste companies, etc.

These knowledge network provide assistance with a preventative environmental initiative. Most of these "advisors" are also competent sparring partners in terms of development of cleaner products.

10. The tool-box – how to keep the process going



In the 1990's, in Denmark, the Ministry of the Environment put emphasis on life-cycle assessment as a decision-making tool to evaluate the most significant environmental impacts associated with a product. An enterprise will require various tools depending upon the goal(s) and the level of ambition for the environmental initiative, particularly if attention is directed towards marketing aspects of cleaner products.

There are tools suitable for at least three types of tasks:

A. Assessment of the most significant environmental impacts from cradle to grave
B. Ideas for environmental improvements to a product / eco-design
C. Environmental communication in the product chain and cooperation with interested partners

In addition, there are tools concerning consumer and market surveys, economic analyses, quality development, etc. The latter tools are outside the context of this report.

There is short discussion of the three types of tools below. Finally, there is a list of references to more detailed literature.

A) LIFE-CYCLE ASSESSMENT – ENVIRONMENTAL IMPACTS FROM CRADLE TO GRAVE

Depending upon the goal, a life-cycle assessment may be undertaken with three different degrees of detail which have very different requirements in terms of data collection and analysis. They are as follows:

Life-cycle thinking / conceptual life-cycle assessment involves a rough mapping of the relevant environmental impacts in the various phases of a product's life cycle. The goal of this type of assessment may be summarised in the following question: based on the existing knowledge regarding the environmental impacts from cradle to grave, how will an enterprise prioritise initiatives for improvements to a product's environmental profile?

The enterprise may undertake the assessment alone and the steps are the following:

- Obtain an overview over the phases of the life cycle and the relevant environmental impacts
- Use guidelines and rules of thumb
- Obtain ideas for immediate environmental improvements – "low hanging fruits".

This type of assessment involves a qualitative evaluation of the enterprise's situation based on contact and discussions with relevant collaboration partners. (See Chapter 3 for suggested questions for discussion.) This evaluation may be supplemented with quantitative information based on key figures, standards, and common knowledge.

Simplified environmental assessment / life-cycle screening is used to identify the most important environmental impacts and life-cycle phases. This information can then be used to identify "hot spots" which should be assessed in greater detail. One tool which may be used in this process is the MEKA scheme (a Danish acronym for the words materials, energy, chemicals and other) which aims at making data collection and analysis more manageable. This involves:

- Identification of the significant environmental impacts and life-cycle phases
- Identification of hot spots
- Ideas for systematic environmental improvements to the product.

In the past few years, Technological Information Centres (TIC), located throughout Denmark, have assisted a number of enterprises in using the MEKA method to perform an initial "life-cycle check".

A detailed life-cycle assessment provides information which will permit comparison of similar products, as well as detailed information regarding the most significant environmental impacts in the entire life cycle of the product. This assessment method is time consuming, requires extensive data collection, and specialised environmental expertise. Tools such as the computer program, SimaPro, from Holland or the Danish UMIP (an Danish acronym for Development of Environmental-friendly Industrial Products) are helpful.

The majority of Danish enterprises will normally require assistance from an environmental consulting firm to conduct a detailed life-cycle assessment. Such an assessment involves the following:

- Identification of the most significant environmental impacts and life-cycle phases
- Documentation as a prerequisite for environmental product declarations and eco-labels
- Comparison of products.

These three degrees of detail for assessment of a product's environmental im-

Figure 10.
Assessment of a product's environmental impacts

Level of ambition	Internal environmental commitment and readiness	Environmental profile for a cleaner product	Marketing a cleaner product
Survey (analysis)	Overview over life-cycle phases, authorities' requirements, etc.	Simplified environmental assessment and user survey	Detailed life-cycle assessment and market survey
Goals	Select initiative areas for environmental improvements	Implement obvious environmental improvements	Documentation of most important environmental impacts
Cooperation	Contact with relevant collaboration partners	Cooperation among suppliers regarding documentation and environmental improvements	Common routines for exchange of experience in the product chain
Results (statement)	Can respond to enquiries regarding a product's environmental profile	Conforms to environmental criteria, for example public procurement guidelines	Marketing of the product's environmental characteristics

pacts correspond in general to the three levels of ambition discussed previously (see Chapter 3).

The ambition level also determines how much time, and knowledge, and how many resources must be allocated to an initiative. The longer an enterprise moves to the right in Figure 10, the greater the time and expertise required. Expressed in another way, more detailed data collection requires more time and necessitates the involvement of a greater number of environmental specialists. However, it is only necessary to undertake a detailed life-cycle assessment if the enterprise wishes to market its product as environmentally better than the competitors.

