Ecodesign in Central America

Marcel Crul

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Proefschrift

ter verkrijging van de graad van doctor aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof. dr. ir. J.T. Fokkema,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op maandag 20 oktober 2003 om 15:30 uur
door

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doctorandus in de biologie
geboren te Breda

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Ecodesign in Central America
Marcel Crul
Thesis Delft University of Technology, Delft, The Netherlands
Design for Sustainability Programme publication nr. 9
ISBN 90-5155-018-9

Coverdesign: Pluuz & Reeks, Delft, logo © 1999, CEGESTI, San José, Costa Rica
Layout by Pluuz & Reeks, Delft
Printed by Druk. Tan Heck, Delft The Netherlands

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Acknowledgement

End of 1997 Han Brezet invited me to join his group (DfS Programme) at Delft University of Technology part-time as project coordinator, for the duration of the Ecodesign project in Central America, which turned out to be four years and four months. He suggested me to combine this with writing a PhD thesis on it. I liked the subject, and so got the chance to do a PhD study on an environmental and societal topic, which was an old wish of me. Having a lot of ongoing projects in my consultancy Aries Environmental Innovation, I planned to do both the project coordination and the PhD study in the part-time of the appointment at Delft University and finish both at the same time. I was wrong about that. Some of my friends still laugh at the optimistic time planning I had. But here we are then – one and a half year after the project, it is done. A few months ago, Niels Röling invited Cees van Woerkum of Wageningen University to be on my PhD committee. I then recalled that 20 years ago, I was a student of Cees, doing a small research project on…communication on environmental issues in developing countries. A full circle.

I want to extent my gratitude to the many people who made this study, and the project on which it is based, possible.

First of all I want to thank my doctoral thesis supervisors Han Brezet and Niels Röling. They were patient, supportive, creative and critical at the moments it was needed, and they helped me organise the multitude of research activities and data in a meaningful way. Their different backgrounds provided a good and synergetic 'body of knowledge' for my study.

Han, after 15 years of working together in several projects, thanks for offering the opportunity of this PhD project, keeping me on track and helping me to sort out a workable way forward. The societal focus of my study is certainly not mainstream in a Technical University, but you saw the relevance of such topics for Ecodesign and supported the choices made.

Niels, thanks for providing essential new knowledge and sources, and supporting me on methodological issues and in trying to 'build the story'. It was a pleasure to renew the contact with you and Wageningen University after so many years.

Very important for this thesis were my direct friends and colleagues of the 'Ecodiseño CentroAmerica' project, which I would like to thank for the great cooperation we had during the four years we worked together:

Jan Carel Diehl from DfS Delft UT, thanks for all the hard work and for all the good times. Thanks to my friends Marianella Feoli, Guillermo Velasquez and Guadalupe Riba as CEGESTI coordinators of the project, and all their colleagues at CEGESTI that were involved. Special thanks for translating the summary of this thesis in Spanish. Sabine Maresch, former CICAT coordinator, many thanks for your enthousiastic and professional work during the first years of the project, also thanks to all other CICAT personell that were involved. Henk Lolkema, at that time responsible for the project at the Dutch Embassy in San Jose Costa Rica, now in Surinam, thanks for your support and for the trust you had in the project. You always said you liked the project because it delivered on time and with good results, stayed within budget and so gave you no trouble at all. Thanks also to all the managers and workers of the companies and to all project counterparts in the region who got into Ecodesign and worked hard on it, and thus helped to make the project into a successful one. There are too many to name all of them here, therefore I refer to the hopefully complete list of project people in annex C. A special thanks to the students from Delft UT, Landivar University Guatemala and ITCR Costa Rica that were involved in the project – they all did a lot of hard work in the companies and thus made this project possible. These students are also listed in annex B and C.

Linda Roos and Alexandra Rukavina of DfS, thank you for the indispensable administrative and secretarial support. Suzanne Hallenga-Brink, thank you for the work on layout and cover design.

I am also greatly indebted to my Irish, Austrian, German, Czech and Italian colleagues of the European Commission research project INNET (2000-2002). Theory and praxis development in this project on “Innovation and Cleaner Production in Local Networks” partly ran parallel to my PhD work, and I have gratefully used some of these efforts for this study as well.

I am grateful for the hospitality that the community of the Sion Abbey in Diepenveen gave me. Three times a week of writing in the lovely and quiet surroundings of the monastry, staying on schedule helped by the routine of the sermons, were decisive periods in finishing this study.

Last but not least I want to thank my family, Mieke, Wouter and Tim for their support and patience. I know, it took some (sabbatical) time. This is yet another book in the family. Mieke’s book ‘Verlaat Verdriet’ (‘Delayed Mourning’ of people who have lost a parent in their childhood) was started later, published earlier, and already has seen three prints and thousands of copies. Can’t beat that.

Berg en Dal, October 2003

Part 1: Introduction

Chapter 1: The Ecodesign Project in Central America

In this chapter the setting of the Ecodesign project is described in 1.1, followed in 1.2 by a more detailed project description and an overview of the outputs that were delivered. In 1.3 a brief description is given of the key initial tool, the UNEP Ecodesign manual.

1.1 The study: following a process of change

This study describes the change process started by the Ecodesign project in Central America, a project performed between 1998 and 2002. The project took place in a period of diminishing attention for the environment. The worldwide optimism about a clean future that arose from the Rio1992 summit had all but disappeared – reflected by a disappointing Johannesburg summit in 2002.

Ecodesign – environmental conscious product development – is a practical approach that goes beyond environmental improvement of the industrial processes at the company. It is an approach with the main focus on the company's product and its suppliers/product/technology/market system (see Brezet and van Hemel 1997). On an environmental scale, it is an approach at an intermediate level, which can be practically implemented in industry and can form the stepping stone for further actions in the direction of sustainability.

Central America in this period knew peace for at least several years in all countries of the region. It was a period of (re)building society and the local economy in an arena of strong globalisation: at the end of a period of strong economic growth worldwide and at the beginning of the following economically adverse period, that did not help increasing interest in the environment.

Set in the transition phases of these different developments, this study analyses the events in the regional Ecodesign project. This study itself describes and analyses a process of change, being the introduction of ecodesign in Central America. The outcomes of change processes such as this one are difficult to predict, and steering and managing is possible mostly on the process level, not on the level of results and developments. Started as a technology transfer concept, using the ecodesign concept and praxis developed in Europe, the first two years of the project showed a successful uptake of this concept by the nine companies that participated and by the counterparts of the project. With these experiences, the concept was translated and adapted into a regional Central American approach. Given the opportunity for an extension, the focus in the next two and a half years of the project changed to enhanced regional and national ownership of the approach (condensed in local networks) and in learning efforts on various levels by professionals in industry and universities. Simultaneously, the practical ecodesign work was broadened from single products to sectors, services and production chains.

A survey on ecodesign literature (Baumann et al. 2002) concludes that too much Ecodesign literature is of a conceptual and normative nature and that not enough real empirical work is presented. At least this study is one of the empirical ones. The survey also concludes that the process of product development inside a company is seldom linked to processes outside. This study tries to make that link: it follows the introduction of Ecodesign in Central America on different levels: on adoption of ecodesign inside the company, and on facilitation and capacity building processes in society. The study analyses these levels by empirical research of the actual industrial cases and facilitation and capacity activities that have taken place. On the basis of these findings it reflects on the theoretical basis and recommends strategic lines for future efforts to introduce ecodesign.

1.2 The Project

The awareness that industrial activities continue to be a major source of environmental problems of both local and global scope is a growing concern in the region of Central America, but is still well below levels in Europe and the US. Analysis of 16 leading industries across Central America found general levels of environmental performance to be low. In all countries of the region, and in most of the industries, environmentally related information and supporting services were found to be weak. Environmental rules were found to be unclear, frequently out of date and largely irrelevant for most of the industries. Market pressure and access to international markets were found to be more important drivers in most instances. Of particular concern were the conflicting signals received by the private sector that influenced behaviour deemed environmentally unsound or conflicting. For example, subsidized water, and implicit subsidies for imported chemical inputs are leading to a distorted resource allocation that causes environmental harm. Financial policies and banking practices were also found to cause environmentally harm, and in some cases even environmentally illegal behaviour (INCAE 1999). Concern over this situation, the need to include environmental variables into business strategy to improve global competitiveness and to attract foreign investment for industry has grown in the region. Companies exporting to the US and Europe are confronted with stricter environmental legislation, and demands for EMS, ISO and ecolabels. Multilateral and bilateral international projects, as well as regional and national projects are executed to improve the environmental performance of industry. International companies that have a production site in the region often require the same environmental standards as for their companies in the US and Europe. In most of the countries in the region, UNEP/UNIDO Cleaner Production centres have been established that are doing work on environmental improvements in the production processes of companies. Around 1995, in several studies it was made clear that more environmentally sound production and products were a high priority for the future development of Central American industry. One of the priorities stated in a Costa Rican needs assessment made by UNIDO was capacity building on environmental sound product development (Athié et al. 1995). The Ecodesign project described in this study was the first project in the region focusing on cleaner products.

