RESPONSIVENESS OF INDUSTRY TO ECO-EFFICIENCY IMPROVEMENTS IN THE PRODUCT CHAIN

The case of Akzo Nobel

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1. Introduction

During the last decade industry has made considerable progress in environmental management. Significant efforts have been made to improve the manufacturing technologies for existing and newly designed processes, in terms of optimizing the consumption of raw materials and energy and also minimizing the environmental impacts. In this way the “eco-efficiency” of the companies’ processes has been substantially increased over time. Recently, the front-runners in industry have begun to broaden their perspective to include environmental improvement of their products during the entire lifecycle (from cradle to grave). The idea behind the adoption of this new perspective is that a lifecycle approach may be beneficial economically and may lead to even higher eco-efficiencies. Through cooperation and communication in the product chain major environmental improvements may be achieved, which could not have been realized by one company alone. Moreover, it is expected that strategic environmental challenges of this kind might strengthen the market position of the companies concerned. Environmental threats may thus be avoided and, on a more optimistic note, promising business opportunities may be utilized.

Various authors indeed claim the benefits of this marriage between ecology and economy in lifecycle management (e.g. Fussler, 1996; Shelton and Shopley, 1996; Steger, 1996). Most publications, however, provide ad-hoc examples of successful cases where economic advantages could be gained and at the same time environmental improvements be achieved (e.g. DeSimone and Popoff, 1997). Little attention has been paid to the conditions under which business opportunities and eco-efficiency improvements in the product chain can go hand in hand. Most authors who have researched the relationship between eco-efficiency and market opportunities have provided a list of potential advantages (Shrivastava, 1995), but the conditions under which these benefits can be secured remain a “black box .”

The objective of this paper is to afford an insight into the business conditions that favor a proper match between market opportunities and eco-efficiency improvements in the product chain. To assess the feasibility of achieving these advantages, six pilot studies were set up within the chemical company Akzo Nobel headquartered in Arnhem, the Netherlands. It is a multinational with almost 70,000 employees and activities in more than 50 countries. The pilot studies were coordinated by the author of this paper, who was therefore intimately involved in the process. Despite the methodological problems of this kind of action research, the approach provided a wealth of formal and informal information. This information is used to reflect upon the business conditions that influence the responsiveness of companies to eco-efficiency improvements in the product chain.

Below I will first explain the methodological and theoretical frameworks within which the six pilot studies will be analyzed. Next, the results of each pilot study will be summarized in an anonymous way. Finally, the overall results of the six pilot studies will be evaluated in terms of the business conditions for successfully meeting strategic environmental challenges over the whole lifecycle.

2. Methodological framework

Data collection was primarily based on six pilot studies carried out in (sub-)business units (BUs) of each of the four main product groups of Akzo Nobel: pharmaceuticals, coatings, chemicals, and fibers. Within the chemicals and fibers groups two pilot studies were performed. The major objective of these pilot studies was to assess under which business conditions a lifecycle perspective could benefit the (sub-)BUs economically and ecologically.
All pilot studies adopted a similar approach, called STRETCH. STRETCH is the acronym for the Selection of sTRategic EnvironmenTal CHallenges) (Cramer and Stevels, 1997). Following this approach, the available options for eco-efficiency improvements in the product chain were identified and assessed from a market opportunity perspective. The basic idea behind this approach is that the selection of promising eco-efficiency improvements over the whole lifecycle should be attuned closely to the (sub-)BUs' general business strategy and to the demands of external stakeholders (including suppliers and customers). In order to ensure that the STRETCH approach becomes an integral part of the general business planning, it is to be embedded structurally in the organization and attuned to related activities (e.g. ISO 14001). Therefore, the STRETCH approach consists of the following six steps:

Step 1:	Survey the unit's (potential) product/market strategies and the most important driving forces that determine business strategy in general.
Step 2:	Monitor new developments and trends in the environmental debate and changes in pressure exerted by external stakeholders.
Step 3:	Identify potential eco-efficiency improvements that can be made in the product chain.
Step 4:	Select eco-efficiency improvements that can lead to the development of promising market opportunities or the avoidance of potential market threats in view of the previous steps, then formulate an action plan for short-term and long-term eco-efficiency improvements in the product chain.
Step 5:	Embed the STRETCH approach in the organization.
Step 6:	Bring the results into line with related BU activities, viz. ISO 14001 compliance, product stewardship, and product development.