B) Ideas for environmental improvements / eco-designs

Internationally, there is a tradition of working with Eco-design and Design for the Environment. This begins with a life-cycle perspective, from which a number of ideas and guidelines regarding improvements to a product's environmental profile in each individual phase are generated. The approach puts focus on creativity and is action-oriented.

Philips operates, for example, with a "Fast Five" design approach where a proposed new product is compared to a reference product via the following five questions:

- Energy – does the proposed product design use less energy than the reference product?
- Recycling – is the new product more easily recycled?
- Hazardous waste – does the proposed product contain less chemical waste than the reference product?
- Product value – does the new design contribute to a longer product life, increase the desirability of the product and make it easier to repair?
- Service – is this a new way to provide a service with fewer environmental impacts?

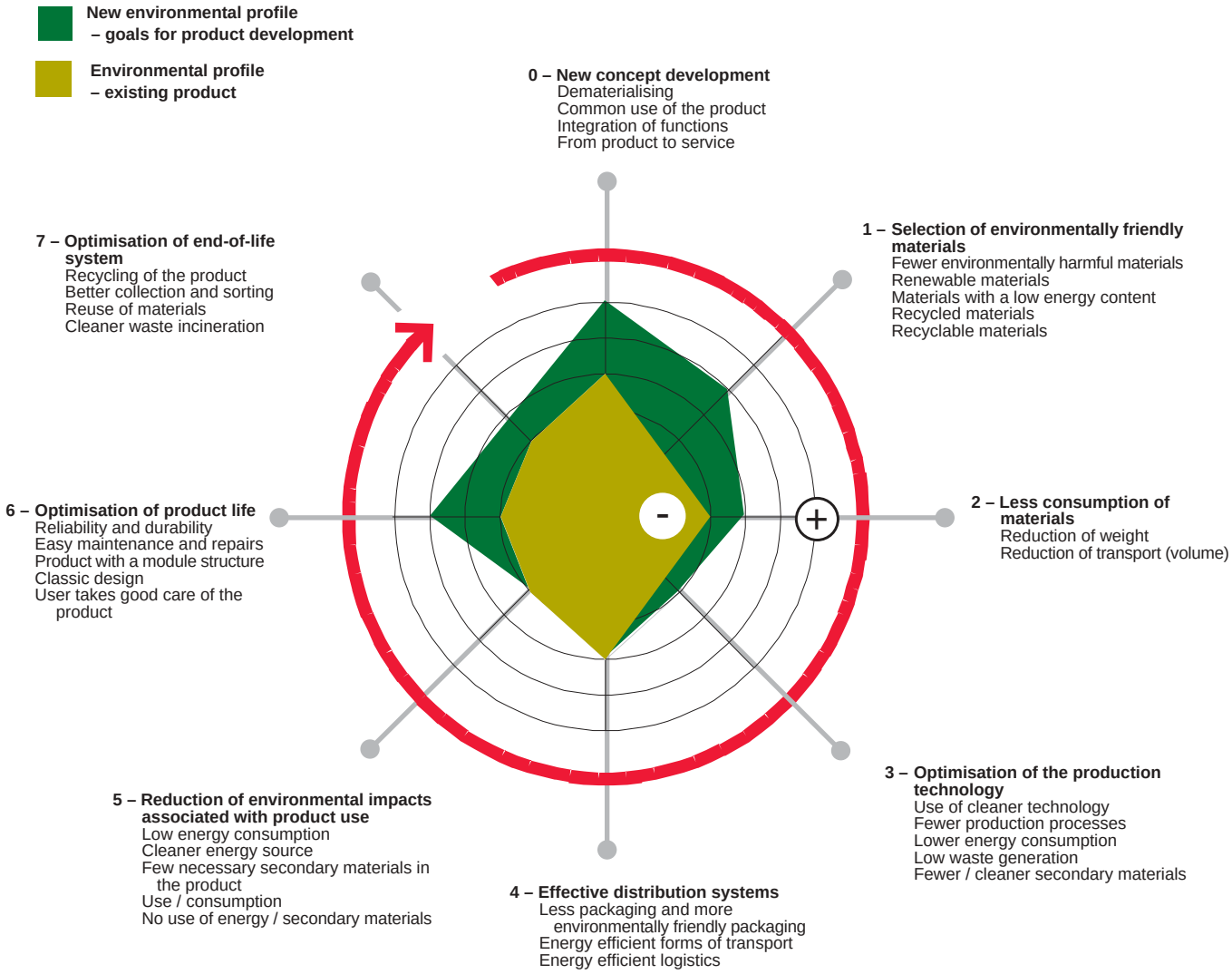
If the answer is YES five times then the proposed new product is an excellent alternative. If the answer is "yes" only three times, then the product is considered to be an interesting alternative, but one which still requires some improvement. A single "yes" means that the designer ought instead to consider upgrades to the reference product.