Ecodesign – the design of eco-efficient or of more sustainable products - is common practice in many companies worldwide, mostly in the affluent industrialised countries. Demonstration projects and programmes in Europe, Australia and the US showed the feasibility of the approach during the period 1990-2000. One of the first projects in The Netherlands was the PROMISE project in 1991-93, organised by the Dutch Technology Assessment organisation NOTA (later renamed as the Rathenau Institute). The project included 8 industrial case studies, manual development, a TA study and policy advice. The results of this project were the starting point of many of the follow-up projects in The Netherlands and elsewhere in Europe. It was also the origin of the UNEP manual that was published in 1997, becoming the 'standard' manual for many projects afterwards – including the first phase of the current project. Delft University of Technology (DUT), Design for Sustainability Programme (DfS) was involved in several of the projects in The Netherlands and Europe from 1990, and started to support ecodesign demonstration projects in industrialising countries in Asia, Latin America and Africa from 1992. Those first projects were usually individual industrial case studies on the basis of graduate student internships in the companies. Two of those industry projects took place in Costa Rica, and thus initial contacts were made between DfS and the counterparts in this project, CEGESTI and ITCR.

"Ecodiseño Centro-America' (Ecodesign in Central America) is a project on the introduction and dissemination of Ecodesign in that region (1998 - beginning of 2002), with a total budget of 600.000 Euro, of which 500.000 Euro was financed by the Dutch Embassy in San José, Costa Rica. DUT/DFS together with CEGESTI, a non-profit consultancy foundation in Costa Rica, coordinated the project. The project was executed in industries in Costa Rica, Guatemala and El Salvador, with workshop participation also from Honduras and Nicaragua. Local counterparts in Costa Rica, Guatemala and El Salvador provided expertise and support to the project.

The logo of the project that is shown at the beginning of this chapter and on the cover tries to show some of the focal points of the project: The project is in and for Central America (map), but sees this topic on a global setting (globe) and with environmental improvements (colour green) in the full life cycle of products (circle) in mind. Annex C provides an overview of facts & figures of the project.

The central purpose of the Ecodesign project was: to improve the environmental aspects of products, designed and produced in Central American companies, with a focus on Small and Medium sized enterprises (SMEs) by introducing, practising and adapting the concept of ecodesign in that region. In the framework of the Ecodesign project as it is performed in Central America, the expectation is that the experience gained in Europe with Ecodesign programmes must be adapted to the specific requirements in Central America, and combined with the existing experiences and approaches in the region. Further, to implement and sustain a concept such as ecodesign in the region, a change process has to be started that includes all relevant actors in the region and leads to a situation of 'continuous learning' on the topic.

Objectives

Originally, the project period was two years (1998-1999). Because of the promising results during these first years, an extension of the project with two more years (2000-2001) was requested and granted end of 1999. Finally, the project was completed in April 2002. Key objectives of the first two years (98-99) for the Ecodesign project were therefore:

- execution of demonstration projects in SME's in the region
- regional capacity building for ecodesign
- regional awareness building for ecodesign

The opportunity to formulate new activities for the extension period of the project gave us the chance, learning from the experiences of the two first project years, to improve and widen the scope of the project. The objectives of the first period (demonstration, capacity, awareness) remained valid also in this phase. Next to these, new objectives for the second period became:

- expansion of ecodesign form single products to chain, sector and service approaches
- expansion of capacity building towards young professionals and university staff
- targeted awareness raising and networking activities for each of the participating countries.

UNEP Ecodesign manual

The methodology that was used initially in the project is described in the UNEP Ecodesign manual (Brezet and van Hemel 1997). This manual is said to be the reference manual for ecodesign in projects worldwide (Baumann et al 2001). The manual introduces the concept of ecodesign and its importance for industry. After that, a step-by-step plan is presented, running more or less parallel to the traditional product development process, to help companies implement the ecodesign principles. The plan is subdivided in seven steps. The steps deal in detail with (1) organising an ecodesign project (2) selecting a product (3) establishing an ecodesign strategy (4) generating and selecting product ideas (5) detailing the concept (6) communicating and launching the project and (7) establishing follow-up activities. The manual further has a set of supplementary modules, dealing in detail with topics such as life cycle analysis, life cycle costing and green marketing.

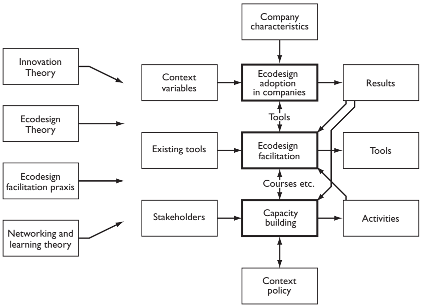
Outputs

During the entire Ecodesign project the following activities were undertaken and outputs produced:

- A region-specific, Spanish Ecodesign manual
- 14 Fact sheets on product/service improvement, and 4 more from ITCR Ecodesign projects
- 14 Ecodesign projects in industry: 6 in Costa Rica (including one service-oriented project), 5 in Guatemala (including a metal sector approach) and 3 in El Salvador (including a chain-oriented approach)
- Regional Conference on Ecodesign
- National Workshops on Ecodesign in Costa Rica, Guatemala and El Salvador
- Over 20 skilled Ecodesign advisors in the region, and over 50 trained professionals in the region
- Courses on Ecodesign held in Delft (initial course and high-level course) and several courses held in the region
- Survey on the use of regional eco-indicators
- Organisation of a regional Ecodesign award contest – now embedded in a regional CCAD award scheme also for environmental innovation and energy efficiency
- Ecodesign webpage
- A variety of awareness raising activities including industry conferences, workshops
- Publications in local industry magazines and scientific conferences
- Reports on all phases of the project and mid-term review reports
- Counterparts in Guatemala, El Salvador and Honduras having regular activities in Ecodesign, supporting local companies

Most of the project results are described in detail in this study, and analysed with respect to their impact, follow-up and sustainability. Clearly, capacity for ecodesign has been built in the region, and awareness for the topic has increased, for instance shown by the establishment of the ongoing two-yearly regional award scheme for industry. However, an ongoing and sustained increased activity on ecodesign in regional industries has not yet emerged. One ecodesign project is not enough to accomplish this. The industrial, governmental and societal attitude towards increased sustainability and environmental protection still has to grow. The project was only a starting point in this respect.

Chapter 2: Problem definition and research focus



In this chapter, the problem definition and focus of the study are determined (2.1 – 2.2). On the basis of this, the initial research questions for the study are formulated in section 2.3. An initial research model is developed (2.4) which shows the three variables of the study and the type of independent factors that influence them.

2.1 Problem definition

In the previous chapter, the outline of the Ecodesign project is described. The project and the present study are of course closely related, but their purposes are different. While the project aims to successfully introduce ecodesign, the purpose of this thesis is as follows: Through action-integrated case study research, using the Ecodesign project as interactive empirical 'field research', this study tries to:
Analyse and describe the process of introducing 'ecodesign' in companies in Central America:

- Define the key elements, preconditions and barriers that are involved in this introduction;
- Analyse and describe the process of change that takes place at the company level when introducing ecodesign (adoption);
- Analyse the various levels of facilitation that are necessary to introduce ecodesign in the region;
- Analyse the process of capacity building necessary for the facilitation of ecodesign;
- Recommend future strategic activities that can support the further introduction of Ecodesign.