Information about *step 1* was gathered through interviews with members of the management teams of the (sub-)BUs and through (partly confidential) documents about their business strategy. Data about *step 2* were collected via various ways, depending on the available information sources. Use was made of interviews with various (sub-)BU members (particularly the marketing people), results of customer questionnaires, and documents revealing the forms of environmental pressure.
Before the possibilities for improvement of the present performance of the (sub-)BU (*step 3*) were investigated, a shared vision and strategy on environmental issues was formulated to determine the scope of the eco-efficiency improvements to be proposed. A helpful tool here was a checklist of possible reasons why attention should be devoted to eco-efficiency improvements in the product chain. By checking the items in the list that were relevant to the unit, a good picture could be obtained of the units' shared

vision and strategy. To help identify potential eco-efficiency improvements in the product chain, three kinds of environmental data were gathered:

1. Quantitative data about the specific products selected by each (sub-)BU. These data were based on a LifeCycle Analysis (LCA) addressing the environmental impacts of products from cradle (raw materials production) to grave (the final waste stage). The depth of the LCA studies was dependent on the questions to be answered.
2. Environmental data about current transportation activities and alternative modes of transportation, particularly related to the production facilities.
3. Qualitative data based on strategic considerations of market opportunities derived from steps 1 and 2.

Step 4 concerned the selection of the most promising eco-efficiency improvements in the product chain based on the results of the three previous steps. This led to a list of recommendations to be incorporated in the strategic planning procedures of the (sub-)BUs. These recommendations dealt with eco-efficiency improvements to be made in the shorter and longer term in the whole product chain (e.g. in relation to the suppliers, own production processes, logistics, and the customers).
Step 5 focused on the way in which the STRETCH approach could be incorporated in the work of the main departments involved: R&D, Marketing & Sales, Purchasing, and Communications. Guidance documents were written to describe the main additional tasks to be carried out by these departments. Finally, *step 6* made sure that the STRETCH approach was carefully attuned to already existing activities related to eco-efficiency improvements in the product chain.

Every pilot study was coordinated by a member of the management team (usually the R&D manager), one or more assistants, and the author of this paper. The underlying analyses were made in close cooperation with the (sub-)BU and other experts working in the service units of Akzo Nobel. Four pilot studies focused on a group of products produced by the (sub-)BU in question, while two pilot studies dealt with only one major product. The final results were summarized in a confidential report that was discussed and approved by the management teams of the (sub-)BUs involved. The pilot studies were carried out during May 1997 - July 1998.

3. Theoretical framework

The information gathered during the six pilot studies forms the basis for a reflection on the business conditions that favor the adoption of strategic environmental challenges. The hypothesis is that the business opportunities for eco-efficiency improvements will vary among the cases, depending on their specific situation. It is assumed that win-win situations of eco-efficiency efforts will not always be as evident as is sometimes claimed. As Walley and Whitehead stated “It’s not Easy Being Green” (1994). Insight into the specifics of business conditions can enhance our understanding of the prospects for industry to strive for higher eco-efficiencies in product chains. In this way false expectations about potential benefits from such endeavors can be avoided.

A wealth of theoretical literature is available on the concept of business conditions, each focusing on a particular set of indicators that describe the business organization, including its organizational strength and business

potential (e.g. Pettinger, 1996). Such indicators are often translated into so-called SWOT analyses that highlight the Strengths, Weaknesses, Threats and Opportunities of a particular business.
The checklists of factors in assessing both the external and internal conditions of an organization can become very long (Mintzberg, 1994). Numerous external conditions are mentioned that relate to the social, technical, economic and political environment, and to the competitors' strategies. Similarly, a great number of internal conditions are identified that specify the capabilities and strength of the organization.
For the purpose of the analysis to be made here it is not workable to rely upon long checklists of possible external and internal conditions. Instead a limited number of business conditions have been selected that seem to be crucial to the responsiveness to strategic environmental challenges. This selection was made by confronting the parameters mentioned in general strategic management literature with those in environmental management literature. Moreover, the practical experience gained with the STRETCH approach during the pilot studies also provided some guidance in selecting the parameters to be studied.

The STRETCH approach assumes that the level of ambition of a company to increase eco-efficiency is the result of the general business strategy and the demands of external stakeholders. In case of lifecycle management network aspects also play a dominant role (e.g. relationships in the product chain). These assumptions are also expressed in the literature about environmental management (Hopfenbeck, 1993; IVA, 1995; De Groene, 1995; Cramer 1998). Whether a company grasps the potential opportunities will also depend of course on the internal structure and culture of the company in question, including its history and the views of certain important actors in the firm, for instance the general manager (Östlund, 1994; Welford, 1997).
In the analysis presented here the structure and culture of the organization is not explicitly included. In some respects this parameter did not differ among the six pilot studies. The (sub-)BUs all conformed to the same corporate strategy both in terms of business performance and environmental directives. Moreover, the management teams of the (sub-)BUs involved were committed to join the endeavors to identify potential strategic environmental challenges. Therefore, the persons involved in the process did not hit the so-called "Green Wall," which means a lack of management support for the greening process in their business (Shelton and Shopley,1996). Furthermore, some aspects related to the structural and cultural differences are also reflected in the business strategy. Other aspects (for instance, differences in leadership style) are harder to grasp and would require a separate in-depth analysis of the organization's culture.

