ECOLOGICAL MODERNISATION AND INSTITUTIONAL TRANSFORMATIONS IN THE DANISH TEXTILE INDUSTRY[1]

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ABSTRACT

An effort towards an ecological modernisation has characterised Danish environmental policy in the 90s. The targeting of corporate behaviour can be divided into four regulatory basic set-ups in an add-on process. Looking at the meso-level, the study of the Danish textile industry indicates that the interplay between regulatory and knowledge institutions, and corporate orientation has formed a selective milieu and demarked technology systems related to each of the set-ups. This milieu concerns the building of competence within the industry and, externally, among its stakeholders; forming a technology development path; constructing an environmental priority and shaping actor-profiles. The milieu produced as a result has favoured a technical, process-oriented and local focus in the search of environmental solutions within the industry. In addition to the learning process of the former, a multi stakeholder and LCA-oriented market-establishing endeavour has been initiated. Both strategies have beneficial, but also problematic impacts, as the forming of corporate actors and stakeholders may not converge with a plea for radical environmental improvements.

Keywords*:* Ecological modernisation, environmental regulation, institutional transformation, textile industry, environmental innovation

1.INTRODUCTION

The object of this paper is to examine the transformation of the environmental regulation and corresponding corporate reflection in the Danish textile finishing industry. The perspective of the analysis is that of an ecological modernisation process in the Danish industry and in the Danish environmental policy scheme. The aim is to analyse the content of this transformation focusing on how new institutional structures and environmental perceptions have developed within the textile industry, how they have been interpreted, and influenced the environmental activities at the manufacturing level. The analytic endeavour does have a normative motive - the process is observed and analysed with the aim of assessing and developing a better understanding of which policy options that are open to us in relation to the development of more environmentally friendly production schemes

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1. *This paper is a revised version of a paper "Construction of a selective milieu of environmental development in the Danish Textile Industry" presented at The 3rd International Conference of the European Society for Ecological Economics Vienna, May 3 to May 6, 2000.*

The interface between policy programs and the enterprises in the industry is at the centre of the analysis. Firstly, the paper raises the question, of how policy programs are communicated to the enterprises and how these programs may succeed in installing ecological modernisation and innovative responses in the industry. Secondly, the paper raises the question of how these stimuli (changed institutional framework and communicated perceptions of environment) have been reflected and interpreted by the enterprises within their strategic schemes. The basic tenet of the paper is that the study of the processes of interaction, in terms of institutional and enterprise practices, is vital for developing the means for the profound environmental transformation of industrial production. To achieve this, the paper seeks to integrate two lines of analysis; one of the institutional development which concerns the environmental transformation of the textile industry, the other of the processes at the enterprises which reflect the changes in their milieu. At *a macro level* the concept of ecological modernisation has dominated environmental and industrial policy in Denmark in the 90s (Holm et al., 2000). The main features of this process have been a sequence of programs and policy initiatives taken by the Danish National Environmental Protection Agency (DEPA). At *a meso level,* the paper examines how the policy programs have supported specific institutional and discursive formations, and (in a dynamic perspective) how systemic competencies and environmental perception have been produced within the institutional regulatory complex of Danish textile industry. The aim is to specify the resultant selective milieu that favours specific paths of technological development and environmental actions. At *a micro level* the impacts of this milieu are studied from a bottom-up perspective: Exploring how firms operating in networks reflect upon, interpret and perform in response to the environmental policy programmes. The paper examines which practices have developed in two out of five studied in depth cases.[2]

The paper falls into four main sections: 1) The theoretical and methodological framework of the analysis of institutional transformations. 2) A presentation of the ecological modernisation of the Danish Textile industry – a reflective process 3) An analysis of enterprise practices within the new institutional setting. 4) Concluding remarks on the interaction of programs and enterprise responses.

2. THEORETICAL PERSPECTIVE – INSTITUTIONAL REFLEXIVITY AND STRATEGIC ACTION.

A core element in our study is the question of *how* the enterprise, as a focal agent embedded in network, interprets and acts in relation to environmental problems within given institutional frameworks. Thus, the interplay between enterprises and institutional frameworks is understood as being contingent, leaving scope for enterprises to manoeuvre. The institutional setting is open for various interpretations and responds. In this analysis we will relate to three main bodies of theory:

- X ecological modernisation: reflexive modernisation and institutional reflexivity
- X institutional transformation and technological paths

[2] The study results from a joint project *Towards an Integration of Environmental and Ecology-oriented Technology Policy. Stimulus and Response in Environment Related Innovation Networks* (ENVINNO) funded by the Target Socio-economic Research Programme, EU. The project includes partners from Austria, Denmark, Spain, Germany, the Netherlands and UK.

X environmental communication and strategic interpretation of enterprises

2.1 Reflexive modernisation and institutional reflexivity

The objective of the paper is to examine and push the limits of a transformation process based on institutional modernisation. In this endeavour we relate to the idea of ecological modernisation – and in particular to the concept of institutional reflexivity (Mol 1995, Murphy 2000). The basic claim of ecological modernisation is that modern society possesses a capability to carry through such an institutional reflexivity and build a capability in society to handle its ecological crisis. The problems of modernisation can be solved via development of the modern institutions. In some areas of the discussion of ecological modernisation the institutions of the market and science have been ascribed a reflective capability enabling them to meet the challenges of the ecological crisis. Such a 'teleological interpretation' has been contested in the broader discussions on reflexive modernisation (Giddens, Beck, Lash, 1994).

Ecological modernisation can be envisaged as a dual process. On the one hand it is a certain way of conceiving the environmental problems and their regulatory and market opportunities, on the other hand it is a specific change in structural and institutional conditions of the production (Mol, 1995). It can be viewed as institutional reflexivity[i] (Mol, 1995, Murphy, 2000, Buttel, 2000) - a process in which the modern society and its institutions attach specific meaning to the environmental problems and build up capability to reflect on the social conditions, on their existence, and to change them accordingly[ii] (Beck, 1994:174). This places the focus on how the environment is perceived how it is communicated, on which agents are involved and how different agents reflect, act and communicate environmentally. It is a central feature of this understanding that in this reflexive process both the institutions and ways of reflection are changed. There is a change in the role and relations of firms, industries, government and agents (such as NGO's). Ecological modernisation entails that they become freer of structure; in fact they have to redefine structure (Beck, 1994:176, Mol, 2000). How enterprises in specific industrial settings reflect and interpret their role - and as part of this, whom they define as central stakeholders - becomes a central issue.

Mol (2000:46-47) identifies five main areas of institutional transformation, which he interprets as structural transformations that have enhanced the capability to cope with the ecological crisis: 1) Changed role of science and technology – integrated in proactive schemes. 2) Increased importance of economic and market dynamics and economic agents. 3) Changes in state-industry relations – changed role of regulation. 4) Changed discursive practices with reference to sustainability. 5) Modification of position, role and ideology of social movements. We relate to Mol's research program concerning institutional reflexivity, but we will pay special attention to the 'cultural dimension' to emphasise the importance of those discursive processes in which specific ways of perceiving and communicating 'the environment' are given preference based on discourse coalitions and fights (Hajer, 1995).

Our research question is: which institutional reflexivity is developed and installed in the Danish textile industry over time? In this 'open question' we agree with Buttel's (2000) understanding of the research program of the ecological modernisation. He notes a first generation of ecological modernisation research body, which were based on the claim that "*capitalist liberal democracy has the institutional capacity to reform its impact on the natural environment, and that one can predict that the further development ("modernisation") of capitalist liberal democracy would tend to result in improvement in*

ecological outcome". This closed approach is now, he observes, transformed into a new generation of research working on "*identifying the specific socio-political processes through which the further modernisation of capitalist liberal democracies leads to (or block) beneficial ecological outcomes*".

2.2 Institutional transformation and technological paths

On the most general level, institutions are *the rules, i.e. predefined patterns of conduct, that the members of a social group have generally accepted* (Berger and Luckmann). The rules can be informal rules, such as norms, habits and customs; or formal rules such as written laws, regulations and standards (Hukkinen, 1999:17).

Mol (1995 (63ff)) focuses on the economic, policy and social network of the producers in his attempt to pinpoint the institutional changes. He addresses the meso level. The analytic model *should be aimed at analysing meso-leel transformations (economic sectors, instead of primarily focusing on either the micro level (individual firms) or the macro level (national economy)*. The network approach is understood as a reflexive institutional analysis. *The network models have the advantage of combining both the structural properties of institutions and the interactions between actors constructing of network* (Mol 1995: 62-63).