The introduction of ecodesign in Central America takes place in a regional setting that differs from the setting in industrialised countries where ecodesign is more common. This has implications for the problem definition and focus of this study. First, although several environmental initiatives were ongoing in industry at the moment the Ecodesign project was executed, there are relatively few external stimuli in place for industry to adopt such an approach. Legislation aimed at clean products does not exist, institutional support is small, and market pressure only exists for internationally owned companies or exporting companies. It can therefore be expected that internal factors for stimulating ecodesign will be more important than external ones. With environmental awareness of industry at a low level, this implies that the 'innovation' aspect of ecodesign will be prominent. Introducing ecodesign in Central American industries will be studied as a special case of normal (product) innovation. It is 'normal', in the sense that the general theory and practice of industrial innovation adoption and diffusion are assumed also to apply to ecodesign in Central American industry. At the same time it is 'special', and scientifically challenging, in the sense that for many of the small and medium sized companies targeted in the project, it will be the first encounter with a systematic, stepwise process of product development, taking into account both the product and the market. Also, in ecodesign, environmental aspects, information and requirements are introduced that are not commonly taken into account, and not forced by external factors. From the viewpoint of existing ecodesign 'praxis' (the full spectrum of concept, theory and practice), several new elements are expected to occur when introducing the concept in Central America. Adaptations will have to be made: Typical local settings such as the prominent place of family–ownership of companies will be taken into account. It can also be expected that the specific socio-economic situation of Central America as an industrialising region has to be taken into account, and that the methods and tools to introduce ecodesign have to be adapted, not meaning that a completely new approach has to be formulated. Facilitation in a broad sense – at different levels: in the industry projects, in expertise enhancements of facilitators themselves, in education and in capacity building - will play a crucial role in the introduction of ecodesign. The level of expertise and access to information will be lower and, as stated before, external stimulating factors such as government and market pressure will be weaker compared to the European context, making facilitation and capacity building a more central issue. It is also one of the first times that the European-based ecodesign method is not only used, but also evaluated and adapted for use in an industrialising region – this can deliver interesting findings also for ecodesign in other industrialising regions.

Ecodesign is closely connected to more general beliefs and values of 'sustainable development'. This will bring us to widen the approach beyond the technical and methodological 'industrial practice' approach of product development only. To build societal capacity for sustained activities in ecodesign, several societal actors will have to play a crucial role in awareness raising and capacity building. This study sees the introduction of ecodesign in Central America as an initial and specific part of a process of societal change and continuous learning towards sustainability, in which a range of societal actors has to be involved in local (in this case national) networks. This is one of the first projects where capacity building for ecodesign and continuous learning by the key actor groups in an industrialising region is an explicit target. There is little experience how this capacity building should be organised and continued. In the European context, external pressure from regulation and markets plays an important role. These type of factors exist to a much lesser extent in this project, and therefore other strategies will have to be used.

The Ecodesign project can also be seen as a development co-operation effort between The Netherlands and Central America, and it will therefore be analysed to what extent it is successful as a form of modern Technology Transfer, or Capacity Development for the Environment, in which the transition to local leadership plays a key role.

At the macro economic level, diffusion of ecodesign in Central America depends of course on the context of (regional) competitiveness and industrial and economic development at a regional and global scale. This topic is not explicitly researched in this study, but forms an important framework condition for the successful introduction of ecodesign. Existing theory and experience in this field have to be taken into account and dealt with as much as possible in relation with the research topics at hand. A key source for information on the macro-economic topic was the 'Regional Competitiveness Agenda' for the whole region of Central America. The formulation of this agenda was initiated by the presidents of the countries of Central America. In 1999, INCAE has published the complete version of this Agenda, in essence being a strategy proposing concrete steps to jump-start the economic progress of the region (INCAE 1999). The relation between competitiveness and the environment takes a prominent position in the Agenda, making this Agenda and its connected surveys and studies an extremely important source of information on the macro-economic factors influencing the introduction of ecodesign, and an important regional initiative to connect future strategies with.

2.2 Focus of the study

On the basis of the purpose and assumptions for this study as described above, the focus is as follows:

Taking the differences into consideration that can be expected when introducing a European ecodesign approach in Central America; the study will focus on the actual adoption of ecodesign by companies in Central America, on the success rate of the adoption and on the key factors that influence this success rate. With regard to facilitation, the focus of the study will be directed both towards the applicability and optimisation of the methodological tools and approaches for ecodesign, and on the organisation and effects of training and education efforts that form the higher levels of facilitation. With regard to capacity building, the focus of the study will be on the successful involvement of key actors in ecodesign activities; Network-building at the level of the individual countries in the region is tested and evaluated.

To obtain insight into the key factors that influence the results and success of ecodesign introduction, relevant theories available in the field of innovation, ecodesign, facilitation and networking/capacity building will be selected and analysed to develop and detail the analytical framework. Many of those theoretical implications, implicitly or explicitly, have also been used in developing the first phase of the Ecodesign project in Central America for 1998-99, and more prominently they were part of the preparation of the second project phase 2000-2002.

All activities of the project then serve as empirical material for this study, organised as company case studies and local network case studies.

The study will be of an explanatory and exploratory nature, trying to understand the mechanisms how and the reasons why certain developments took place. The explanatory focus in the study is on an in-depth research on ecodesign adoption at the company level. With respect to ecodesign facilitation and capacity building, the research will be of a more exploratory nature.

The macro economic level itself is not empirically researched, so no direct analysis is made of the relation and patterns between macro-economic factors and adoption. Still, relevant factors from literature are described and taken into account in analysis and recommendations.

2.3 Initial research questions

Based on the problem definition described before, the central research questions of this study are:

1) **How successful is the adoption and implementation of ecodesign by companies in Central America that participated in the project, and what are the key factors that influence this?**
2) **Is facilitation of ecodesign – both in-company support and facilitators' expertise building – successful and locally owned?**
3) **Is there sustained capacity in Central America to continue and expand ecodesign activities?**

The following more detailed initial research questions were derived from these central questions:

Adoption in companies

Q1) How does the adoption of ecodesign – seen as a product innovation process – take place in participating companies in Central America?

Q2) Are the ecodesign projects in the companies successful, is the approach continued and does the approach diffuse to other companies?

Q3) What are the key company-internal factors that influence (positively or negatively) this adoption of ecodesign?

Q4) What are the key contextual variables (stimuli and barriers) that influence the ecodesign adoption?

Facilitation:

Q5) How was the initially provided ecodesign methodology handled?

Q6) What elements of the ecodesign approach can be optimised for use in Central America?

Q7) How does the transition to local facilitation of ecodesign develop? Is it optimised?

Capacity Building:

Q8) How did the process of capacity building and awareness raising on ecodesign develop in Central America?

Q9) Who are the key actors in this process and what is their role and involvement?

Q10) Is building capacity and awareness on ecodesign successful? Can/should it be optimised?

2.4 Initial research model

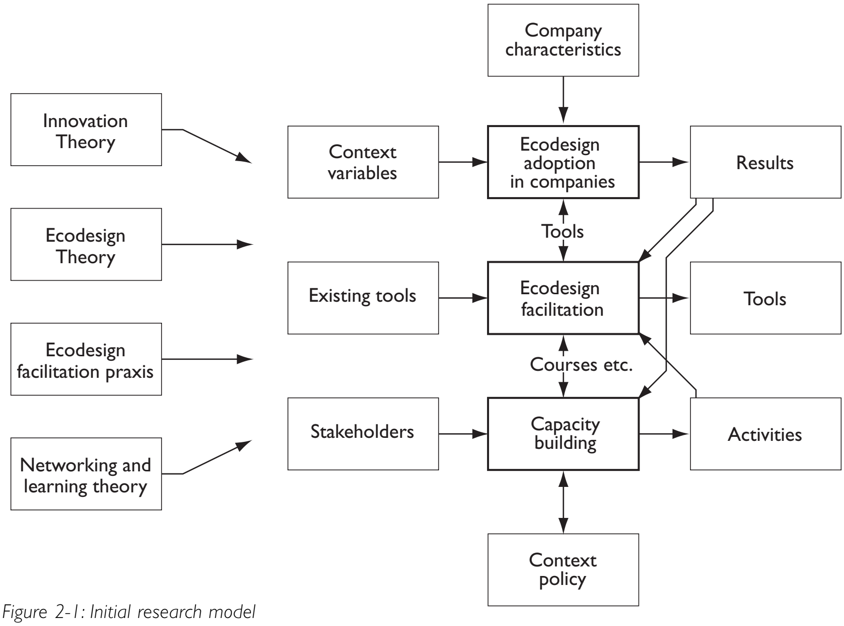


Figure 2-1: Initial research model

The initial research model as shown in figure 2-1 consists of three connected focal points on the right side of the diagram:

1) The process of adoption of ecodesign in the individual company,
2) The facilitation approaches – ecodesign methods, tools, courses etc.
   This facilitation is both needed to accomplish that adoption in the company (tools) takes place, and to form capacity in the different countries (courses) - see the arrows connecting the three levels,
3) The capacity building actions necessary to sustain and move forward the introduction of ecodesign.