Therefore, the comparative analysis made here will focus on the general business strategy, network characteristics (particularly the company's position in the product chain) and external environmental pressure/demand (including the possibilities of using the environment as a competitive edge). As all pilot studies focus on professional markets and not on consumer markets, this particular parameter was not taken into account.
In order to specify the general business strategy, I relied upon the work of Pettinger (1996). After Ansoff (1988) Pettinger defines strategy as a set of

decision-making rules for the guidance of organizational behavior. Strategy is concerned with identifying opportunities for successful and effective activities. These come either from the capabilities and expertise of the organization, or from the actual and potential market demand, or a combination of both. In assessing the sources of strategy Pettinger identifies a number of "business potential" indicators. From this list I have selected those business indicators that seem relevant for the issue at stake here.
As a result the following parameters were used in reflecting upon the results of the six pilot studies:

Potentially relevant parameters for adopting strategic environmental challenges

General business strategy

- Current activities (production of raw material, intermediate or final product)
- Market share, both current and envisaged
- Market state: growth, maturity, decline, steady/turbulent
- Market position
- Entry and exit barriers
- Technology: availability, usage, potential

Network characteristics

- Position in the value chain

External environmental pressure/demand

- Environment as a competitive edge
- Environmental pressure of the various influencer groups ("stakeholders") surrounding the organization.
- Other dominant external drives and restraints

Below the results of each pilot study will be evaluated in terms of the parameters mentioned above.

Pilot study 1: The Coatings case

Case 1 is a BU within the Coatings group of Akzo Nobel. The BU is divided into a number of sub-BUs related to the various regions (the sub-BUs W. Europe, E. Europe, N. America, S. America, and Asia Pacific). Every sub-BU has his own profit responsibility. Geographic expansion of the BU in W. Europe started in the 1970s and in the United States since the 1980s. While being one of the hundreds of small suppliers a few decades ago, case 1 has become today one of the major players, together with its competitors accounting for about two-thirds of the global market.
The BU has a strong market position. Since many years the batchwise production processes have not changed radically. Products are sold to a market of professional customers. The growth potential of the market is high, which is among other factors due to further technological developments and market growth, especially in developing economies. The market of the BU is divided into three segments: the high, medium and low segment. The price of the products depends on the quality of the product and the degree of service provided to customers.
Until now the BU has mainly focused on the high segment. Financially this has been an enormous successful strategy through the combination of high-quality products with excellent services to the customers. As growth

expectations in the high segment market are modest, the company now aims to increase its market share, particularly in the more rapidly growing medium segment. Therefore, since recently the BU has been making efforts to broaden its product range, thus supplying different markets worldwide. For the company this implies new ways of working and new ways of using and expanding the available resources.

The main driving force that influences the BU's market strategy is the profitability of the company and its customers. Other economic factors, such as changes in the market structure through growing competition and further professionalization of their customers, influence the marketing organization but not so much product development.
The relationship with the company's customers is very close due to the high degree of service provided. Its position amidst customers and suppliers in the product chain is rather strong and stable. Because of the high competitiveness of the market, case 1 is investing a substantial amount of money in R&D and therefore has a high innovative capacity. Competition is particularly expected from the other main competitors and hardly from newcomers in the market due to the high entry barriers.

Environmental and health/safety issues play a modest role. The main environmental pressure comes from governments and seldom from other societal groups (e.g. environmental and consumer organizations). The main topic both governments and other external parties are presently addressing is the use of volatile organic compounds (VOC) and the use of heavy metals. Customers usually do not ask explicitly for more environmentally sound products. However, if better, equally priced products are on the market, they seem to be willing to buy these products. Qualitative market research in the Netherlands shows that customers consider case 1 as a leader in the market but not in environmental issues.
The quantitative and qualitative environmental analyses of the environmental performance of the present products showed that various incremental and more far-reaching eco-efficiency improvements could be made. Although the options generated still needed further R&D, the management team clearly stated the importance of investigating these options in view of both eco-efficiency improvements and market opportunities. If these innovations lead to promising results, they may become profitable in both existing and new markets.

Management mentioned a great variety of reasons why the BU should pay attention to eco-efficiency improvements, namely reduction of production costs, improvement of the internal organization, better relationship with current customers, acquisition of new customers, increase of actual market share, improvement of the potential to survive, contribution to the improvement of the environment, and reduction of potential threats (less criticism of external parties, being ahead of legislation, and decrease of environmental risks).

Pilot study 2: The Pharma case

Case study 2 concerns a BU that manufactures pharmaceutical ingredients and sells about half of these to other business units in Akzo Nobel and the

rest to external pharmaceutical companies in the world market. The BU is active worldwide.
The company's production departments today manufacture several hundred different products. The current, dedicated multipurpose batch production activities is not expected to change drastically in the next ten years. A shift toward modern biotechnological processes may be expected in the longer run. However, this largely depends on the needs and product specifications of the market.
The business position of the BU is strong. In recent years sales have shown a substantial growth. The future market perspectives are considered promising, and the company aims to accomplish additional growth by developing new products. The company's technological capacity is of high quality.
The market in which the company operates, is dynamic. As competition is fierce, excellent service and quality assurance have become competitive assets. Therefore, the BU aims to maintain its strong market position through its good reputation in terms of service, quality and reliability. Its consistent environmental management seems to become a competitive edge.