A central question is how to install innovative environmental responses in enterprises and industries. In an evolutionary and institutional perspective innovative changes are shaped by institutions and institutional changes, producing a tension between technology and institutions; institutions produces the necessary stability for technological change but at the same time produce a rigidity leaving established tracks of technology easier to follow (Johnson, 1992). In this perspective ecological modernisation becomes a question of an institutional transformation (learning process).

2.3 Environmental communication, network resources and strategic interpretation

From the point of view of the enterprise, the path of technological development and the level of integration of environmental concern that is chosen, can be seen as dependent on strategic interpretation, internal resources and competencies and the network, in which the enterprise is embedded (Hansen, Sondergard and Meredith 1998). The enterprise network consists of the relations between the enterprise and its external customers, suppliers, knowledge institutions, authorities and institutions in the civil society. In an analytic perspective we may differentiate (Hansen, Kerndrup and Sondergard, 1998) between the business network (primarily related to the value system), the regulatory network and the knowledge network as three different communicative systems in which the enterprises are embedded. The problem arises, e.g. when demands communicated (grounded on environmental considerations) clashes with the values, strategies and perceptions of the enterprises.

In this process of strategic interpretation, environmental programs may well provide systemic resources (e.g. technology push schemes), but how the enterprises attach to the programs will rely on strategic interpretations.

2.4 Methodology

The paper is based on a documentary study (complemented with interviews) concerning the development of the Danish Textile industry with specific emphasis on the environmental regulation and transformations, and on in depth studies of the practises of two enterprises analysed in their network and institutional setting. In these case studies emphasis has been given to the interaction with the institutional framework and with their networks. We have been looking for changes in how environment was communicated and perceived.

Changes in the enterprise's technological innovations and environmental practises were the immediate focus of the case studies[iii]. In this paper these studies are used to achieve a bottom-up understanding of how the institutional milieu has contributed to transform parts of the Danish industry. The bottom-up studies allows us a) to get a more detailed understanding of, how environmental demands are communicated, interpreted and turned into practices, b) to make visible elements of processes of learning and reflections within the industry. The meso level study of the institutional set-up is made from interviews with key actors in the industry, in the knowledge and regulatory network besides a number of internal evaluation studies of the cleaner technology programmes within DEPA. The development within the Danish textile industry is – in this way – seen as a historical reflexive process, where changes in visions and perceptions of regulation and of enterprises and actors within the industry are interwoven. Two parallel questions are raised:

- Which environmental paths are institutionalised?
- Which institutional learning has been accomplished?

In the final part of the paper a new initiative – the product panel - within the textile industry is discussed within an institutional learning perspective

3. ECOLOGICAL MODERNISATION OF THE DANISH TEXTILE INDUSTRY

The textile processing industry (textile printers, textile dyers, …) has, in Denmark, been regulated by local licensing and control. In recent years the industry has been subject to new environmental regulatory schemes. The textile processing industry has been a target group for cleaner technology programs of DEPA (1990 -). Within these programs various strategies and instruments have been elaborated, as well as a number of R&D projects in new processes and products have been initiated.

During this process a number of corporate, R&D, and other actors have been formed, that interpret, perform and diffuse ecological modernisation discourses. A number of new technologies and products have been developed serving the means for corporate transition towards cleaner production. In addition, new c*ompetencies* have developed among business and their networks, shaping their capability to perform technological innovations in line with ecological modernisation. Of major importance is the fact that during these institutional learning processes new environmental rationalities are being formed. Public subvention, R&D and market framing schemes within the cleaner technology policy, seek to install an ecological modernisation comprehension of "environmental investments pay". The actors within the textile trade have by-and-by accepted this discourse, but interpreted it from the option to merge with existing business options of the industry. This *strategic interpretation* means that enterprises actively select among various available options, in accordance with their perception of business opportunities - not necessarily picking the most environmentally beneficial options. The

risk is immanent that a technological path is being formed, hampering more radical solutions.

In what follows we present the institutionalisation of ecological modernisation in the Danish textile industry along four identified paths of regulatory and institutional set-ups. Within these paths we seek to explore (1) the forming of new actors and new actor constellations, (2) the construction of new technological development tracks, (3) the generation of competencies within the knowledge network, and (4) among the enterprises, (5) the shaping of new environmental discourses. Based on this study we conclude with a critical evaluation of the environmental promises from the Danish ecological modernisation.

3.1 The Danish Textile industry

Due to global market restructuring, the Danish textile industry underwent major structural changes in the 90s; the business is now concentrated on high value-added activities, such as design, textile finishing and franchising. Environmental upgrading of the industry has been part of this repositioning process, and within this development a minor section of the industry has adopted green strategies based on ecological design. The main elements of the restructuring process have been the development of specialised product niches (e.g. technical textiles), the ability to compete on quality, flexibility (and price) and focus on design and processing of textiles (while the labour intensive sewing work has been out-sourced to Eastern Europe). Still most of the Danish textile production is processed by Danish textile finishing enterprises (Remmen, 1999)[iv]. Approximately 40 enterprises are still performing printing or dyeing processes (Sandbak, 2000).

Within the framework set out by the Ministry of Business, the industry elaborated 'a strategy and framework program of the development of the industry' (1994)[v]. The program pinpointed the development of marketing competencies, organisation and management, networks and high flexibility as being the main issues. And in particular, it pointed to the need for a greater effort in product development and innovation. It recommended a greater focus on design and on the development of specialised products and niche products that meet a growing environmental and quality awareness of the consumer. Developing environmental qualities thus was identified as one way to evade fierce price competition - and was communicated as a potential strategic parameter in the transformation process of the industry. More important was, however, that this was adopted by Dansk Tekstil og Bekladningsforbund, (DTB), the branch organisation of the textile industry. The organisation adopted a strategy designating eco-modernisation as one strategic option of the textile industry. In addition, they actively engaged in the development and implementation of the environmental programs addressing the textile industry.

3.2 Environmental policy development and industry

During the period 1974-1995, the dominant measures in Denmark's environmental protection to regulate industry, were those of issuing legally binding licenses, approvals/permits and subsequently controlling by local inspectors. The implementation of legislation has taken place in two tempi: in close co-operation with industrial and agriculture associations, the Ministry of the Environment has had the role of producing general guidelines, thresholds for the control, servicing and the issuing of permits among the local authorities. Secondly, the local authorities have been obliged to make targets for

local ambient quality and neighbour nuisances. Optional guidelines and thresholds of the ambient quality approach were in principal based on mapping and deciding specific environmental aims for the ambient quality of a specific recipient (city, stream, lake), and therefore differing from recipient to recipient. From this background the local authorities were supposed to issue pollution permits, to give wastewater licences, control industry and agriculture, ensure nature preservation, draw wastewater plans and build solid waste sites and wastewater utilities. The *technological spin-offs* from the ambient quality strategy have been diverse dilution techniques, whereas no requirements were made of the internal processes or products within the industry. For industry, the institutional set-up has typically resulted in rejection strategies or simple paying-the-bill attitudes. But in the long run they have been misled to expand until they hit the ceiling of the Ambient Environmental Quality (AEQ) quota.

The optional regulation of industry only with reference to ambient environmental quality standards resulted in an accumulation of the ecological pressures. This led to supplementary regulation since late 1970´s where regulation focused on the *pollutant infrastructure* and *end-of-line solutions* (filters, wastewater treatment units, incineration, and separation of hazardous waste). The end-of-line solutions were reflected in new *emission standards* focussing on effluents from chimneys and pipelines. Due to a comprehensive *Plan for Aquatic Environment* in 1987 approximately 1 billion EURO were invested by municipalities in biological and mechanical wastewater treatment plants over a 10 years period. This was in order to fulfil the general mandatory guidelines for organic effluents (on N, P and B15) that followed the action plan. The Plan for Aquatic Environment was related to problems from regional and national eutrophication in the mid-80´s, stemming from diffusion of organic substances from industrial point sources, agriculture and public sewage treatment plants. Also all larger industries with direct outlets to fjords and bays were faced with new emission standards. Whereas the smaller industries were obliged to link up to, and sign contracts with, public wastewater treatment plants and pay tax related to the contract amount and type of discharges. The capacity of the wastewater treatment plants thus became an intermediate variable for the corporate individual standards on organic substances. Also other pollutant handling infrastructures were faced with standards on emissions and depositing, which were passed on to their subcontractors. Thus the increased amount of waste handled by incineration plants led to mandatory emission standards. Instead of solely recipient assessments, the emission standards placed a focus on amounts, toxicity, diffusion and exposure.