These focal points are connected to theory and practice from various fields of knowledge as shown to the left: Key areas for this are Innovation, Ecodesign, Facilitation, Networking and Learning theory and practice.

The three focal points - adoption, facilitation and capacity building –are the dependent variables in the model, each shaped and influenced by a large number of external and internal factors, the independent variables. These factors can initially be described as follows.

Variable: Adoption

The model for adoption of ecodesign by individual industries can be described as a process in which the company goes through several steps or phases to adopt and implement ecodesign. The process of ecodesign in our study is confined to the life-cycle system controlled or influenced by the company, and takes place under a set of drivers and constraints for the process, with a certain approach and a management/decision system.

The company adoption process is influenced by several external and internal factors:

- Contextual variables, such as the economic situation, sector/competition situation, social surroundings of the company, policy climate, market influence etc.
- Company-internal variables or characteristics of the company: innovation strength of the company, personal drives of managers, level of interest and training of personnel.
- Characteristics of facilitation that influence the company level, such as the type of requirements and environmental situation related to the product/system, the state-of-the-art of the facilitation approach, the expertise and role of the internal/external consultants.

The adoption process itself can lead to concrete results on ecodesign, indicated by a certain level of success on factors such as environmental improvement of the product, product quality, market penetration, sales etc. And a 'learning curve': experiences learned because of success/failure of projects, and integration and continuation of activities.

Variable: Facilitation

Facilitation on ecodesign in this context exists of in-company facilitation activities directly connected to the ecodesign project, and in addition to this consists of expertise building on several levels: company management and staff and consultants/advisors. Facilitation also includes the full 'toolbox' of approaches, tools and methods for ecodesign that can be applied.

Facilitation on ecodesign is influenced by the following factors:

- It is initially based on the knowledge and application of existing ecodesign tools and methods, which then are shaped for use in the local situation.
- As a next factor, the results and experiences coming out of the industrial case studies are input into the further development of facilitation and lead to new and improved ways of facilitation.
- Further, coming from the capacity building level, the continuously developing local capacity and networks – through activities such as training and education - contribute to the expansion and improvement of the available knowledge and approaches for ecodesign from the local stakeholders, both in ecodesign and in other related fields of knowledge and experience.

The facilitation process leads to concrete new and adapted tools and approaches for ecodesign.

Variable: Capacity building

Capacity building and diffusion of Ecodesign at the regional level in Central America can be described as a building of capacity in different stakeholder organisations connected in several ecodesign networks, both national and regional.

Capacity building depends on several factors:

- It depends on the availability and willingness of existing stakeholders
  This process of capacity building and diffusion takes place in the networks of actors, under distinct influences from actor organisations, and is primarily formed by influences and efforts from these stakeholders.
- The results of the company case studies and facilitation for an input for the level and speed of capacity building.
- In addition, the capacity building process is influenced by external factors such as the overall macro-economical and societal developments and policy developments.

The initial detailed research questions Q1-Q10 can be allocated to the respective 'boxes' in the research model, as shown in figure 2-2:

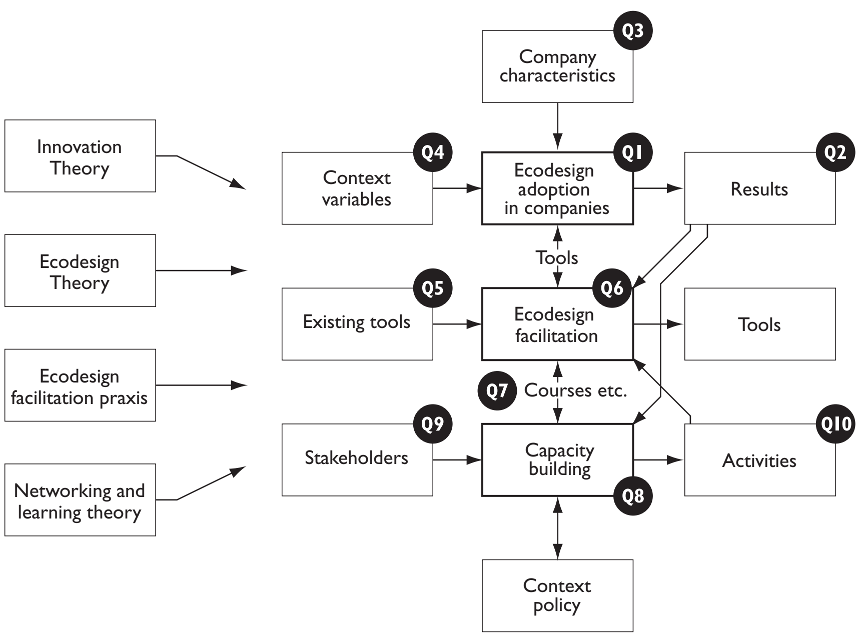
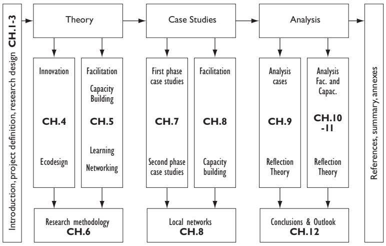


Figure 2-2: Initial research model with research questions.

This initial research model forms the basis for the theoretical development described in Part II of this study, and on the basis of this theory development it is improved and detailed further in Chapter 6.

Chapter 3: Research design



In this chapter the research design of this study is described. In 3.1 it is argued why a case study approach is most applicable for this study, and is explained how the quality of this study can be checked. In 3.2 the basic theoretical fields are selected. In 3.3 the research steps are formulated based on a case study research approach.

In this chapter, a number of choices with regard to the focus and structure of this research are described: The way the research is organised, what type of research approaches were selected for use, what type of data are collected, what theoretical fields are studied, and the resulting overall research pathway that emerges from these decisions. In designing this research study, the decisions taken are closely connected with the situation and planning as it existed at the beginning of and during the Ecodesign project.

The conceptual starting point of the study is a model for ecodesign as it exists in Europe, based on a set of theories and experiences (innovation, ecodesign, facilitation). This model was developed, tested and used in several other projects and programmes, and with this 'praxis' formed the starting point also in the project in Central America. The empirical part of the study is bound by the requirements coming from the set-up of the Ecodesign project. The set-up of the project was defined up front for the 1998-1999 period in the project formulation phase, and as such was a fixed format that could be studied. However, there was a large degree of freedom to improve and adapt the activities for the second phase 2000-2002, but still within the scope of the Dutch Embassy programme of which it was part. The decisions for change are analysed and described as well in this study.

Several new elements are introduced in this project: a key innovative element of the project is that the project engages in a *concerted and integrated* process of change in companies, at facilitators' institutions and in local networks in Central America. This is not about describing the status-quo on ecodesign in a country, or performing a number of isolated company projects (as often done before), this is about actively introducing and implementing ecodesign on all relevant levels. Another key new element is the fact that to our knowledge, this is the first ecodesign project performed and investigated on this scale in an *industrialising region*. This implies that not the same context exists as in Europe, US or Japan: companies come from a different starting position with regard to product innovation and environmental aspects of their products. The regulative, institutional and market settings differs distinctively. This means the actual innovation process in the company could develop different, and the opportunities and barriers for ecodesign will be different from the experience and knowledge based on European projects. Therefore, the need is recognised for in-depth analysis of the practical experiences on several levels: the level of industrial case studies, the level of facilitation, the level of networking and capacity building.

The focus in this study is on empirical research of the full context of introduction of the ecodesign approach in a regional setting and in multiple industrial cases, based upon theory and practice. Because of the previous experiences and the existing body of knowledge on ecodesign introduction in individual companies, the key type of research questions for the adoption of ecodesign in companies is of an explanatory nature ("how" and 'why"). However, for the lesser explored issues of facilitation and capacity, the focus of the research will be on exploratory research ("what" and "who" questions). Because of the multi-facetted nature of ecodesign, the cases are described in an embedded way, meaning that the data gathered in them include several different units of analysis, including actual (eco)innovation, the companies' change process, and the company level and overall facilitation approaches.