Aside of market developments, regulation is currently the main external factor that largely influences the company's business activities. The characteristics of the pharmaceutical ingredients are strongly determined by drug regulation. In fact, this regulation can hamper innovation. Every modification of the synthesis route (e.g. the use of another solvent) requires approval of the registration authorities (e.g. the Food and Drug Administration - FDA). In order to get approval the company should carry out extensive validation tests together with its customers. Because this is time-consuming and costly (also for the customers), the BU is reluctant to switch to another processing route. Major attention is therefore being paid to the reduction of environmental effects during production (e.g. caused by the use of solvents).
The BU is largely influenced by its customers, because they determine the variety of products (and hence the type of synthesis routes) the company makes. Only incidentally does the customer ask for information about environmental issues or request to visit the plant. The BU is considered to be a reliable supplier that guarantees service, continuity and quality (also with respect to the environment). The bargaining power of the company vis-à-vis suppliers is modest.
Government environmental regulation also plays a crucial role in the company's production activities. However, the immediate government pressure has been largely eliminated as a result of the stringent environmental measures taken in the last ten years at the BU's main production site.

The analysis of the eco-efficiency potential over the whole lifecycle has shown that the output streams (due to the company's own production processes) contribute less to the overall environmental impact than the input streams (production by suppliers of particularly organic solvents, inorganic chemicals and energy). The general opinion of the company is that no eco-efficiency leaps can be expected any more in its own production processes. This would require more fundamental changes in the production processes, which are costly, especially for current processes.

For various reasons the possibilities of eco-efficiency improvement of the input streams are limited as well. The room for substitution of the solvents and inorganic chemicals is largely restricted by the stringent quality requirements of customers and registration authorities. The only input parameter the company can influence itself is the consumption of energy. Most of the environmental effects related to energy consumption occur outside the plant during the generation of electricity from fossil energy. Indirectly the company can reduce these effects by using less energy itself (through energy saving and cogeneration) and/or by installing durable energy sources. Most incremental energy efficiency measures have already been taken by the company. More fundamental measures will not be implemented in the short run, mainly because of economic reasons.

This outcome is also reflected in the list of reasons why the BU should pay attention to eco-efficiency improvements. Management brought forward the following arguments: reduction of environmental fees, improvement of the potential to survive, improvement of the employees' motivation to work for the company, to be sure of market outlets worldwide, contribution to the improvement of the environment, and reduction of potential threats (less criticism, being ahead of legislation, decrease of environmental risks, and avoidance of bad environmental performance leading to negative publicity).

Pilot study 3: The Fibers case A

Pilot study 3 is part of the same BU as pilot study 4. About three quarters of the BU's total business is concentrated in case A. The main business of case 3 is the development, production and marketing of intermediate products, especially for application in global medical markets.

In the past this case A had a very strong market position as an independent supplier. However, due to severe competition and backward integration of customers the sub-BU has lost considerable market share. Competition continues to increase in a rather stable market. At the same time prices -- especially for the classic products -- are under increasing pressure. Therefore, reduction of the cost price for these products is presently case A's main driving force. The classic intermediate products are produced with processes that have reached the aging phase of the lifecycle. No new major investments are made in these processes, except when the sub-BU is forced to do so. For instance, if the taxes for emissions and/or waste increase substantially, investments in production improvements may become cost-effective here. Attempts have been made to replace the old processes by new ones. In practice, many problems were encountered to realize this objective. First, the introduction of a new intermediate product requires strict registration procedures, which also affect the customers. The costs involved hampers its

introduction. Second, the cost price of new products is higher due to more expensive raw materials. The current customers still prefer the cheaper products. The qualitatively better and more expensive products can mainly be sold in new markets and to new customers. Despite these problems, the sub-BU has recently developed a few promising new products.
Case A considers itself a producer of intermediates. The distance to the final consumer is large. The communication in the chain is primarily focused on the unit's own customers. They usually receive Material Safety Data Sheets from the sub-BU, informing them about the environmental and safety aspects of its products. The sub-BU seldom gets questions from its customers about the environmental aspects of its products. Moreover, they never ask about the pollution problems caused by the production processes of the sub- BU. The customers assume that a first-class company like Akzo Nobel complies with the standards and environmental regulations.
The main external threat concerning environmental issues stems from stricter environmental regulations to be expected, particularly in the area of air emissions. The costs to comply with more stringent regulations will be high. Higher energy prices may become another cost-increasing factor.

A first quick scan of the possibilities to improve the eco-efficiency of the production processes of case A has learnt that major environmental improvements can be made but at high costs. As the classic production processes are at the final stage of their lifecycle, major investments would not pay off. Therefore, management has decided to start first with eco-efficiency improvements that can be made in the relatively new operations with good market perspectives. As case A mainly uses the classic processes, the more in-depth analysis has focused on case B: pilot study 4.