Through these emission standards and the establishment of pollutant handling infrastructure, industry learnt that there were *external solutions* to their waste problems, and if these were used or installed, no liability could be imposed on the polluter. Environmental protection was still an add-on cost, also for the public as tax-paid municipal treatment plants and subsidised industry. By that time the waste-handling infrastructure produced *problem shifting* as new media suffered from the pollution from incineration, wastewater sludge and recycled composite. From mid 80´s measures to re-internalise environmental concern by economic incentives were favoured and the discursive constellation of regulatory ideas beyond legal rules began. Thus it is in this period the discourse on *ecological modernisation*, *cleaner technology and pollution prevention* was favoured as a means to reconcile economy and environment through "win-win-situations".

The *first genuine technology innovation effort* was initiated by DEPA's 1986 R&D program for subsidising research and development that aimed at producing new cleaner/Best Available Technologies. The cleaner technology programs (CT-programmes) served to foster innovations among firms and the Danish technological R&D institutions,

and to demonstrate for authorities and industries the available options in pollution prevention. The programme has been administered within a corporate management regime, where industries and R&D institutions could forward their own preferences. A vast number of reports have been made from various trades and relating to various kinds of environmental and technological foci. In the first generation of CT programs, the focus was on a policy for R&D in a *push for new technological inventions* to reduce hazardous emissions and waste from industrial processes. In the first and also in the second CT program (1988-92) the focus on development of cleaner technologies was among *single* firms. Very often, in the 1986-92 period, the subsequent diffusion of the developed, available, technologies was not taking place. The second generation of CT programs in the 90´s focussed on generating an in-house *corporate pull for cleaner technologies*, accordingly initiating environmental management, green accounting and competence building among management staff. Lately, the third generation of CT programs has shifted towards generating *a market pull for cleaner products within a LCA perspective*. The areas receiving support include innovative research in technology and product design, networking and benchmarking activities for product standards, and competence building. Three focus areas have been given priority: electronics, goods transport and textiles, the latter will be in focus in what follows.

Along the CT programs a learning process were resulting in a *differentiation among companies as to front runners, compliance oriented and reluctant*. A command-and-control line was favoured for the latter, whereas service and routine control were prescribed for the compliance oriented. But it was among the front runners, or 'want-to-be's, that central, local and regional authorities have met new challenges to opt for a corporate management regime. These firms have served as sparring partners for R&D, for developing new cleaner technologies, for designing new cleaner technology subvention schemes, lobbying on product standards in CERN/ISO, and for enforcing environmental regulation on competitors.

Generally, a major focus on the role of green consumerism as a motor for changing markets has been given high priority. These *market-pull*-oriented initiatives which also cover the product program, reflect an effort to initiate market dynamics where green consumerism and green purchasing by public institutions and corporate front runners are supposed to be an efficient alternative to command-and-control. The product orientation of Danish environmental policy, thereby stresses the enhancement of environmental communication and profiling between industries, retailers and consumers.

3.3 Environmental programmes and the textile industry

The textile industry, and in particular the textile finishing industry, has been a priority concern of cleaner technology programmes and local environmental regulation schemes in Denmark. Environmental problems related to outlet of dye-stuff and ancillary materials and to high consumption of water and energy have been addressed within pro-active schemes of cleaner technology, environmental management and product orientated programmes. The latest initiatives have addressed the market and have gathered stakeholders of the textile product chain to enable a co-ordinated introduction of ecological products based on LCA and environmental labelling. Within the textile industry four main steps (regulatory schemes) can bee identified, representing a gradual expansion of the scope of the environmental policy programs: 1.*Permits*. 2. *Cleaner technology.* 3. *Environmental management systems*. 4. *Product oriented approach*. The development can be perceived as cumulative – the system of permits still form the backbone of the

environmental regulation, but in the attempt to induce innovative dynamics new approaches have been developed. They comprise the movement from command and control to a reflexive approach. In addition, during the process they have interacted and developed, as will be shown below.

Environmental permits

With the act on Environmental Protection of 1974, environmental permits were made mandatory for the textile wet processing industry. The permits or approvals cover handling of toxic substances, nuisance and air emissions. Initially it covered all new plants and processes established after 1974, but in 1990 environmental permits were made mandatory for all textile wet processing industry, including the plants established before 1974.

With the view to dealing with the complex environmental problems related to the chemicals used in the industry, the regional environmental authorities of Ringkjoebing developed a 'score system' to assess environmental performance of the used chemicals. The main concern of the authorities was the environmental impact of the discharge of wastewater from the industry and the 'score system' was developed with the purpose of assessing the environmental effects on the recipients. In collaboration with VandKvalitetsInstituttet (VKI) (Research Institute specialised in water quality) they forwarded a proposal of a score system to the industry, anticipating that the system should be used to assess existing and future chemicals used by the industry. The industry went into the project realising the advantages of a common foundation of the process to assess and communicate environmental qualities of the chemicals of the textile industry. As a result, the system was implemented in a modified set-up. The branch organisation, Dansk Tekstil & Bekladning (DTB), adopted the system and took the responsibility to develop a common database that enabled them to elaborate score reports to their member enterprises. The enterprises were obliged to forward a score report to the environmental authorities in the counties or the municipalities every half year. The score reports enabled the enterprise and the authorities to identify the most problematic chemicals within a common framework. The report was the starting point of negotiations between the enterprise and the authorities to prioritise the effort in substituting or reducing the use of chemicals. The main value of the 'score systems' may be that it contributed to the development of a shared environmental perception throughout the industry and that it allowed a constructive communication between industry and authorities.

The waste water system in Danish textile industry is based on public sewage treatment works run by the municipalities; only a minor section of the industry runs private waste water treatment plants. Wastewater is regulated separately in special licenses. The municipalities are responsible for issuing licenses and controlling the manufacturers that emit to public sewage treatment works, whereas the counties are responsible for controlling the operation of the public works run by the municipalities and of production sites that emit direct to the recipients. The above described Aquatic Water Plan of 1987, issued all municipalities to install or expand biological waste water treatment, to cleanse up organic spills from direct emittants to recipients. With the Aquatic Water Plan new thresholds were demanded for the performance of public treatment works, surpassing new performance demands to industrial emittants. Here organic substances (Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD)) seriously came into focus in wastewater regulation of also textile wet processing industries in Denmark.

The sludge produced in the sewage treatment works were initially diffused on crop fields as fertilisers. The sludge was monitored to keep track of harmful substances; in particular, heavy metals were subject to regulation. In the first half of the 90's, this concept

was criticised by the farmers' organisations. As a result a new statuary order enforced the municipalities to keep the content of heavy metals and four 'indicator compound's within new lower limits. But many municipalities chose to abandon the reuse of the sludge as fertiliser; instead the sludge is deposited or incinerated. The (ironic) outcome, in relation to the textile industry (and other industries), is that the new handling schemes for the sludge, in this way, reduced the system's built in stimuli to eliminate harmful substances from their wastewater discharge.

Eliminating the environmental impact at the source and the use of cleaner technology has been an integrated part of the Danish environmental regulation since the new Environmental Protection Act of 1991. It includes the demand that cleaner technology schemes have to be integrated in the enterprises' environmental permits to ensure that best available technologies are implemented. As part of this regulatory scheme, it is anticipated that DEPA should issue industry-targeted recommendations (Brancheorienteringer) to be used as reference for Best Available Technology (BAT) demands. The agency, however, in most industries has failed to elaborate such recommendations (with the IPPC Directive (Integrated Prevention and Pollution Control), BAT-notes elaborated at the EU level are going to replace them). This has been the case in the textile industry too. The cleaner technology program did contribute with documentation of best practices, but although a branch profile (describing best practises) has been drafted, a recommendation (Brancheorientering) has never been issued. This has made the process of defining cleaner technology schemes as part of the permits within the textile industry a task of the counties and municipalities.

The cleaner technology programs targeted at textile industry

The textile industry was included in the second CT program (Handlingsprogram for renere teknologi) starting in 1990. Prior to this program 'DTI Bekladning og Tekstil' (DTI-BT), the specialised textile knowledge centre within the national technological service system, had conducted explorative studies (funded by an industrial program within the Agency for Development of Trade and Industry (ADTI)), surveying the environmental impact of the industry and examining possible solutions. The study identified wet processing in the textile industry (dyeing, printing and finishing processes) as the environmentally most crucial processes. These studies, to some extent, defined the agenda of the subsequent programs, pointing to the development of technical solutions on the environmental problems related to wet processing in textile industry as the strategic focus (Remmen, 1999).