There are a variety of decision-making tools to assist with eco-designs with names such as spider web, strategy wheel, eco-compass, etc. which emphasise a visual representation of the issues (see Figure 11).

Based on a rough assessment of a reference product, the existing product's environmental profile is presented graphically by giving the product a grade for each individual life-cycle phase. This provides the background for discussions regarding the goals for future product development. In addition, the environmental profile for the proposed product is sketched in with a grade for each phase. This visual presentation identifies clearly where a new product requires environmental improvements and may also assist in motivating product developers and other employees.

A spider-web approach is illustrated in Figure 11. The practical value of this tool may be further improved if each phase and each concrete action task are formu-

Figure 11.
A product's environmental profile (adapted from Brezet & van Hemel, 1997)



lated in such a way that they address the common characteristics of the various product families (see the literature list).

C) Environmental communication and product chain cooperation

A life-cycle-based environmental initiative with focus on developing and marketing cleaner products makes new demands on environmental communication with an enterprise's various partners (see also Chapters 8 and 9). There are a number of tools to assist in working systematically with environmental communication and dialogue within an enterprise and between enterprises.

When establishing more systematic environmental communication, an enterprise must determine the following:

- With which partners / interested parties does the enterprise wish to enter into dialogue?
- What are the partners' requests and goals regarding environmental dialogue?
- What messages will be communicated using which means?
- How does an enterprise develop a plan for environmental dialogue?
- How are credible environmental arguments constructed?
- How can the results of environmental dialogue be evaluated?

The answers to these questions and others are answered in the literature list under "C".

Further information and sources of inspiration

General literature concerning cleaner products and life-cycle-based environmental initiatives

- Kirsten Schmidt, m.fl.: Manual on Product-oriented Environmental Work. Environmental News No 64, Danish EPA 2002. (Gives an introduction to a product-orientated and life-cycle-based environmental initiative along the same lines as this booklet).
- Livscykluscheck (LCC) – Stimulering af mindre virksomheders interesse for arbejdet med renere produkter. Teknologisk Information Center, 2002 (See www.tic.dk - clarification of needs, life-cycle check and about forty fact sheets).
- Intensified Product-oriented Environmental Initiative. Environmental Project No. 460, 1999.
- Arne Remmen: Renere produkter – nye værktøjer, aktører og relationer. Evaluation of completed projects under the Danish Ministry of Environment's Cleaner Technology Action Plan 1993-97. Orientering nr.12, Danish EPA, Ministry of Environment and Energy, 2000.

A) Environmental and life-cycle assessment:

- Torben Lenau, m.fl.: Miljørigtig udvikling i produktfamilier – en håndbog. Miljønyt Nr. 67, 2002. (Based on an environmental assessment, the most significant improvement possibilities are listed for related product groups).
- Kirsten Pommer, m.fl.: Håndbog i miljøvurdering af produkter – en enkel metode, Miljønyt, nr. 58, Danish EPA 2001. (A manual for a simplified environmental assessment).
- DS-håndbog 126. Livscyklusvurderinger– en kommenteret oversættelse af ISO 14040 til 14043. Dansk Standard, 2001. (A presentation and discusssion of LCA standards).
- Jesper Olesen, m.fl.: Miljørigtig konstruktion. UMIP publikation, Danish EPA and the Confederation of Danish Industries, 1996. (Discusses how the designer / engineer can integrate environmental considerations into product development).
- Henrik Wenzel, m.fl.: Miljøvurdering af produkter. UMIP publikation, Danish EPA and the Confederation of Danish Industries, 1996.
- Astrup Jensen et. al.: Life-cycle Assessment – a guide to approaches, experiences and information sources. European Environment Agency, Copenhagen, 1997
- Pablo Frankl & Frieder Rubik: Life-cycle Assessment in Industry and Enterprise. Adoption Patterns, Applications and Implications. Springer Verlag, 2000. (Discusses European enterprises' experiences with life-cycle assessments).

B) Eco-design / design for the environment:

- Han Brezet & Carolien van Hemel: ECODESIGN – A promising approach to sustainable production and consumption. UNEP 1997. (Based on Dutch experience, this handbook gives an introduction to eco-design).
- Ursula Tischner, et.al.,: How to do EcoDesign? A Guide for environmentally and economically sound Design. Verlag form praxis, 2000. (Contains a comprehensive discussion of a number of Eco-design tools).
- Herman Meinders: Point of no return. Phillips EcoDesign guidelines. Phillips, 1997. (Phillip's suggestions regarding integration of environment into design and product development).
- Sustainable Solution Design Association: A Handbook on the Environment for the Textil and Fashion Industry 2002. (How the environment may be taken into consideration in textile design).
- Eco-Conscious Design of Electrical and Electronic Equipment. (Danish CD-rom about eco-design and simple environmental assessment of electronic products).