Pilot study 4: The Fibers case B
The second, much smaller case B of Fibers also focuses on medical applications but includes technical applications as well. As far as medical applications are concerned, competition is limited. Forward integration is not an important issue because of the low number of customers. In order to ascertain its market leadership case B strives for further improvement of the partnership relation with its customers.
The products related to technical applications are sold to module builders (sometimes also to system builders). This market is more diverse and has many competitors. The strategy is therefore dependent on the application in question. Particularly these last-mentioned products are expected to show substantial growth in the coming years. Because of this promising market development, there is also some room to invest in eco-efficiency improvements. These vary from meeting customer's requirements to improving the production process.
In order to check additional customers requirements the case B manager has approached various customers about this issue. No customer questioned the environmental performance of its supplier (Akzo Nobel). Neither the recyclability nor reuse of the Akzo Nobel products was a point of discussion. The customers select their suppliers on the basis of price, quality and service but not for their environmental performance. The only environmental pressure comes from the local authorities. They continue to tighten environmental

regulations and force the BU as a whole to reduce emissions to air and water. Moreover, it is expected that the costs of energy will increase.

In assessing the potential for eco-efficiency improvements, attention was primarily focused on the sub-BU's own production processes and not on the rest of the product chain. Crucial decisions still had to be made on substantially improving the eco-efficiency in the sub-BU's own part of the chain. Major emissions to air and water were still to be reduced. Sub-BU B felt that it should first show its commitment to improve its own operations, before starting communication about eco-efficiency improvements in the whole product chain. Moreover, case B doubted whether it could - as a small player - influence the environmental performance of the rest of the chain. The customers were the ones who largely determine which products are made and how.

A more detailed analysis of the processes applied by case B showed that hardly any substantial, cost-effective eco-efficiency improvement could be made in the short term. The most feasible improvements were related to the reduction of waste and emission through end-of-pipe technologies. More preventive approaches were difficult to identify, unless the existing products and processes should be redesigned in a more fundamental way. Such investments could not be made at that moment. Several good housekeeping measures could reduce the emissions to some extent but not fundamentally enough. In view of the stricter environmental regulations to be expected, case B expressed the need to prepare an action plan to respond adequately. However, at present the sub-BU does not envisage any major eco-efficiency improvements that would also be promising economically.

Reduction of costs is therefore one of the main drivers for the sub-BU to pay attention to eco-efficiency improvements. This could be the reduction of environmental fees and production costs through the use of less energy and/or material input per unit of product or through the exchange of (waste) water and/or energy (heat) in a cascade fashion. Moreover, the improvement of the internal organization plays a role, for instance through synergy with other product requirements and with quality and occupational health and safety issues as well as through improvement of the employees' motivation. Finally, reduction of threats is considered to be of importance (less criticism of external parties, being ahead of legislation, and measures to avoid that the unit is lagging behind).

Pilot study 5. The Chemicals case A

Pilot study 5 represents a sub-BU of Chemicals. The pilot study focused on one main final product: a performance chemical used as an auxiliary substance for a large number of diverse end-use markets. Important applications include cleaners, food, mining, oil industry, photography, pulp and paper processing, and textiles.

The market of this auxiliary substance is dominated by a few big players, including Akzo Nobel. The products of the main competitors are quite similar. Akzo Nobel therefore aims to secure its good market position by providing excellent service to the customer, broadening the product range, and expanding its market efforts in other areas of application.

Generally, the product represents a low volume and therefore a low cost item in the application. The bargaining power of customers is high, particularly in commodities.

The auxiliary substance is considered to be a well-documented low risk substance. Nevertheless, environmental concern arose from authorities in some European countries in the late 1980s as the product was slowly (not readily) biodegradable. Consequently, some customers showed a lot of interest in readily biodegradable alternatives. However, during the 1990s producers and customers alike have come to realize that there is no easy general substitute with an integrally better environmental performance.
For the producers of this performance chemical the emphasis is now on cost/performance, control of effluent, and the overall effect on the environment. For instance, the sub-BU is working on the development of a method to quickly biodegrade the current product under moderate alkaline conditions. Especially when the product is emitted from one particular "point" source, the method developed by Akzo Nobel seems to be promising. There also remain opportunities for biodegradable alternatives. Intensive research continues to be carried out by the leading producers (including Akzo Nobel) to find effective alternative products without environmental or health risks. Also newcomers who are able to find a better alternative can rapidly get an entry to the market.

No national environmental agency prescribes maximum allowable emissions, but local governments may regulate the emissions through their permitting system. This situation leads to unpredictable outcomes.
The performance chemical needs to conform to specific quality requirements (including environmental aspects). However, the customers of Akzo Nobel seldom put direct pressure on the company to improve the environmental performance of its product. In fact, Akzo Nobel's sub-BU itself usually takes the initiative to approach the customers selectively. Priority is given by the sub-BU to those that emit the performance chemical as a "point-emission".