The cleaner technology activities within the textile industry were gathered within a third CT textile program, 1993-97[vi]. This program was the result of negotiations with stakeholders within the textile industry and related institutions. The branch organisation, DTB, has acted as a very active player, both in this program and in the regulatory work addressing the industry. The program has been based on a consensus and the branch organisation and other stakeholders have been given substantial influence over the implementation of the program. One result of this co-operation was the setting down of the objectives of the program. The goals focussed on wet processing and summarised in four points[vii]:1) Reduction of wastewater discharges with 30% before year 2000. 2) Reducing the number of chemicals in the industry injurious (or suspected to be) to health or environmentally damaging. 3) Improving environmentally problematic processes and equipment. 4) Finally, reduction in energy consumption. The framework program and the consensus obtained in the industry enabled a focussed and consistent implementation of the

program. As a result, a dominated path of environmental technology was defined in the industry.

In the period from 1990 – 1997, the CT programs within the textile industry have funded 25 projects with a total of 25 million DKr (3.5 million ECU). From the outset, the focus was on textile wet processing and the development of processes and technology. The first initiative within the textile industry was a comprehensive study of technological options concerning 'Integrated process layout obtaining maximum re-circulation of process water - in particular in enterprises with textile dying in batches' (DANTEX)[viii]. In the subsequent years (1991-94) a number of specialised cleaner technology projects were initiated, most of them focussing on waste water, examining technologies which enabled reuse of process water, chemicals and energy[ix]. One of these projects, the MEMTEX-project, tested membrane filtering of process water from textile wet processing, including textile printing in pilot plants.[x]

The content of the projects was highly influenced by a group of knowledge centres. As described, DTI's textile branch DTI-BT had elaborated the first study, in which wet processing and process and technology development towards wastewater problems were appointed as the main track of development. This strategy was adopted by the industry as a whole and by the DEPA. Consequently, two other knowledge centres were involved. The Institute of product development (IPU), a research and consultancy centre rooted in the Technical University of Denmark, was involved due to its technical competence on industrial processes and integrated water treatment techniques (They had been a main actor in a cleaner technology program within the electroplating industry). And the Water Quality Institute (VKI), a research and consultancy centre rooted in the national technical service system, was involved to take advantage of its specialised knowledge on toxicity and water treatment processes. These three institutes, DTI, IPU and VKI were to form the backbone in the cleaner technology program targeted at the textile industry.

During the CT programs these three actors developed a dominant knowledge network, which took the initiative to develop the projects, took part in the decision process of the program and were executing the projects. Consequently, they obtained a position that enabled them to ensure a consistent process of development, this was directed by the environmental perception that were laid down in the framework program. In addition, this construction ensured a systemic competence at these three institutes that could be used by the industry. However, the strengths of the construction were at the same time its greatest weaknesses. It represented a closure, in terms of actors and options that had access to the program and it introduced a problem to transfer ownership of the developed technology to the enterprises (Remmen, 1999).

The program has consolidated a technology and production oriented approach. The central part of the program has concentrated on development of technical solutions in terms of better processes and technical plants for treatment and re-circulation of wastewater. Some projects have supported substitution and LCA schemes, but even these programs have been very 'technique-oriented'. One example is the attempt to develop a LCA database, designed to be used as a tool in design and process development. On a technology level, the cleaner technology program has demonstrated and documented a number of potential technologies, but in most cases the diffusion of the new concepts has been limited (see table 1). The table indicates that available technological options are not sufficient to get cleaner technology diffused in the industry.

Table 1. Diffusion of technological options (Sources: Wenzel 1999, DEPA 1997, Sandbak 2000)

CT-options developed and documented within the cleaner technology program.	Status of the developed technology	Diffusion in industry
Replacement of detergents and complex binders in after treatment of dyed cotton batch: Replaced by hot water.	Fully implemented at one textile dyer	Partly implemented at some plants, but most plants hesitate sticking to proved procedures.
Membrane filtering of process-water in reactive dyeing: reuse of water, chemicals and energy	Full scale pilot plant has been demonstrated	No textile dyers has implemented the technology

Environmental management

Leaving the technology push paradigm DEPA and ADTI made a joint effort to support the adoption of Environmental Management Systems (EMS) (1995-97, funding totals 18 million ECU). The purpose was to obtain the diffusion of green practise by means of competence building and initiation of environmental management schemes. Furthermore, the new scheme sought to enhance the capacity of local corporate staff to monitor and document local environmental performance, and improve the management's knowledge of material flow and of environmental profile of local production.

Two thirds of the program was targeted to selected industries. Within the textile industry the branch organisation DTB was given responsibility of implementing the program[xi]. A private consultancy was hired to develop a branch specific manual of environmental management. The work of development was rooted in a group of textile enterprises. The project led to the introduction of EMS in most of the participating enterprises.

The enterprises were led into a reflexive position. They were encouraged to develop a basic knowledge on their environmental performance enabling them to engage in the subsequent programs of environmental documentation and communication (see below).

The product oriented program

Following the evaluation of the CT programs, a more strategic and market oriented approach has been introduced by the DEPA: "A reinforced product oriented environmental effort" (Miljostyrelsen 1996). The stated goal of the program is environmental improvements in product life cycles. An integration of this goal in the market is seen as a prerequisite and in general terms the strategic approach of the program is to bring forward institutional preconditions of such an integration. A main element in the program is the formation of three product panels designated to examine product-oriented strategies looking at design, marketing and environmental communication as main strategic elements (Miljostyrelsen, 1999).

One of these panels was formed in the textile industry. In its working program (Miljostyrelsen 1999c), the textile product panel has focussed on establishing (systemic) competencies within the industry on ecological design. The main activities planned (May 1999) within the textile product panel are: a) development of ecological collections (eco-labelled with the EU-flower) in the industry, b) development of operational tools enabling actors in the textile chain to integrate and document ecological qualities in the design and industrial purchasing functions, c) development of a knowledge centre on environmental documentation (labelling) - financed by the textile branch organisation (DTB), and d)

development of an information strategy addressing actors in the textile industry and consumers. A common goal for the product panel members is to encourage Danish manufacturers of textiles and clothes to achieve the EU flower or the Nordic Swan.

The program marks a changed in approach. Technology is not considered as the main barrier to environmental improvements. Within the textile industry the technology options and resources available are seen as providing amble scope of environmental improvements (Sandbak 2000). The barriers are located in the behaviour of the players in the industry and the way the environment have been perceived and communicated in the product chain. In its main elements the product-orientated program changes the institutional framework. The program focuses on the development of new competencies both at the systemic level and at the individual enterprise:

- The development of chain- and market oriented competencies. Program projects now address such issues as barriers of implementing eco-labelling, environmental supply management and economic assessment of the production, purchase and sale of environmental friendly textiles.
- The development of instruments of environmental documentation (Life Cycles Assessments, risk assessment, … - dedicated to industries and product groups) and the establishment of a knowledge centre on the development and dissemination of knowledge on environmental documentation and communication
- The challenge of the individual firm is seen as an move from environmental management focused on local eco-efficiency to LCA-management - involving the need of achieving new competencies on interaction with actors in the product chain and stakeholders.

These changes are, to some extent, general to the product-oriented program. Looking at the textile industry, the implementation of the program has been able to profit of the achievements of the previous programs. Research in technology options is still taking place, but the project funding has shifted to the development of instruments to environmental documentation[xii] and market-related instruments. The actors that are addressed and given assess to the (discursive) processes of the environmental policy arena have changed. The product program is characterised by :

- Addressing strategic actors, such as retail chains, franchisers and industrial laundries, in the product chain
- Addressing strategic functions, such as design, purchase and product development, and focussing on an upgrading of their environmental competencies
- Addressing the chain, the development of co-ordinated action and relations between the actors in the product chain is made a priority goal. This is supported by the development of common platforms of communication, such as instruments of environmental documentation. The product panel forms a formal institutional frame of a co-ordinated action in the industry.

In the outset, the product panel (in the appointment of members) has addressed the environmental frontrunners of the industry, but the initiatives of the panel have had a more wide impact. When the product panel revealed its plan of a joint launch of eco-labelled collections (October 1999), the producers of the Danish industry showed great interest. As a result the launch of the eco-labelled collections was postponed (now spring 2001) to enable a wider group of actors in the textile industry to join the project. The outcome is not possible to predict, but the eco-labelling move of the product panel has forced the textile

producers and the actors of the textile chain to reflect on strategic potentials of joining a project of eco-labelled product design.