3.1 Research approach

The objective of this study, to analyse the introduction and dissemination of ecodesign in Central America, is a complex assignment, practised in a situation and region of the world that will show very different perspectives from the various actor groups involved. It is also a complex and not yet well established context both with regard to the environmental situation, the socio-economical situation in the region and the actual innovation situation of the main target group: small and medium sized companies in the region. The positivist research paradigm would suggest that this can be studied as an external reality, governed by immutable natural laws. The constructivist view would be that reality is not objective, but constructed and given meaning by the individual – so multiple realities exist (Guba and Lincoln 1998). The position taken in this study is in between both extremes: for certain aspects, for instance on elements of the innovation and adoption processes, we believe that these can be studied as an outside reality, and we will rely on existing theory, focus on the facts and try to operationalise and quantify phenomena. On the other hand, for other elements of innovation, and for issues such as societal facilitation and capacity, we believe that several models and constructions exist for different people, thereby creating various realities. Taking this ontological and epistemological middle ground, from a methodological viewpoint we will rely on the use of multiple analytical and evaluative methods to try to understand the phenomena studied, and get valuable input from different perspectives.

Several generic methodologies for organisational research are to our disposal (van der Zwaan 1995):
- experiments
- surveys
- case studies
- action research
- evaluative research

From the context of the study, a case study approach emerges, used to analyse the multiple industrial and societal cases and confront these with the theoretical framework, a case study approach in which action is an integrated aspect, used to design and analyse the interventions made during the project, and recommend future intervention strategies.

3.1.1 Case study approach

Multiple case study design

One of the key activities in the project is the execution of industrial case studies in Central America. This gave the opportunity to design this study as case study research based on multiple cases (Yin 1994). Multiple case study design has the advantage over single case study design that the evidence from it is considered more compelling, and the study is regarded as more robust. On the other hand, very detailed analysis of a specific unusual or rare case is not possible in this design. For the current study, this is not a first requirement so a multiple case study design is preferred. The decision to organise this research in such a way has implications for the type of analysis required. The underlying logic for the design is 'replication logic' – that is, select and analyse a number of cases in such a way, that it either predicts similar results (literal replication) or produces contrasting results, but for predictable reasons (theoretical replication). From the theoretical framework developed, the conditions under which a particular phenomenon is likely to be found (literal replication) should emerge, as well as the conditions when it is not likely to be found (theoretical replication). From this rich analysis, generalisations for future cases then can be made. Also, results that are not expected on the basis of the theory can lead to modifications of the theory itself.

So for example, the initial propositions for this study are that the introduction of ecodesign in Central America will follow the theoretical 'rules' of product innovation and of the experiences with ecodesign praxis elsewhere in the world. These propositions are pursued in the first batch of case studies in the period 1998-1999. Certainly within a specific local setting (so Costa Rica, or Guatemala) on would expect a high degree of literal replication between the cases, or if not a good reason supported from theory why this is not the case (theoretical replication). For the second batch, some adaptations to the set-up are made based on the preliminary findings. It is expected then that this second batch would generate different findings based on theory, so predicting a theoretical replication. This replication logic must be distinguished from the sampling logic, in which a selected number of samples is assumed to represent the total pool of – in our case – companies, and the resulting data of the sample are assumed to reflect all companies, with confidence intervals for which this representation is accurate. Yin (1994) states: "Any application of this sampling logic to case studies would be misplaced. Case studies are not used to assess incidence of phenomena". Also, because of the complexity of our cases, an impossible large number would be required to allow any statistical consideration. Third, many important topics cannot be empirically tested using the sampling logic, which would leave out a large part of the actual analysis of this study. This implies that the analysis results and conclusions cannot be applied to the situation of all companies in Central America, but that cross-case conclusions can be drawn, explaining how the introduction of ecodesign progressed, and why it progressed in this way. Also, learning from the first cases, changes were already applied during the projects second phase, and the subsequent results were analysed as theoretical replications. Further, the analysis can lead to methodology and theory modifications and policy implications.

Ecodesign is taken as a complex phenomenon, encompassing various elements. Therefore, the case studies are treated as embedded case studies, that is, within the case study several subunits for analysis are discerned. Subunits are for instance innovation, environmental aspects, organisational aspects, technology transfer aspects etcetera.

In total 14 industrial cases have been executed and analysed on adoption, using a structured ecodesign approach that will be detailed in later chapters. For the analysis on facilitation and capacity building, the cases have been logically divided into three sets of national case studies in Central America: the national networks that were involved in the first and second phase of industrial case studies. In the case of Costa Rica, no changes were made in the actors involved, so in fact the same network performed all case studies.

Theory development

Theory development prior to data collection and analysis is an essential part of case study research. This is a more positivistic element and a key difference between case studies and related constructivist approaches such as 'grounded theory' (Strauss and Corbin 1998). In grounded theory, theory is derived from data which are systematically gathered and analyzed. No theoretical propositions are specified on the outset of the study. For case study research, up-front theory development as part of the design process is essential. This theory development serves as a blueprint for the study, and provides guidance in what research questions to state and what data to collect.For the topic of ecodesign introduction in Central America, a range of relevant theoretical fields can be found that all shed light on part of this complex topic. These fields are reviewed and a selection of the most illustrative theories is further developed in connection with each other and with the topic of ecodesign. A number of factors for analysis are formulated and applied to the results of the adoption in industry cases and to the results of facilitation and capacity building cases. As was explained before, more explanatory research is performed on the theoretically better developed issue of innovation adoption, trying to analyse patterns among the selected variables. For facilitation and capacity building, the research is of a more exploratory nature, using the theoretical background to learn more about the variables involved.

The set of theoretical notions is thus not only used to define data collection, but is also used for analytical generalisation (in contrast to statistical generalisation used in sampling logic) of the results of the combined case studies: the previously developed theory is used as a template via which the empirical results of the case studies are compared. If more cases show to support the same theory, replication may be claimed (Yin 1994). After the first phase of the project, implications for further actions and interventions can be derived from the analysis. In case of the Ecodesign project, this leads to the connected, second phase of the project. The results of the overall analysis may further be used as feedback to the selected theory and may lead to modifications for the theoretical framework. Also, on the basis of the results recommendations for future activities are given.

Action-integrated case study approach

The case study approach taken in this study integrates direct action, or intervention, taken in the cases. The cases are not just described and analysed without direct interference, but from the start of the project (1998-1999) efforts are made to change and improve attitudes, behaviour and results in both the companies and the local networks. These efforts are taken primarily by the project team, the same group that is also responsible for the analysis o the results and effects. The actual formulation of the initial project can be seen as the first 'wave' of intervention: case studies, facilitation and capacity activities were designed in an action-oriented way, formulated and executed in dialogue with local counterparts. Next, with the experiences of the first phase of the project, a number of changes and improvements in the approach are incorporated in the design of the second phase of the project (2000-2002) – this can be seen as a second wave of interventions: this has led to a number of new cases and newly designed facilitation activities that were then executed and evaluated, again by the same people that designed the cases. In this study, these second-phase interventions themselves and the results of the next phase case studies are also evaluated. This analysis is connected to the theoretical framework, similar as in the case studies of the first phase. During the execution of the entire project, smaller scale interventions are taken constantly in dialogue with counterparts, companies and other actors.

This interactive approach can be defined as a form of action-integrated case study research, since it can be characterised as an iterative process of evaluating, planning of change and re-implementation in specific cases, leading to a next phase of evaluation.

With this action-integrated approach, some of the characteristics of action research also apply to this study (Argyris 1983):

- it is problem-driven
- the status-quo is being questioned
- at the same time, it is oriented towards empirical verifiable conclusions
- these conclusions can be connected to theory that is applicable in everyday reality.

The advantage of an action-integrated approach is that internal validity of the research will be high almost automatically: because of the primary target of the project to actually use the insights and results obtained, applicability of insights is direct and high, connection of theory and practice is close and immediate. Also, external validity and credibility can be expected to be high because of the high degree of reality caused by the step-by-step process- and problem-oriented approach taken (van der Zwaan 1995). From the assumption in this project that action - changes and learning by all involved - is an essential part of the whole research design, it follows logically that interventions in the reality researched are a requirement to obtain valid research conclusions.