In assessing the eco-efficiency improvements over the whole lifecycle, several options came to the fore. For example, the main raw material inputs could be improved by switching to a different supplier who uses less environmentally burdensome production processes. Also in the production phase some incremental eco-efficiency improvements could still be made.
One of the major threats for case 5 is the fact that the existing product is slowly biodegradable. Therefore, the biodegradability is assigned high priority in case 5. For this auxiliary product eco-efficiency improvements can be directly translated into market opportunities. As a result it was considered crucial to carry out R&D focused on improving the method to biodegrade the present, low risk product once released and on developing alternatives with an overall reduction of the impacts on the environment and human health.

Similarly to case 1, the management of case 5 also mentioned the strengthening of its market position as one of the main criteria why the BU should pay attention to eco-efficiency improvements. The management stressed the importance of a better relationship with current customers, acquisition of new customers, increase of actual market share and entrance of

new markets. Moreover, a variety of other reasons was put forward: reduction of production costs, reduction of environmental fees, improvement of the internal organization, increase of the innovative capacity within the organization, improvement of the potential to survive, contribution to the improvement of the environment and reduction of potential threats (less criticism of external parties, being ahead of legislation, decrease of environmental risks, bad environmental performance, fear of lagging behind).

Pilot study 6: The Chemicals case B

The last case is also a sub-BU of Chemicals, and focuses on one main product as well. This sub-BU produces an essential intermediate product x for a variety of final products. Akzo Nobel is the world's largest producer of this essential chemical. It is followed by two main competitors and numerous small companies. The market of this intermediate product is unlikely to show major new developments over the next ten years: most applications are mature and will only grow to the same extent as the overall economy. There are few new markets for the unit to penetrate. The unit aims to strengthen its position by focusing on consistently high quality, supply reliability, and tailor-made delivery forms. R&D efforts mainly focus on incremental improvements of the existing, mature production processes.

The company's sales network spans the globe. The intermediate product is a toxic and corrosive organic acid that must be treated with great caution. Therefore, the company offers extensive technical service and advice. About half of the output is intended for the manufacture of the final product y that is also produced by Akzo Nobel. The product y is among others used as an auxiliary substance in oil drilling, mining, food additives, personal care products, and in detergents. The growth expectations of this product y vary per market segment. The threat of newcomers is limited, although global competition will be intensified and some regional newcomers will penetrate in niche markets. The threat of substitutes for this final product y is rather low due to its competitive price. The bargaining power of suppliers is rather high, while that of customers is rather low (except in a few specific sectors).

Case 6 focused on the intermediate product and its use in the final product y, both part of the Chemicals case B. The general attitude of sub-BU is to consider itself as a producer of intermediate products and auxiliary substances only. The distance to the final consumer is usually huge. Communication in the chain is primarily focused on the immediate customers and suppliers.
The immediate customers do not put much pressure on the sub-BU to improve its environmental performance. In fact, the only external pressure on the sub- BU comes from government bodies that demand strict observance of the environmental regulations. These mainly concern the production processes and the transportation of hazardous goods. The general perception is that the sub-BU complies with these regulations.

Until now the sub-BU has primarily been focusing its eco-efficiency efforts on improving the production processes incrementally. As these processes are very mature no major leaps in eco-efficiency improvements can be expected any more. Therefore, it was investigated whether major eco-efficiency

improvements could be made by expanding the scope to include the whole product lifecycle of both intermediate product and final product.
Theoretically major leaps could be identified for some of the inputs in the production processes. In practice, however, these options were not feasible economically or organizationally. For instance, a major eco-efficiency improvement could be made in the production of a feedstock by switching to a different process route (based on renewables) used by another supplier. However, in practice none of the alternative routes can presently compete with the current process, which has the advantages of lower raw material prices and good quality.
Another example is the use of a renewable feedstock material. Here the eco-efficiency depends *inter alia* on the process applied and the origin of the natural product. Although problems were encountered in getting exact data from suppliers about these issues, the main bottleneck was the specificity of the material needed to produce the final product. Current suppliers could guarantee this high quality.
In principle, eco-efficiency improvements could also be made in the application phase. However, as customers do not ask for these improvements, there is little enthusiasm in the sub-BU to proceed along these lines. Replacement of the intermediate and final product with other products is theoretically possible but too expensive at present.

The limited possibilities to implement more far-reaching improvements in the product chain is also reflected in the reasons to pay attention to eco-efficiency improvements as brought forward by the sub-BU's management. The main arguments were: reduction of production costs and environmental fees; improvement of the internal organization through synergy with quality, occupational health and safety issues; better relationship with current customers; improvement of the potential to survive and reduction of potential threats (being ahead of legislation and decrease of environmental risks).