The way these new institutional settings are reflected upon by the actors of the industry is crucial. The program represents a deliberate attempt to combine the build up of systemic competencies in terms of resources (technologies and instruments) and environmental perceptions, and the empowerment of the actors in the textile chain to fill a role in an environmental reflexive process. Left without mandatory instruments, the faith of the program rely on the practices of the players of the industry; if and how they may take up their roles as ecologist modernisation agents.

The practices of the players in the industry become crucial - the way the players of the industry reflect on the program produces a new setting of the industry. If the retail chains engage in the program, they may enforce changes all the way along the production chain. It is in the practices the outcome of the program can be judged - including the environmental outcome. The importance of the practices of the actors is reinforced by the changed interaction between the environmental authorities and the players of the industry. As part of the modernisation process the environmental authorities have deliberately refrained from taking a privileged position; environmental action is now defined and prioritised in an interplay with the industry in a socio-political process - in an open ended process.[xiii]

In the following section we observe how these stimuli have been interpreted in the changed settings and converted into action by enterprises within the finishing process segment of the industry, by presenting the results of two case studies within the ENVINNO-project.

4. ENTERPRISE PRACTICES REFLECTING INSTITUTIONAL SETTINGS - ELEMENTS IN AN INSTITUTIONAL LEARNING PROCESS.

4.1 Textile finishing and printing

The enterprise practices have been studied in the textile finishing and printing segment of the industry. The development of environmental practices of two textile printers, Södahl Design (SD) and Danish Colour Design (DCD) (including its co-operation with Novotex, a pioneer in green textiles), have been studied (Hansen 2000a,b, ENVINNO working papers). The ambition was to examine a) how they have developed their resources and competencies, and b) how they have responded and reflected on the institutional settings developed through the program activities (different regulatory set-ups) described above.

SD and DCD have both been environmental frontrunners, but the ways they have related to the programs have differed. Their different practices expose the dynamics in the institutional practises of the programs (different regulatory set-up), in terms of their ability to induce environmental responsibility and innovative corporate behaviour in the industry – and in this way they expose elements of the institutional transformation and learning process.

Environmental profile of textile printing

In the printing and finishing of woven material the cloth passes through a number of chemical processes to enhance appearance, durability, and serviceability of the end product. These wet processes result in a large consumption of water and in waste

generation and emissions[xiv]. In addition drying ovens and mechanical finishing imply a high consumption of energy.

The main components of the wastewater stream originate from pigments, acrylates and conditioners used in the printing paste. The wastewater is generated during operation of the printing machine and cleaning of rollers and feeding. The main environmental problems of the discharged wastewater from printing is related to the chemical oxygen demand (COD) of the suspended material and toxic effects of chemicals (such as pigments containing heavy metals, azo-dyes) (EPA 1997, Commission 1999).

Business characteristics of the enterprises

Södahl Design (SD) (approximately100 employees) produces household textiles. The Sö dahl Design's production site covers all stages in turning bleached woven cotton into finished consumer goods; including printing, finishing, cutting, sewing, packaging and marketing. It produces special designed collections, which are marketed as brand goods. Two thirds of the production is exported, with Scandinavia, Germany and UK as the most important markets.

Danish Colour Design Textiles (DCD) (approximately 30 employees) is a 100% order based subcontracting textile printer. It markets printing and finishing of woven materials of cotton and synthetic fibre for final goods producers. British, German and Danish contractors dominate. In recent years DCD has experienced a decline in turn over and employment due to fierce competition on standard printing deliveries.

Novotex (approximately 80 employees) produces clothes and linen within a green concept ("Green cotton"™). The most of the processes are out-sourced. The activities at the plant in Jutland are primarily related to design, purchase, logistic, marketing, although some sewing and finishing activities still is performed. 95% of its production is exported. The management of the enterprise has deliberately sought a position as a strategic actor in the product chain – with the perspective to practice an integrated chain management based on LCA. They actively seek partnerships in the industry based on their "Green cotton" concept.

All these enterprises are situated in Mid Jutland (SD and DCD in the same municipality) in a region with numerous textile enterprises, which form a specialised industrial textile network. They can be considered as environmental frontrunners. Novotex and SD are ISO 14001 and EMAS certified (CDC is ISO 14000 certified). Novotex and DCD have achieved the EU eco-label and the Nordic Swan on part of their products.

4.2 Reactive responses and environmental communications in the environmental permit regime.

Initially, the environmental shifts of SD and DCD have been driven by demands in the environmental permits and the wastewater license. Reactive responses were the rule. DCD was during the 80´s not very innovative concerning environmental performance, but urged by a growing number of strict demands from local authorities (the renewal of the permit negotiated in 1989-90) they switched over and adopted a proactive approach. Confronted with high compliance costs DCD began to implement cleaner technology options.

Both enterprises have succeeded in achieving substantial reductions in their consumption of water (and discharge of wastewater). SD has succeeded to raise eco-efficiency by a factor four (1994 – 98). Initially, the reduction was based on the eliminating of over consumption. Later most of the reduction was achieved by introducing re-circulation schemes (rinse water from the last flushes of the rollers (and feeding

systems) were reused in the first part of the rinsing process) developed within the cleaner technology program in "the resources-project" (Miljostyrelsen, 1994). DCD was an active participant in this project and the enterprise was very fast to implement the water saving options – savings, which turned out to be very profitable.

Cleaner technology schemes were communicated and entered into by the enterprises in a win-win-perspective on costs. The local regulation was recipient orientated. The management of water consumption and wastewater and to some extent substitution of hazardous chemicals has been the main concern of the public environmental regulation. Within these codes "a water saving trajectory" developed. The drawback of this 'water saving trajectory' was that the amount of chemicals discharged not was reduced accordingly (see below – CT-program). Cleaner technology action programs could have been included in the environmental permits. In the renewal of SD's permit (1996) the municipality noticed SD's work on cleaner technology (the Memtex project), but refrained from making it part of the conditions of the permit. The 'permit institution' push on cleaner technology was indirectly, as it was communicated in threshold values on emissions and wastewater.

The Score System introduced a more radical communication (see chapter 2.3), shifting the focus to the bio-degradability, bio-accumulation, and harmfulness to the wastewater treatment plant of the chemicals used in the printing process. It was integrated in the environmental work of both SD and DCD – resulting in gradual substitution of chemicals with high scores.

4.3 The cleaner technology program – two interpretations and reflexive responses.

The cleaner technology programs was designed as a technology push instrument; technological options and systemic competencies in term of strong actors knitted together in a knowledge network was the immediate achievements of the programs (see chapter 2.3). New actors and competencies were institutionalised at a systemic level. The question here is how the enterprises' environmental perceptions, competencies, and technology paths have changed due to the program. Two 'cases' from the programs are examined: the implementation of the membrane project (MEMTEX) and the program's relations to the Novotex vertical.

4.3.1 The membrane project (MEMTEX) – interpreted within local regulation and business strategy horizons.

The use of membrane technology in wastewater reuse schemes had been developed within the program project "the DANTEX project" (Miljostyrelsen, 1998a). In this project the IPU (the Institute of Product Development) had demonstrated that the membrane technology offered a technical, environmentally functional, and also economically feasible, technology to reactive dyeing of cotton. Based on these experiences the IPU, together with environmentally active enterprises, fostered the idea testing these results on a broader array of process water within the textile industry (1996). This included Södahl Design (SD).

When organising the project, the IPU used the network relations established in the Dantex project (VKI and DTI-BT). Experts on membrane filtering were attached to the project. The Memtex-project was in this way rooted in national networks covering membrane technology and wastewater competencies. The pilot-tests revealed that the membrane technology was not readily adaptable to Södahl's production. To rinse the wastewater at SD to process water quality (enabling reuse), the IPU had to introduce a

special membrane module and to add a pre rinsing step and a final nano-filtration. However, the membrane technology was brought to function in this modified concept (Miljostyrelsen, 1997). If it could be implemented it would have been a key technology enabling Södahl Design to control and manage a main component of their environmental performance[xv]. But SD perceived the membrane filtration to be a failure. They closed the project and chose another solution - a traditional biological wastewater treatment plant (1997), designed to avoid the fees related to COD content imposed by the public sewage treatment works.

SD's abandonment of the membrane option was in part a result of the institutional set up of the cleaner technology program, in part a result of the strategic interpretations of SD. From the perspective of Södahl Design, the participation in the Memtex-project, was part of a search of possible technological options to their wastewater problem. But the project was not a result of a search strategy structured by SD's routines and networks or by the specific problem of their production. On the contrary, the focus on membrane technology was the result of previous search rounds, which had come to a closure (identifying membrane technology as a promising option). In this project the IPU wanted to test the limits of this technology.