There are also disadvantages of integration of action in research. One of the key issues in this respect is that the close involvement of the researchers in the change process can hinder objective observation and analysis of the results by the same persons. As facilitator or change-agent, the researcher takes his own vision and his value system into the change process. This bias is not eliminated, but on the contrary put to use in the project. Clearly, the type of values thus influences the outcome of the research project itself. The researcher should acknowledge this bias and take in into account in the analysis. Another problem can be the under-involvement of the researcher in the change process exactly to avoid this loss of objectiveness – this however backfires on the essence of making useful interventions, and did not occur in this project. A third problem is the fact that the time-consuming change process is often eating into precious research time. It did. Parts of the research work had to wait. Last, the question can be put forward whether the researchers in action-oriented research are qualified enough as change agents. Perhaps for the type of project we describe here, it is better to hire a professional process-advisor in stead of researchers from a technical university. This has been shown in the past: in an innovation programme, performed in over 100 companies in The Netherlands around 1980, it was concluded that process-oriented advisors performed significantly better then technical or programmatic oriented advisors (Buys 1987). In the current project, this was solved by teaming up more process and programme oriented researchers with more technical oriented researchers.

3.1.2 Complexity: Soft systems thinking

In a complex topic such as the introduction of ecodesign in a region, the notion of soft systems thinking can be valuable as a 'mindset'. Soft systems methodology is defined as ' a methodology that aims to bring about improvement in areas of social concern by activating in the people involved in the situation a learning cycle which is ideally never ending. The learning takes place through the iterative process of using systems concepts to reflect upon and debate perceptions of the real world, taking action in the real world, and again reflecting on the happenings using systems concepts. The reflection and debate is structured by a number of systemic models. These are conceived as holistic ideal types of certain aspects of the problem situation rather than as accounts of it. It is taken as given that no objective and complete account of a problem situation can be provided.' (Bulow 1989). Soft system methodology 'focuses on facilitating the design of useful interventions. It recognises widely different yet equally relevant world-views of stakeholders' (Engel 1997).

The overall formal process of Soft Systems Methodology (SSM) as a research framework is described by Checkland and Scholes (1990). SSM is basically a double systemic approach in which first relevant models that define systems of purposeful activity are formulated, and then used by comparing them against perceptions of the real world. Second, these systems models are used to initiate a debate on purposeful change to improve the situation of concern, leading to well defined actions to do so. The case study approach developed and used in this study clearly have many elements in common with soft system thinking. One of the essential elements of a soft system approach is, that different (positivistic) scientific models can be used as useful concepts to describe (part of) the experiences in the real world, oriented towards the issue at stake – introducing ecodesign in Central America. This is done in the selection of theories that were used to analyse the cases of the project. Another essential element of soft system thinking is the notion that a continuous learning cycle of all entities involved in necessary to actually improve the area of concern. This focus on learning is strong in the second part of the current project

3.1.3 Quality check of the research design

The case study approach in this study is used to apply and check a theoretical framework in a rigorous and scientifically strict way with the empirical results of the case studies. To check the quality of the research design, the following positivistic quality checks were proposed for case study research by Yin (1994):
- Construct validity: Are correct operational measures selected for the concepts being studied?
- Internal validity: Are the patterns of relationship we see and conclude in the analysis real and not the result of some other factor we did not consider?
- External validity: Establishing the domain to which this study's findings can be generalized.
- Reliability: Demonstrating that the operations of this study – such as the data collection procedure – can be repeated with the same results.

Next to this, the following other checks from the constructivist approach can be added (Guba and Lincoln 1994):
- Credibility: Can the realities of the stakeholders be matched to those attributed in this study to the stakeholders?
- Fairness: Are the constructions made in the study clarified to and honoured by the stakeholders?
- Authenticity: Are stakeholders empowered to act, and do they learn in the process?

Taking an advance on the project evaluation, these checks are now briefly evaluated on the basis of the research design.

Construct validity

To develop the correct operational measures for the ecodesign variables studied, it has to be established that the measures to be selected do indeed reflect the specific changes that will be selected as dependent variables. It is planned to look closely at the ecodesign adoption process inside the case study companies. The key topic in the companies is a product (re)design, with a focus on environmental improvement. All research factors selected in this study are derived from exactly these topics: product innovation and ecodesign, and thus do reflect the specific results and changes encountered. Although the influence on adoption is complex, and this selection will not be complete, theoretical evidence is provided that these factors are crucial for adoption. For the facilitation level, it is decided to look at the actual facilitation inside the companies on ecodesign, and in addition to this at a higher level from the perspective of technology transfer. All operational measures reflect those topics again. Additional analytical results on adaptation of the facilitation approach will be directly fed back to the original theoretical sources for comparison. The capacity building level is a much wider and less well definable area. The basic key stakeholder analysis focuses on those aspects of the organisation that are directly relevant for ecodesign, thus focusing again on the concept at stake. Changes in capacity can be very diffuse and related to a variety of changes outside the specified field of this study. Therefore the factors will be narrowed down again to network quality, configurations analysis and a number of basic organisational learning aspects. The research factors are restricted to the same areas. To come to the analysis and answers of the research questions, multiple sources of data collection will be used that are all detailed in Chapter 6 to provide a chain of evidence on all topics. Also, the key findings are established not only by the researcher but also by the project team, thus further enhancing construct validity.

Internal validity

The key issue to be proved here, is that the patterns we might see and conclude in the analysis, are real and not the result of some other factor we do not consider. We will try to reduce the possibility of finding such wrong patterns by linking the results of our study as strict as possible to the theoretical factors stated in Chapter 6. Although some of those factors will have cross-links with others, the operationalisation in a scoring system is made as independent as possible. By linking the explanations of the case studies directly and individually to the factors, we will try to keep the explanation –building as straight forward and transparent as possible. The scoring for all cases will be done independently by different members of the project team. Also, this project being a type of action-oriented research, the connection between theory and practice will be very close and actions can be taken immediate, minimising the occurrence of analysing the wrong patterns. Where relations between research factors are complex, no one-on-one relations are forced and the complexity will be explained as consistent as possible. We therefore can conclude that the internal validity of the planned case studies can be considered high.

External validity

The issue at stake here is whether the findings of this study are generalisable beyond the immediate individual case studies. To repeat the statement made earlier in this chapter, this is not to be confused with the sampling logic that would be generalizing a sample to a larger universe – all companies in Central America. The focus of the analytical generalisation is to generalise the case study results to some broader insight and explanation building on ecodesign. For the company case studies, we can expect a relatively high external validity on the basis of the high number study cases planned.

This will not so much be the case on the level of facilitation and capacity building, where we are working with a much smaller number of cases, and a set of research factors that are more complex to analyse in a semi-quantitative way. Therefore, the results from that part of the analysis will not be presented as generalisable to a broader context, and the conclusions on this point are limited to the actual networks. Also, the type of analysis on these issues will be more explorative, aiming at finding logical explanations instead of trends and patterns. On this explorative level, explanation building is expected to be possible and generalisable beyond the cases. Another reason why external validity is expected to be high is that a high degree of reality that can be expected because of the problem-oriented approach taken.

Reliability

Would a later investigator, using the same procedures, following the same route of change actions and conducting the same case studies (not replicating them), come to the same findings? This should be the case if data collection and reporting would be organised in a strict and controllable way. The data collection of the case studies will be done verifiably and in a similar way for all cases, following the generally fixed steps of the manual. Data collection protocols will be established up front and be maintained during the project. Requirements for the students report are standardized and will be checked in a rigorous way by their professors. Triangulation (using multiple sources of data for analysis of phenomena) will be used in the analysis. Reporting to the sponsors also includes a large number of standardized and audited elements that were used throughout the entire project. Inside the project team, reporting formats will be developed for each step of the project to improve data collection and sharing, and these same schemes will be used in composing this study. Therefore, it can be concluded that reliability of the planned case studies data and results description is high.

Credibility

Can the realities experienced by the stakeholders be matched to those attributed in this study to the stakeholders? In this study, credibility will be ensured by a prolonged engagement in the activities, thereby establishing trust with the key actors involved and communicating frequently with them on their experiences, beliefs and values. Further, the findings and conclusions of activities will always presented to and checked with the counterparts in the project, thereby allowing them to correct any misperception.