5. Reflection on the cases
The main results derived from the six pilot studies, can be summarized in the following table:

cases parameters	case 1 (coatings)	case 2 (pharma)	case 3 (fibers, A)	case 4 (fibers, B)	case 5 (chemicals, A)	case 6 (chemicals, B)
activities	final products	intermediate products	intermediate products	intermediate products	auxiliary substance in final product	intermediate product/auxiliary substance in end-applications
market share	large	medium	medium	small	large	large
market state	growth	growth	mature	growth	mature	mature
market position	strong	strong in segments	weak	weak	strong	strong
technological position	strong	strong	modest	modest	strong	strong

entry barriers	high	high	high	modest	modest	high
influence in chain	high	limited	limited	limited	modest	limited
environment as a competitive edge	high	modest	low	low	high	low
environmental pressure	modest to high	modest	limited	limited	modest	modest
eco-efficient business opportunities	+++	+	-	-	++	-

From the above table it can be derived that the managers of the six (sub-) BU's studied differ widely in their assessment of the business opportunities to be achieved through eco-efficiency improvements.
The Fibers cases 3 and 4 did not lead to the selection of promising, cost-effective eco-efficiency improvements, except for some good housekeeping measures and incremental process improvements. This is mainly due to the fact that these two cases did not feel any environmental pressure from their customers and only modestly from the (local) government. Moreover, their influence in the product chain is limited. Many more far-reaching environmental improvements could still be made, particularly in their own production processes. However, short-term environmental measures would be costly. Since their market position was weak, they preferred to postpone the implementation of such measures until they were forced by government to do so.

The Chemicals case 6 did not lead to promising business opportunities either. In this case some environmental pressure was felt, for instance because of the high toxicity of the intermediate product. However, no acute pressure was exerted put on the sub-BU, neither by customers and governments nor by competitors. Although the market position of this sub-BU was stronger than for cases 3 and 4, the sub-BU did not assign priority to promising but costly eco-efficiency leaps. These would be too expensive or too different from the current mature product. Moreover, the influence of the sub-BU in the product chain is limited. In its cost-price oriented market the sub-BU would not be able to compete with higher prices. And developing a substitute for the present product was not considered feasible within their scope.

The Chemicals case 5 largely resembles the business characteristics of case 6, but the business opportunities through eco-efficiency improvements are much more positive. How can this be explained? Performance chemicals are closely related to product performance and therefore eco-efficiency belongs in this case to the sub-BU's core business. Although immediate environmental pressure is modest, the sub-BU is aware of the strategic risk of being ousted from the market by a competitor with a more effective and environmentally friendly alternative. Compared to the other cases, the entry barrier for newcomers is relatively low. Therefore this sub-BU must be keen to remain a front runner. Compared to case 6, its flexibility to develop an alternative

product is greater. The potential changes in the current production processes to develop a new product seem to be less drastic (and therefore less costly) than in, for instance, case 6. Moreover, if the sub-BU would find a better alternative or would further develop its biodegradability method, it can certainly expand its market share substantially. Case 6 is far less certain of this positive market perspective.

In the Pharma case 2 only few promising business opportunities through eco-efficiency improvements in the product chain were considered feasible. This is notably due to the BU's limited flexibility to change its products. The customers and drug regulation largely determine their product specifications. Although the environmental impact of the products purchased from their suppliers is higher than that of their own production processes, the BU can hardly influence the eco-efficiency of these input streams. Since the BU has improved its own production processes substantially during the last decade, many eco-efficiency leaps cannot be expected here either. The few promising improvements identified are seriously being investigated now. The modest environmental pressure from customers and the potential of using the environment as a competitive edge stimulate this attitude.

Case 1 is the most obvious case in which business opportunities and eco-efficiency improvements can go hand in hand. This is due to several factors, which all point in the same direction. There exists a modest to high environmental pressure, to which the BU can respond through eco-efficiency improvements of its production processes and products. As a producer of the final products, its influence on the introduction of such changes in the product chain is much greater than in the other cases where intermediate products and raw materials are produced. Its market and technological positions are strong, while also its flexibility to develop new products is relatively great. Within the framework of its current production processes various new products can be made. As the entry barriers are high, competition among the big players is fierce. Although environmental issues do not play a major role in this competition, eco-efficiency improvements can become crucial if they benefit both the customer and the company itself. Therefore, the BU is keen to develop new, more eco-efficient processes and products.