The competence on membranes was centralised in the knowledge network. The IPU consultant, together with expert consultants, ran the test runs. However, in part the competence was passed to SD. SD's environmental co-ordinator operated the pilot plant and took part in the analysis of the results. As a result he got hands-on experiences with the technology. In this way the technical competencies of the co-ordinator enabled Södahl to gain from the project (enhanced knowledge on their wastewater). However, if SD should have implemented the membrane technology, they would have needed to address expert knowledge of the 'membrane network' on commercial terms. It reveals a weakness in the set up of the membrane project. It builds up a highly qualified know-how on membrane processes, but the transfer of the knowledge to the enterprise (the adaptation) was not incorporated. On the contrary, the price structure of using the consultants constituted a barrier making the systemic knowledge difficult to access.

However, SD has adopted the environment as a strategic parameter and they have related to an eco-modernisation project in the branch (Hansen 2000a). But this is perceived in a way that reflects SD's position in market and business network. Elements such as eco-management, eco- labelling and eco-design are all vital in relation to a 'life-stile'-market. But in relation to short-term decision on wastewater discharge, 'the eco-modernisation project' is open to interpretation. The formal elements as the eco-management systems and the eco-labelling allow for much manoeuvring; on crucial element they refer to other systems (EMAS demanding compliance with public demands) or provide low demand (EU-flower guidelines). As a result, the problem of the wastewater was primarily defined in relation to the perceptions and resources offered in the cleaner technology program and in relation to the local regulation.

The initiatives within the cleaner technology program offered a new perspective: How to establish recycling and reuse as close at the sources as possible. However, the project was seen by SD as a reactive move to comply with public demands - it was not interpreted as a strategic innovative move ahead of the demands presented in the regulatory and business network. The membrane technology was not necessary to comply with the environmental problems, as they were communicated from the environmentally authorities. Investments in the development of the technology could not be justified in the regulatory demands. The way the demands were communicated - focus on amount and COD, on a few heavy metals - did not support a (more expensive) solution offering an almost

complete removal of the suspended material from the waste water discharge from Södahl Design. There were not produced a setting that defined that Södahl had to take responsibility of the substances led to the waste water system or the system of solid waste. A setting, which might have made the implementation of membrane technologies a strategic move leading to advantages in comparison to other producers.

In a policy perspective, we can interpret the outcome of the membrane project at Sö dahl as a mismatch in the horizons communicated (or a mismatch in stimuli) from the Technology oriented Environmental Policy (TEP) (represented by the cleaner technology program) and the environmental policy (EP) (represented by the local regulation). The demands in the discharge licence and the fee on discharge signals a much more limited agenda. And the adequate technology to meet these demands was the traditional treatment plant. From the perspective of the environmental regulation, the membrane technology goes long beyond what is needed to meet the demands. It becomes a 'mismatched' technology due to the environmental perception communicated in the environmental policy system.

4.3.2 The Novotex vertical – reflections embedded in an environmentally pioneering product chain.

Novotex' demands on environmental performance have played an important role in how Danish Colour Design (DCD) has perceived its production and environmental work. The "green cotton" project, seeking to produce environmentally friendly textiles in an LCA perspective, can be envisaged as a capacity building process. In the development of "green cotton" as a business concept Novotex has succeeded to engage external partners, such as DCD, in interactive learning processes. Public environmental and technology programs have been used by Novotex and its partners to develop environmental friendly technology options. Over the years the projects has changed from exploring the basis environmental problems related to the textile product chain to the problems of developing integrated chain management in a LCA perspective[xvi].

Changes in technology paths and environmental perceptions

In 1993 Novotex participated as an environmental pioneer within the trade in a cleaner technology project from DEPA on environmental management. Part of the project was done in collaboration with subcontractors, and here DCD were faced with specific demands from Novotex: formaldehyde from fixation process of printed fabrics was to be substituted. Thus, the urge grew for DCD to change this process, not only in order to avoid costly demands on monitoring airborne solvents, but also to be able join a new quality cluster and stabilise a sub-contracting relationship to Novotex. Novotex also used the Score System (see ch. 2.3) in demanding environmental impact monitoring by their sub-suppliers; thus DCD was met with the business networks confirmation that meeting the public demands were important. At the same time, Novotex requested a substitution of paste-colours with heavy metals, as the German market demanded this environmental profile. The relations to Novotex spurred DCD to improve their environmental performance and to look for ways to avoid heavy metal.

In their entrepreneurial endeavour Novotex has been a key driver of environmental textile production in the Danish textile industry. The environmental demands (and goals) of Novotex forced their supplier to engage in processes of environmental improvement. This has resulted in a layer of environmentally oriented textile suppliers, which in turn has taken part in drawing up project within the cleaner technology program (Ch. 2.3).

Novotex' 'green cotton' concept and their demand has introduced a radical environmental perception, which DCD has used as a reference of their search for technological options. To some extent, DCD has made this perception part of their environmental perception, and gradually the relation to Novotex has developed into a mutual interactive learning process based on this common platform.

This has defined an 'environmental track of development. The main environmentally innovative achievement of DCD has been its systematic environmental optimising of its dye-system and dyeing processes. DCD initiated their search for 'heavy metal free' dyes back in 1993 – inspired by Novotex request. They succeeded to implement the new dye system, which enabled them to offer a heavy metal free line of printing dyes (eco-tex). However, besides the production to Novotex, the use of DCD Eco-tex dye system has only found minor markets on children's clothes in Sweden and Germany. The week penetration of the market can not be explained by price alone – DCD price related to the heavy metal free dye system is approximately 3 % higher than the price of their 'standard' dye system.

4.4 Environmental management systems –upgrading of local environmental competencies

SD implemented environmental management system supported by the local technological service system. The main results were a higher degree of integration of environmental aspects in the management system and a substantial rise in the level of control and knowledge of the process operations at the plant. The introduction of EMS was experienced as a win-win move as it produced substantial savings due to more optimised operations and facilitated the introduction of eco-labelling.

The LCA approach in the 'green cotton' concept combined with the outsourcing of most processes has made the management of external relation to suppliers a strategic activity to Novotex. On top of their EMS they have developed a supply management system (funded by CT-program (Miljostyrelsen 1998c), which enable them to perform an environmental evaluation of their supplier and to document the environmental performance of their products. The system should support an environmental product declaration scheme.

The certified EMS has been used as market strategic instruments, and the introduction has strengthened the environmental communication in the product chain. In addition the competencies and expediencies gained in the introduction of EMS in the enterprises have been important preconditions to enter eco-labelling projects.

4.5 The product oriented program and the construction of a market for ecological textiles

The product-oriented program has introduced a LCA perspective integrated with market oriented approaches as new main elements. The members of the corporate institution, the textile product panel (see chapter 2), has strategically chosen to focus on the build up of systemic competencies on LCA documentation and construction of an environmental market (eco-labelled collections). Both DS and Novotex are members of the product panel (Novotex chairs the panel). All the studied enterprises (DCD due to their connection to Novotex) stakes on this new strategy. The enterprises represent a layer of actors perceiving LCA management and eco-labelling as win-win situations in a market strategic perspective.

SD's introduction of eco-labelled products can been seen as a 'rational' move considering SD's position as an end product producer marketing e.g. bedding textiles. In addition, the environmental improvements in previous initiatives (CT and EMS) have made it possible for SD to meet the demands of the eco-labels (EU flower) without introducing major changes. The prime obstacle is the documentation (including documentation from suppliers) required having the products certified. A major part of their internal environmental work is now focused on the task of developing procedures and competencies on the eco-label documentation.

The LCA approach has been part of Novotex strategy during the last decade. They have chaired the EU working group on eco-labelling guidelines on T-shirts and linen, which preceded the new guidelines on textiles. DCD can deliver printing that fulfils the eco-labelling demands from Eco-Tex 100, the EU flower and the Nordic Swan. The environmental efforts (see below) have given DCD a strategic position. However, the economic result, in term of environmentally based turn over, has been very limited so far.

The product panel has led to a joint development of instruments of documentation of environmental performance; the private program of Novotex (and SD) has been turned into a shared environmental project of environmental communication. The program has enabled them to develop a corporate institution gathering the actors of the product chain in a joint strategic project. In this setting a new track of development has been formed.