Fairness

Are constructions based on different value systems and opinions made in the study clarified to and honoured by the stakeholders? We have designed the research to enhance fairness in this study by rigorous stakeholder identification up front, thus charting different values, opinions and interests, and making a clear case of possible differences between the organisations. Always, discussion with stakeholders on the requirements and possibilities for active participation in project activities will take place in a process of open negotiation. Although sometimes this can be a confronting strategy, it does keep communication between parties transparent and fair.

Authenticity

Are stakeholders empowered to act, and do they learn in the process? As soon as the project will be underway, and the first results become available, empowerment of local actors and creation of a continuous learning environment is a key strategy in the project. Stakeholders will be asked whether they understand the issues related to ecodesign and know possible ways of acting. Also, the interconnectivity with other sustainability and competitiveness issues will be emphasized.

3.1.4 The change agent as researcher

An issue at stake in all action and intervention oriented research is how to cope with the double position of being a key change agent in the project and at the same time a researcher in a PhD study. A major part of the answer is simple: Make the quality of the study as high as possible. The check in the design as given above shows that the quality of the study is good and confirms that this double position does not have to lead to less valuable scientific results. An effect of being change agent and researcher at the same time is, that the researcher takes his own vision and value system into the change process. In this research project, this is exactly part of the deal. Having gained insight in the first project phase, and being convinced of the benefits of broadening the concept for the second phase, and evolving facilitation into network building (convictions that were shared by the researcher with the whole project team) this can be considered an added value for the project, and of no negative influence on this study, as long as the decisions are fully described and taken into account in the analysis, which will be done throughout this study.

3.2 Theory selection and research factor development

As a starting point of the research, the various relevant fields of knowledge mentioned in Chapter 2 (both theoretical and practical references) were studied: innovation and ecodesign, facilitation of ecodesign, technology transfer, learning and networking. These fields are selected because they can contribute most to better understanding and answering the research questions stated in Chapter 2. The description and discussion of these theoretical and practical notions is given in Chapters 4 and 5. On the basis of this, a selection is made of (parts of) the theories that are the most useful for this study because they contribute most to the insight, explanation and evaluation of the case studies. In Chapter 6, the insight in theoretical findings has led to a further detailing of the initial research model and research questions that was presented in the previous chapter. This detailed framework is then used for analysing the results of the first phase of the project. This is used as input for the design of the second phase and for consecutive analysis of the results of the second phase. Finally the overall findings and conclusions are confronted again with the theoretical framework to suggest modifications and improvements.

To be able to analyse the results of the case studies in a rigorous and scientific sound way, it was decided to develop the theoretical notions that were selected further and thus define a number of research factors to be used for the analysis. The research factors reflect the key issues of theory (see Chapter 6). these factors are formulated as detailed research questions that further elaborate the initial ten research questions stated in Chapter 2. This complete set of questions is then used to analyse the various case studies (both the industrial cases as the facilitation and capacity building activities. These factors are operationalised by developing a four-scale scoring system (A-B-C-D; reflecting full to zero compliance with the criterion) for each of them. Thus it should be possible to give a comparable insight into each of the case studies. All cases are then analysed on a set of the factors (being different sets for different types of cases: industrial, facilitation or capacity building) – Chapters 9 -11. Next to this semi-quantitative analysis, a further qualitative descriptive assessment of the cases is given as well for additional richness of the evaluation.

3.3 Research steps

In every day practice of this four year effort, a number of iterative diverging and converging steps in the study took place over the years, both following and defining the planning of the practical steps in the four-year Ecodesign project. Basic theoretical and practical knowledge was available from the start, but was extended during the project. Acquired insight in ecodesign praxis from the first phase was applied directly in the ongoing cases, as well as put into the concept of the newly developed regional manual. One can also imagine that ad-hoc decisions within an industrial case were taken on the spot, because the company project required decisions to be taken within one week or even one day. On the other side of the spectrum, well defined theory-based interventions were defined before the first phase and even more before the second phase of the project, and put into the second-phase proposal that was drafted and submitted to the Dutch embassy. Both types of choices and interventions influenced the direction taken in the project and influenced the outcomes emerging.

Thus, this study should ideally describe and analyse a large number of iterative processes on a detailed level. This, however, would obscure the general development in the project. For better analytical clarity of this study therefore, as key guiding principle for the overall linear logic of a theory-based explanatory case study research is used: *develop theory - conduct the case studies - analyse the cases – draw conclusions and feedback of the findings into theory and recommendations*. The far more iterative temporal sequence of events that took place in the real world is important and can be learned from as well. Therefore it is taken into account where necessary in the description of case development as well as in the analysis.

This study follows a path through the steps of the case study approach, and the text is divided into a number of chapters accordingly.

Initial step: Set the stage:
Definition and boundaries of project and study, the selecting of initial theories, selection of initial research questions, initial research model, research design.

This step is described in the introductory part I of this thesis, Chapters 1 -3.

Step1: Develop the theory:
Survey of existing theory and praxis, selection of the most relevant theoretical propositions, operationalisation in research factors and detailed research questions, refinement of research model. This step is described in part II of the thesis, Chapters 4-6.

Step 2: Conduct the case studies
Execution of two phases of industrial case studies, and connected to this, facilitation and capacity building cases and development of local networks for ecodesign in the different countries. This step is described in Part III of the thesis, Chapters 7-8

Step 3: Analyse and conclude:
Analysis of the industrial cases, the facilitation and capacity building. Feedback into theory, recommendation for policy and future activities. This final part is described in the concluding part IV of the thesis, Chapters 9 – 12.

See figure 3-1 for a graphic representation of the total research pathway.

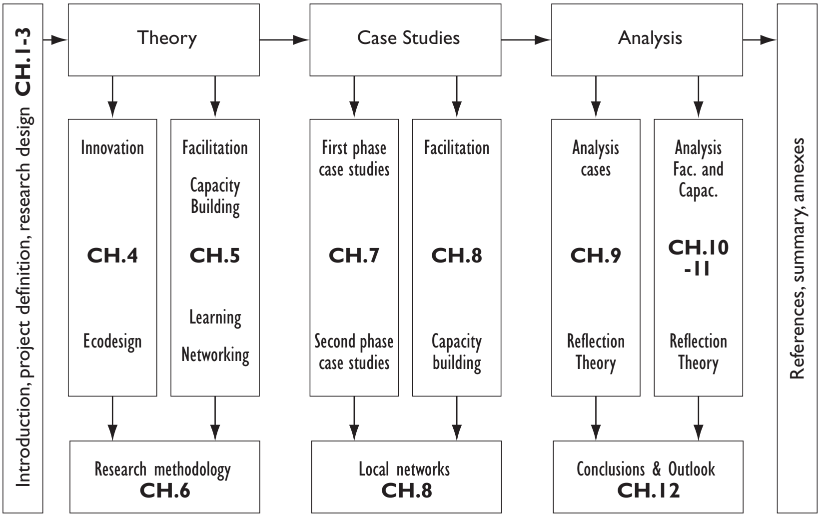
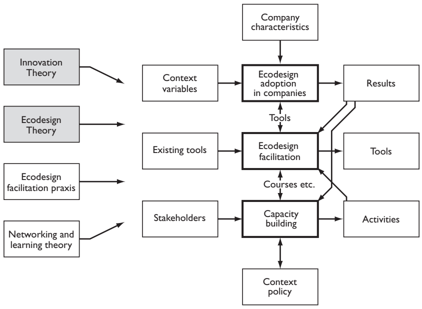


Figure 3-1: Research pathway

Part II: Theory

Chapter 4: Innovation and ecodesign



In this chapter, a range of topics from innovation theories (4.1) and ecodesign (4.2) theories are described that can be of importance to the subject of introduction of ecodesign in Central America. This means that this chapter does not intend to give a comprehensive overview of innovation theory, but is dedicated to find the most relevant theoretical propositions that can help to better design the research methodology and analyse the results of the cases in this study.

4.1 Innovation

Innovation refers to anything that is changed or new compared to the old situation and is then put to use – it is a broad concept that is used in many different circumstances and meanings. Buys (1987) indicates that in most cases it is unclear whether the change indicated by innovation is related to a temporal event, to the substance that has changed and whether the change is relative or absolute. Kanter (1983) defined innovation as 'the process of bringing a new, problem-solving idea into use'. Innovation can both apply to industrial and to social activities. Since the main focus is on ecodesign of products, this survey will be limited to industrial settings. However, one should be aware that many initiatives to further ecodesign in a broader sense, will involve social innovation as well, for example, new type of organisations, networks and strategic alliances. To some extent, this element is also part of this study.