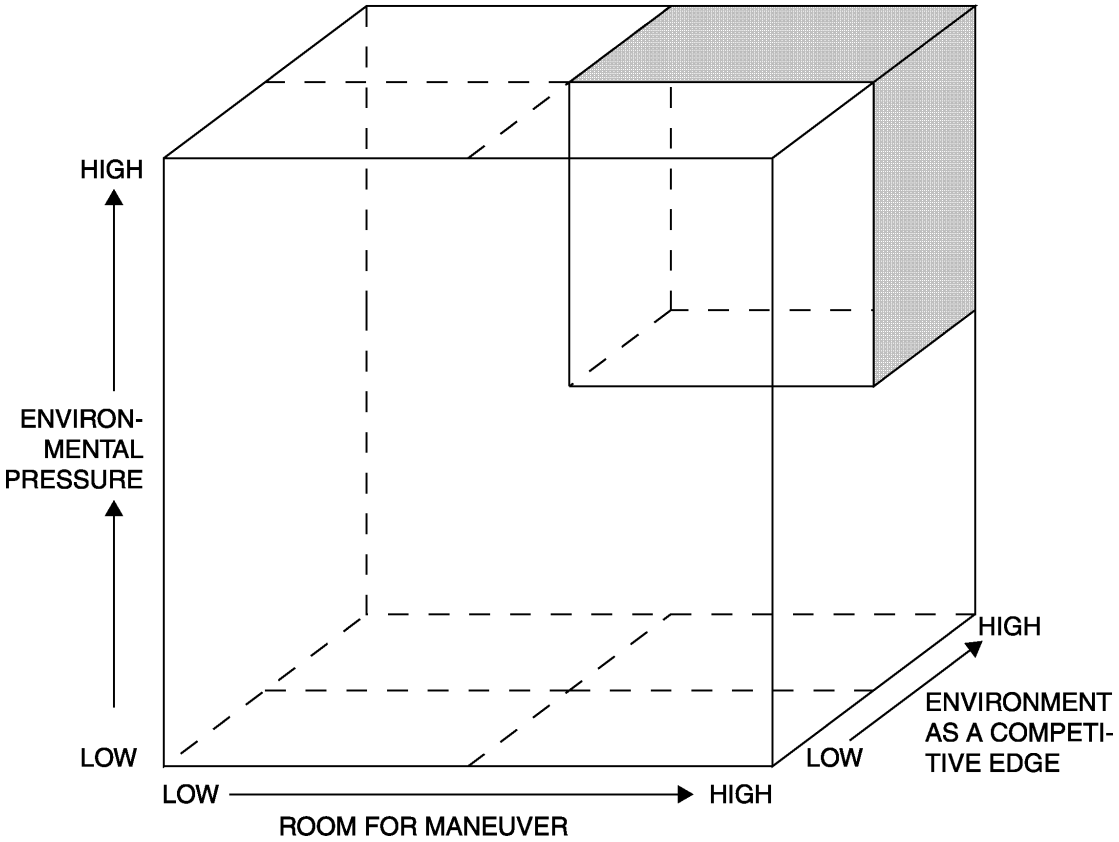
From the six cases studied some key conditions can be derived for successfully meeting strategic environmental challenges over the whole lifecycle. When limited environmental pressure or demand is expressed by customers or external stakeholders, the urge of companies to implement eco-efficiency improvements is absent, especially if such measures cost money. When there exists modest/high environmental pressure or demand from outside the company, it depends on various factors how the company will respond. Two important factors are the influence of the company in the product chain and the flexibility to change its process or product. I call these factors the room for maneuver. When the company's room for maneuver to improve the eco-efficiency of its products is limited, major eco-efficiency leaps are less obvious. This holds in particular when these improvements are costly, their benefits uncertain and the company's market position weak. Invested capital should lead to profits.

The most obvious case for successful implementation of strategic environmental challenges is when the environmental pressure or demand is modest to high and the room for maneuver in altering the process and/or product is great. If in such cases the environment can also be used as a competitive edge, the level of ambition of the company is particularly high. This conclusion can also be drawn from the reasons given by the managers of the various (sub-)BU's why they are interested in paying attention to eco-efficiency improvements in the product chain. Particularly those cases that come close to the most obvious case for successful implementation (cases 1 and 5) stress the importance of using the environmental issue in strengthening their relationships with current customers, acquiring new customers and increasing actual market share.
Other parameters that were taken into account in the analysis did not seem to be crucial in successfully implementing strategic environmental challenges. This holds in particular for the following parameters: market share, market state and entry barriers. A strong market and technological position can facilitate the implementation of eco-efficiency improvements. Whether these conclusions based on this Akzo Nobel case, can be generalized, should be tested through a broader survey including a variety of companies.

From the above analysis we can derive that the following three criteria are mainly determining the degree of success (high, medium, low) of implementing more far-reaching eco-efficiency improvements in the product chain:

- degree of environmental pressure
- degree of room for maneuver in altering the process and/or product in view of the whole lifecycle
- degree to which the environment can be used as a competitive edge

These three variables can be correlated in the following three-dimensional figure (cube).



The (sub-)BU's in the right upper part of the cube are the most obvious cases for successful implementation of strategic environmental challenges.

For companies such as Akzo Nobel the above conclusions have implications for the way in which the STRETCH approach is advocated in the organization. It is important to acknowledge that some (sub-)BU's can directly profit from this approach. These are the cases that approach the criteria of successful implementation mentioned above.
For other (sub-)BU's the STRETCH approach can lead to promising eco-efficiency improvements but require substantial initial investments to grasp these opportunities. Without management support at the higher level within the organization these potential improvements will usually not be implemented.
For a last group of (sub-)BU's the more far-reaching eco-efficiency improvements identified through the STRETCH approach will not be considered feasible within their business scope. In these cases the STRETCH approach fulfills another function. First, the approach can structure environmental management in a more systematic way, which can lead to incremental improvements of existing products and processes in view of the whole lifecycle. Second, the approach can identify which more far-reaching eco-efficiency improvements may be necessary in the long run. The recommendation to the higher management can then be to promote the development of these radically new products through special seed money programs. In this way it can be tested whether the company should prepare itself for this new line of business.

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