On the one hand, it represents an empowerment and increased responsibility of the product chain actors. On the other hand, it may represent a closure based on market strategic considerations and 'green consumers'. One problem is that the environmental demands of the EU-flower on production fall behind the technological potentials developed in the cleaner technology program[xvii]. One example can be the heavy metal free dye system of DCD – in this setting it is only partly turned into a strategic advantage, as heavy metals still are allowed, limited by certain concentration waste water values. The adoption of the eco-label runs the risk to define and institutionalise a setting, where the environmental is reflected the lowest common denominator.

In the product-oriented setting, the institutional conditions are lax and provide weak incentives for aiming at environmental optimised dye systems. And still, the environmental communication in the textile product chain in general is too week to compensate for the lacking stimuli from the regulatory system. The ecological modernisation of textile vertical in this way are kept within a track driven by a economical technological rationality – more radical moves are dependent on a small numbers of environmental drivers such as Novotex and a subset of actors e.g. in Germany and Sweden.

Another obstacle is the development of an ecological market of textiles. The development of such a market, which was anticipated by part of the Danish textile industry in the first part of the 90's, has not taken place. Eco-oriented retail chains, such as FDB (The Danish Co-operative Retail Organisation) and Hennes & Mauritz, tried to introduce eco-collection (children's clothes) without success. Price differences, a narrow range of products and a lack of knowledge among shop workers and customers turned out to be decisive obstacles (Kristian D. Nielsen, 1999), and the project was closed.

5. CONCLUDING REMARKS

From our perspective, the institutional learning process within the textile industry can be seen as an interplay between a national ecological modernisation strategy, a construction of policy programmes and institutions directed towards the textile industry and enterprises

responding to the programmes and given their own strategic interpretation of the programmes. This interaction establish a dynamic learning process with the construction of new actors, the establishing of a new technological selection environment, and the building of new competencies within the enterprises and their network. The main findings of our study of this institutional transformation and learning process are summarised in table 4.1 (next page).

Within the environmental regulation of the textile industry a wastewater track of development has dominated, giving fewer impulses to other paths of development such as more radical substitution schemes and optimising material flow (reducing the materials suspended in waste water). Within the programs the major institutional changes have been:

- The targeted cleaner technology program within the textile industry has produced new knowledge resources concerning cleaner technologies. Technological options, that offer substantial reduction in the consumption of water, chemicals and energy and reduces the discharge of suspended material in the waste water, have been documented and made accessible in the textile environmental knowledge network.
- The implementation of the cleaner technology program within the textile industry has been based on a strategy program brought forward by the stakeholders in the industry and the related network of knowledge institutions. This has focussed and strengthened the program, but it has also produced a closure in terms of actors involved and in terms of the environmental perception in the program and industry. The program has been technique oriented and focussed on wastewater. However, the program has also conditioned a learning process. New schemes on eco-management and eco-design are now being taken up within the industry.
- The environmental regulation and the resources produced in the cleaner technology programs highly influenced the way the enterprises have dealt with their environmental problems. It has influenced how they defined their problem, and it has influenced the solutions that were considered, it has influenced their decision to implement or not and it has greatly influenced their final choice of technologies.

Table 4.1: The institutional learning process in the textile industry

	Permits: 1974 -	**Cleaner Technology: 1991 -**	**Environmental Mana-gement Systems: 1995 -**	**Product oriented program: 1997 -**
Constructi on of actors	Command and control oriented regulators, reactive firms	Closed corporate network of actors (Knowledge institutions, proactive branch organisation, proactive firms focusing on win-win technologies)	Proactive firms with enhanced capacity to control the process operations	Proactive firms actively trying to construct new markets for environmen-tally friendly products. Corporate institution on eco-labelling. New stakeholders from e.g. retail, design
Technology paths	Reduction of over consumption, reuse of water, cleaning	Technology push – development of win-win technologies	Environmental management systems and documentation of environmental	Product and life cycle orientation. Chain management and documentation

	technologies	combining cost reduction and environmental gains Local eco-efficiency	performance	of environmental LCA-performance
Competencies in knowledge network	Knowledge of wastewater and hazardous chemicals in environmental agencies	Construction of new technologies in knowledge institutions, capacity building in business network	Supply chain management in business network	Chain and market oriented, development of instruments for environmental documentation
Competencies in firm	Water reduction and reuse of water	Lack of ownership to cleaner technologies, no focus on competence building	Environmental Management Systems, Environmental supply management system	Eco-labelling, ability to communicate and document environmental performance
Strategic interpretation in firms	Environmental action as cost	Win-win perspective focusing on cost reduction. Reactive response to public demands	Competitive advantages related to environmental documentation and 'green cotton' concept	Win-win perspective focusing on new busi-ness opportunities related to environmen-tally friendly products and env. competencies

The goal of the programs addressing the textile industry has been to support an environmental upgrading of the industry. To achieve this, part of the programs has directly addressed the task to spur and define an environmental innovative behaviour in the industry. Taken all together they have defined a changed playing field, which has influenced the pace and the direction of environmental innovations in the industry.

Consensus and close co-operation among the main actors in the textile industry (the branch organisation, the knowledge institutions, DEPA, the county, and ADTI) have characterised the programs and regulatory initiatives. The fact, that the branch organisation has adopted a restructuring strategy of the branch including an environmental modernisation as a strategic option, has paved the way to environmental initiatives in the industry. In general, the programs and initiatives have benefited of this consensus and co-operation. It has contributed to the consistency in the programs and initiatives and has enabled concerted action on the 'score system', the framework program of cleaner technology, introduction of environmental management, the elaboration criteria to eco-labelling, and the product-oriented program.

Looking at the Danish textile finishing industry the environmental and technological policy programmes have led to a wide incremental introduction of cleaner technology. In this process a selective milieu of the industry has been produced:

a) Within the Danish technology programme a stable constellation of consultants and research institutions have formed a interwoven net of competencies on textile dyeing processes,

b) The industry and (local) environmental authorities have developed a high degree of consensus on environmental perception.
c) A progression in the systemic competencies were build up within this network, in a dynamic learning process the sector as a whole has gone through the stages of dissemination of information, development and diffusion of technology, introduction of environmental management and product oriented strategies.

The outcome of the programs and initiatives has been a high environmental awareness in the industry. Environmental considerations are now integrated in the search and decision processes of the enterprises. Throughout the process a group of frontrunners has participated actively, and they have in this process developed their environmental perception, i.e. the problems addressed and the horizon of solution strategies. Adoption of technological solutions broadly in the industry may have been limited, but among the front runners, there have been a collective learning process, in which the perception has moved from good housekeeping and substitution, to environmental management systems, to product oriented and to LCA and eco-labeling schemes. The changed of the way enterprises now reflect environment may show to be the main achievement of the program.

The most obvious strength of Danish EP is that it is developing in quite a responsive way, enabling the Ministry of the Environment to take up new environmental problems and initiatives from research results, public debates and business technology options at very short warning. The consensus policy style is, according to general evaluation studies of Danish EP (Andersen 1995, 1997, Christiansen 1996, Holm 1999, Mortensen 1999, Nielsen 1997, Wallace 1995), both a strength and a weakness. A strength, because industrial trades are open to communicate on technological options and to participate in finding environmental protection measures they may benefit from. There is a practical capacity for co-ordinating consulting and environmental monitoring with R&D initiatives in cleaner substitutes or technologies, which have established effective feedback mechanisms between the DEPA, the political system, research and networking. The weakness is that the minister and DEPA very often hesitate to enforce legal and binding rules that industry strongly opposes. A weakness is also the risks of falling into technological trajectories, which fit to what industrial suppliers of environmental equipment offer.

Judged up front on the practices of the frontrunners and their interaction with the institutional setting of the textile industry, the industry has moved a long way towards ecological modernisation. Examples are the development of environmental management system, the adoption of a LCA perspective in the improvement of environmental performance and a market oriented win-win strategy. On the other hand, the ecological modernisation strategy could be interpreted as a selective modernisation strategy focusing on the construction of niche markets based on ‘green cotton’ and similar products and a not too ambitious eco-labelling strategy based on the European flower. From this perspective, environmental push based on permits and technology push based on cleaner technologies directed towards the textile industry as such has been supplemented and partly replaced by a market oriented strategy offering new market opportunities for the frontrunners. However, it is an open question whether this market-based strategy will establish new technology paths for the rest of the industry to follow.