C) Environmental communication and product chain cooperation

- Håndbog i miljødialog. The Confederation of Danish Industries, 2001. (A brief introduction to how an enterprise selects interests, areas, goals and means for environmental dialogue. The subjects are handled in greater depth in a series of booklets listed below).
- Hans Niemann, m.fl.: Planning and Organising an Environmental Dialogue. Environmental News, No. 63, The Danish Agency for Trade and Industry & the Danish EPA, 2001.
- Hans Niemann, m.fl.: Miljødialog med kunder. Miljønyt nr. 46, the Danish Agency for Trade and Industry & the Danish EPA, 2000.
- Anette Petersen, m.fl.: Miljødialog med leverandører. Miljønyt nr. 48, the Danish Agency for Trade and Industry & the Danish EPA, 2000.

The following booklets are also included in the same series. (All booklets are available on the internet: www.mst.dk)

- Udformning af skriftlig miljøkommunikation, Miljønyt nr. 42, 2000.
- Miljødialog gennem pressen, Miljønyt nr. 44, 2000.
- Miljødialog med kollegaer, Miljønyt nr. 45, 2000.
- Katalog over midler til miljødialog, Miljønyt nr. 47, 2000.

The following reports regarding product chain cooperation and the environment will be published:

- Heidi Stranddorf, m.fl. Miljøledelse i produktkæder. Danish EPA, 2002 (A good description of enterprise examples).
- Kirsten Schmidt, m.fl.: Miljøledelse i produktkæder – supplerende eksempler med fokus på miljømærker og internationale forhold. Danish EPA, 2002.

All publications by Danish EPA (the Ministry of the Environment) may be found at www.mst.dk

Data Sheet

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Title:
An introduction to Life-cycle Thinking and Management

Authors:
Remmen, Arne;
Münster, Marie

Performing organization:
Department of Development and Planning
Aalborg University, Denmark

Abstract:
This booklet describes how enterprises can begin developing cleaner products based on a life-cycle perspective. It focuses on a simple approach to preventive environmental initiatives, where enterprises can begin at a level that matches their ambitions and their preconditions. The report is aimed at enterprises that, irregardless of size or sector, are interested in reducing environmental impacts from their products.

Resumé:
Hæftet beskriver, hvordan virksomhederne kan komme i gang med at udvikle renere produkter udfra en livscyklustankegang. Der er fokus på en enkel tilgang til en forebyggende miljøindsats, hvor virksomhederne kan gå i gang på et niveau, der passer til deres ambitioner og muligheder.
Rapporten henvender sig til virksomheder, der uanset størrelse og branche er interesseret i at nedbringe miljøpåvirkninger fra deres produkter.

Terms: environmental management; product-chain cooperation; cleaner products; life-cycle perspective; enterprises

Supplementary notes: Translation of “Kom godt i gang med livscyklustankegangen !” (Miljønyt, 65).

This Handbook is part of a ’mini series’ about life-cycle thinking and life-cycle assessment published by the Danish Environmental Protection Agency in its series ’Miljønyt’ (Environment News).
Together, the publications are to support enterprises, authorities, etc. who want to deal with environmental conditions based on a life-cycle approach.

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Nr. 64: Manual on Product-Oriented Environmental Work
Nr. 65: Renere produkte

Did you know:

- that more than 700 Danish enterprises have a certified environmental management system that is consistent with the ISO 14001 standard or the European EMAS regulation
- that environmentally certified enterprises are increasingly taking a cradle-to-grave approach to their products as part of their preventive initiatives concerning environmental issues
- that the detergent Bluecare, that has the Swan label, 12-doubled its market share after a test showed that it was the cheapest, best and most environmentally friendly detergent
- that more than 90% of fridges sold in Denmark today have the energy labels 'Class A' and 'Class B' – a twofold increase compared to sales five years ago
- that good design = longevity of a product = better environment
- that at present environmental labelling criteria exist for 68 product groups in accordance with the Nordic Swan label or the European Flower label
- that 51 procurement guidelines have been published for public-sector and private-sector procurement officers, and that procurement officers from within the public sector annually spend a total of DKK 140bn.
- that there is a list of 60 substances that the environmental authorities want to phase out the use of as soon as possible
- that consultancies can establish how a product affects the environment for DKK 20-30,000.00
- that as much as 66% of the 'load' lorries are driving around with is 'air'. This means that huge environmental improvements can be achieved by optimising transport capacity and logistics plans
- that a product is already made more environmentally friendly, if it is easier to repair
- that more than 80% of a new car can be recycled, and that an increasing number of the big car manufacturers require that their suppliers introduce certified environmental management

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