LIST OF ACRONYMS

ADTI: The national Agency for Development of Trade and Industry (Erhvervsfremmestyrelsen).
BAT: Best Available Technologies.
BOD: Biochemical Oxygen Demand.
COD: Chemical Oxygen Demand.
CT: Cleaner technology
DCD: Danish Colour Design
DEPA: Danish National Environmental Protection Agency (in the Ministry of the Environment and Energy)
DS: Dansk Standard, the Danish standardisation organisation.
EMAS: Eco-Management and Audit Scheme.
EMS: Environmental Management System
EP: Environmental Policy.
ETP: Environmentally oriented Technology Policy.
DBT: Dansk Bekladning og Tekstilarbejder forbund. Trade union organising the employees within the clothing and textile industry.
DTB: Dansk Textil & Bekladning. Branch Organisation of textile and clothing industry.
DTI-BT Danmarks teknologiske institut - Bekladning og Textil. Textile research and service centre at the national technological service centre.
IPU: Institut for ProduktUdvikling. Institute of product development (at the Technical University of Denmark).
ISO: International Standard Organisation.
LCA: Life Cycles Analysis.
RT: Renere Teknology. (Cleaner technology)
SD: Södahl Design
SME: Small and Medium sized Enterprises.
TEP: Technology Oriented Environmental Policy.
TIC: Teknologiske InformationsCenter. Local technological service centre.
TP: Technology Policy.
VKI: VandKvalitetsInstitutet. Research and service centre specialised in water and water treatment. A technological service centre.

INTERVIEWS

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Hans Dankert, Dansk Bekladnings- og tekstilarbejderforbund (The trade union representing employees within the clothing and textile industry)
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Notes

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[i] Ecological modernisation introduces the institutional reflexivity as a central concept. However, the way it is presented by Mol [Mol, 2000] lacks precision: It is unclear whether he addresses the capability to reflect or simply addresses the build up of new structural conditions of the production.

[ii] Beck differentiates between reflection and reflexivity of modernity – reflection specifies the deliberate (rational, knowledgeable and purposeful) while reflexivity specify the uncontrolled, unintended and unseen force of autonomised modernisation [Beck, 1994, 176]. And as part of this he see the reflection of modernity as optimistic in its core; more experts, more modernity hold the potential of coping with the problems shaped by the modernity. Reflexive modernisation does not integrate this optimism – it refers to an open future. Beck's differentiation between reflective and reflexive modernisation questions the basic claim of ecological

modernisation. *Reflexivity of modernity does not aim at self-destruction, but rather the self-alteration of the foundations of industrial modernisation. Whether the world will perish is not only completely open, but also completely uninteresting sociologically* (Beck 1994). Giddens (1994) argues that institutional reflexivity is to prefer as the leading term, as it does not indicate a direction.

[iii] The ability of EP and TEP to create innovative responses was the objective of the studies

iv. Remmen, Arne, 1999, 'Renere Teknologi i Tekstil- og bekladningsindustrien' (Cleaner technology in textile and clothing industry), www.mst.dk

v. Some parts of these discussions took place within the framework of Erhvervfremmestyrelsen (ADTI: The national Agency for Development of Trade and Industry). A working group, including representatives from the industry and the labour union, issued a strategy-paper "Tekstil- og Bekladning. Rapport fra arbejdsgruppe vedrørende en sarlig indsats pa tekstil- og bekladningsomradet" (Textile and Clothing. Report from working group concerning a special effort within the textile and clothing industry), Erhvervsfremmestyrelsen 1994.

vi. Rammeprogram for renere teknologi i tekstil- og bekladningsindustrien, (Framework program on cleaner technology in the textile and clothing industry). 1993-97. Ultimo 1992, Miljøstyrelsen.

vii. Miljøstyrelsen, "Notat vedr. rammeprogram for renere teknologi i tekstil- og bekladningsindustrien" (Memorandum on framework program on cleaner technology in the textile and clothing industry), j.nr. M 128-04221, December 1992.

viii. The DANTEX-projektet (start December 90, funding 650.000 ECU). The project is reported 1998: "Genbrug af procesvand fra reaktivfarvning af bomuld" (Reuse of process water from reactive dyeing of cotton). Miljøprojekt 374, Miljøstyrelsen 1998.

ix. The most important were "Resurs-projektet":" Ressourcehandtering i tekstilfarvebranchen" (Ressource management in textile dyeing industry), Start December 1992, funding 130.000 ECU. Miljøprojekt 268, Miljøstyrelsen 1994, "Kortlagning af ressourcehandtering i tekstil vadbehandling" (Analysis of resource-management in wet textile processing (Development and documentation of receipts with low environmental impact). Start December 1993, funding 100.000 ECU. Arbejdsrapport 60, Miljøstyrelsen, 1995.

x. The MEMTEX-project, Start November 1994, funding 300.000 ECU "Kemikalier-, energi- og vandforbrug i tekstilindustrien" (Chemical, energy and water consumption in textile industry), Arbejdsrapport 95, Miljøstyrelsen, 1997.

xi. Two projects were targeted at the textile industry: "Miljøledelse pa Novotex A/S" (Evironmental management at Novotex A/S), Arbejdsrapport 25, Miljøstyrelsen 1994 and Arbejdsrapport 57 Miljøstyrelsen, 1995 and "Miljørelateret leverandørstyring i tekstilindustrien" (Environmental supplier management in the textile industry). Start September,1994, Miljøprojekt nr 375, Miljøstyrelsen, 1998.

xii. The most important projects are: A) "Tekstilenhedsdatabase - til brug for miljøvurdering og miljøforbedring af tekstilprodukter" (Textile database - on environmental assessment and improvement of textile products), IPU, Start May 1997, funding: 100.000 ECU. The project is continued in an implementation project, start March 1998, funding: 400,000 ECU, B) "Environmental Assessment of Textiles", DTI, Miljøprojekt nr 368, (Funding 150,000 ECU), and C) Kortlagning af kemikalier i tekstiler (Mapping of chemicals in textiles), VKI, Start December 1997, funding, 250.000 ECU. (Not finished).

[xiii] The product panel's decision of making the 'eco-labelling collection' the strategic project may illustrate this. In choosing the EU flower as environmental reference, the players of the industry have defined the level of environmental ambition - and the direction of the modernisation process. This selective approach has been guided of business strategic considerations – relating to the label of EU enhanced market opportunities and was a stronger tool in environmental supply management. The involvement of the actors in the product chain and the integration in business strategy has been the main objective – and the role of the public authorities has been to function as a moderator of this process.

[xiv] The *EU eco-labelling system* (Commission Decision 1999/178/EC) identifies the main environmental performance indicators:

- demands on heavy metals impurities

- stability and process demands when Cu, Ni and Cr metal based complex dyes are used
- ban on a azo-dyes (based on how they decompose in aromatic amines)
- ban on a shortlist of carcinogenic, mutagenic and toxic to reproduction dye-stuffs
- Stability (colour fastness) demands on potential sensitising dyes (skin allergy reactions)
- Use of VOC must be below 5% in the printing paste
- Limits of the amount of free formaldehyde in the final fabrics.

In addition they abandon a number of fabric softener and complexing agents, such as EDTA (ethylene diamine tetra acetate)

[xv] The membrane filtering offers high environmental improvements. The process water from the operation of the printing machine and from the rinsing processes are to be filtered, resulting in a separation in a clean fraction (the permeat) and a fraction where the suspended material is concentrated (the concentrate). The permeat can - dependent on the filter techniques that are used - be of high quality and be recirculated 'as clean water' in the process. The concentrate can be further concentrated and be dealt with as solid waste or (dependent of its purity) or it can be used in organic processes (bio-gas). The environmental benefits of the project were high. The consumption of water and wastewater discharges could be reduced 80% if the technology were successfully implemented (Miljøstyrelsen, 1997). Membrane technology is, however, difficult to implement on wastewater that is produced in textile printing. Prior to the start of the project at least two types of problems were known: a) the resin binders would block the filter if they were present as latex (precipitated), b) the processes of finishing included chemicals (cations) which were know to spoil membrane filters. On the other hand, it was hoped that the resins would not form latex, and that modules of filters based on a tubular design would be able to handle the problems.

[xvi] Main projects: Implementation of environmental management systems (EMS) and of integrated EMS and quality control systems (Miljøstyrelsen 1994, 1995b). Development of a systematic (and simplified) environmental evaluation of suppliers within the textile production chain (Miljøstyrelsen 1998c).

[xvii] The *EU eco-labelling system* (Commission Decision 1999/178/EC. The lax demands of the EU-flower can be illustrated by that dyes based on metal complex are allowed and that the limits of COD content is several times higher than the local demand, which DCD and DS have to meet.