Innovation research and theory has been developed both on the micro company level, including management approaches, and on the macro-economic level. Innovation can be seen as taking place on the micro level of a company or organisation, but at the same time is embedded in a greater macro-economical context and influenced by developments on that level as well.

It is almost impossible to put the diverse –often called 'unmanageable' - body of knowledge on innovation theory into one, more or less consistent, framework. Various paradigms and theories are developed, coming from different disciplines with little connections and little dialogue. From an economic viewpoint, Schumpeter contributed much, as early as 1934, followed by Freeman in the 1970s and Dosi in the 1980s. The field of innovation adoption and diffusion was developed by Rogers, the management and marketing field connected to it has Kotler as important contributor.
In an effort to analyse the theory of innovation, Sundbo (1998) takes the approach of the 'paradigm shift' concept (Kuhn 1970) in which paradigms – prevailing, shared perceptions, over an extended period, in a significant part of the scientific world – change at distinct intervals (crisises) into other paradigms. Sundbo distinguishes three concepts of innovation, each of which is the dominant paradigm during a certain period:

- The entrepreneur concept: the classic founder of the company, the entrepreneur, of a new company with a new idea, is the focal point of the innovation research and analysis.
- The technology concept: in this paradigm, the technology itself is the central issue of investigation and explanation
- The strategy concept: the paradigm in which innovation is mainly approached from a management point of view: companies reflecting on markets, organisations and resources, developing strategies and on that basis innovating.

Sundbo connects those paradigms to the last three Kondratiev 'long waves of global economy'. Those waves are postulated to have a length of about 50 years and can be identified from the start of the 19th century. Each wave goes though the phases recovery, prosperity, recession, and depression (app. 10-20-10-10 years long each) (van Duijn 1983). The thesis is, that each new wave leads to a new innovation paradigm, where in each wave the most extensive innovation takes place in the recovery phase, ebbing out into the prosperity phase. For each concept, the key agent for the innovation differs, from the entrepreneur to the technician to the manager. The overall market situation also evolves: from a forming (global) market to an established and growing market to a saturated and more and more complex and changing market in the current phase. See table 4-1 below.

Table 4-1: Sundbo's three concepts of innovation.

	Third Kondratiev wave (1883-1937)	Fourth Kondratiev wave (1937-1983)	Fifth Kondratiev wave (1984-?)
Innovation paradigm	**Entrepreneurship**	**Technological development**	**Market-oriented strategy**
Explanation of innovation	Psychological	Technological	Sociological
Agent of innovation	Founder/entrepreneur	Technician	Manager
Market situation	Market In process of formation	Market established but unexploited	Market saturated, complex, changing
Result	**Economic growth corporate development**		

This section 4.1 describes mainly concepts and empirical data in the tradition of the technological and market-oriented paradigm type, taking some small 'trips' into the realm of entrepreneurs' innovation. It describes the actual development of (technical) innovations (4.1.1) and the adoption and diffusion process (4.1.2). In 4.1.3 some elements of copying or benchmarking as innovation adoption approaches are described, since this is known to be an important strategy for product development all over the world, and very prominently so in industrializing countries. In section 4.1.4, success factors for innovation, as found in literature are surveyed.

4.1.1 Development of product innovation

Ecodesign of products can be seen as an innovation process inside a company or chain of companies. Environment is one of the driving forces that direct the innovation process. Although there is much specific environmental information needed for the process of ecodesign, the managerial and strategic decisions involved do not differ from other innovation processes. Therefore, it is assumed that existing models of dynamic innovation can also be used to describe and analyse the ecodesign approach on the product level.

Product innovation is considered as a dynamic process characterised by two different types of interactions. The first type is 'horizontal' interactions taking place within a company. Following the product development path these are: market perceptions, parallel simultaneous development of product, process and market, followed by the actual distribution, marketing and use of the products, followed by take back, re-use or disposal. These interactions include several feedback and iterative loops. Within Dutch ecodesign projects, consent has been reached on the main elements of this development path, usually described as the 'Delft' method (Roozenburg and Eekels 1995). See figure 4-1 for a graphic representation of this approach. Again, this approach is focused on the single product level. For systems or complex products, or products such as complex software, different models are needed.

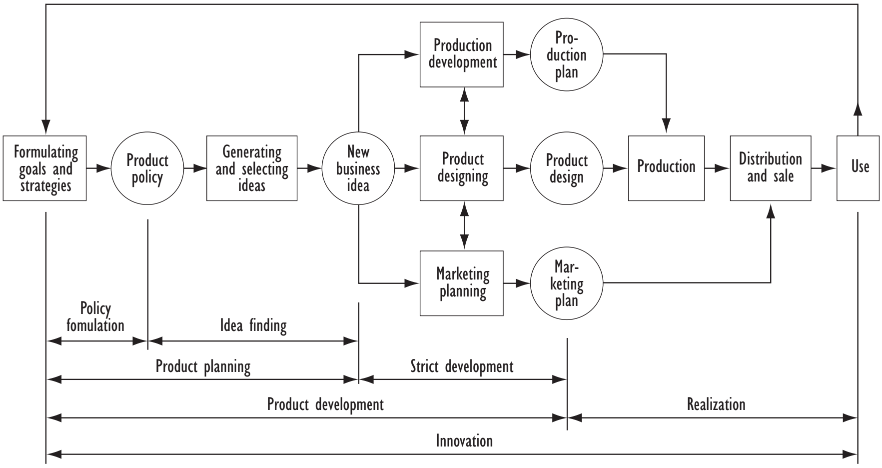


Figure 4-1: Model for product innovation (after Roozenburg en Eekels (1995) XXX

For the industrial cases in the project, this model seems suitable and applicable, and can help in the analysis of the cases. First of all, for the obvious reason that the initial approach and manual are based exactly on this model, so it will be applied to certain extent anyhow. Also, structural and systematic product development is not expected to be common in small and medium sized companies in the region. Analysis on the basis of this model can thus shed light on the level of systematic product development existing and/or needed in the cases. Third, the concurrent development of product, production and market is of high importance for ecodesign, with respect to the life-cycle concept (including production and use) and with respect to the sustainability concept which goes beyond the single product.

The second type of interactions consists of the vertical interactions taking place between this innovation process and the wider science, technology and societal system in which the company operates. It is in this vertical direction that many of the current research into ecodesign can be found. It ranges from methodological developments (like LCA) to new material technologies relevant for ecodesign, and also dissemination projects such as this actual project. Still the most widespread and misused model for this type of interactions is the linear model of innovation (Figure 4-2) . It implies that innovation is perceived to take place in a linear fashion, in which research leads to product development, to production and marketing.

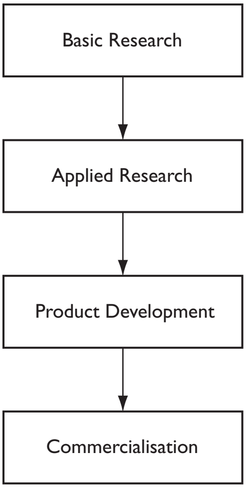


Figure 4-2: Linear model for innovation

There are too many deficiencies in this model to be applicable for our purposes. This pipeline model can be applicable for radical innovations in which new science develops new technologies. This is not the case in our project. A further problem is the lack of feedback mechanisms, which are an inherent part within the ongoing work of product development. Nor are there feedbacks from markets or from users of the product. Also, the benchmarking, copying and reverse engineering approaches that we expect to see frequently in our cases are not taken into account in this model. This type of copying approaches require purposive research of relevant information, effective interactions among technical, marketing and production departments within the company and interactions with suppliers, customers, local research institutes and universities.

A more suitable approach for us is the 'chain-linked' model for innovation (Kline and Rosenberg 1986). This model is one of the first to be developed on the basis of research in commercial innovation processes in industry. The model describes different interactions, moving away from a linear concept. It projects three different layers on top of each other: 1) product development as the basic level, on top of that 2) the existing knowledge base and on top of that 3) the research currently needed and executed. It makes clear that any product innovation process will first call upon our existing knowledge base for answers, usually in a set of serial stages (1,2 in figure 4-3). If it fails to solve the problem, a justified call for new research can be made (3,4). The model describes further paths between the three layers, including radical innovation (D), by direct application of new science in the development process, and also the sometimes large effects of innovations on science.

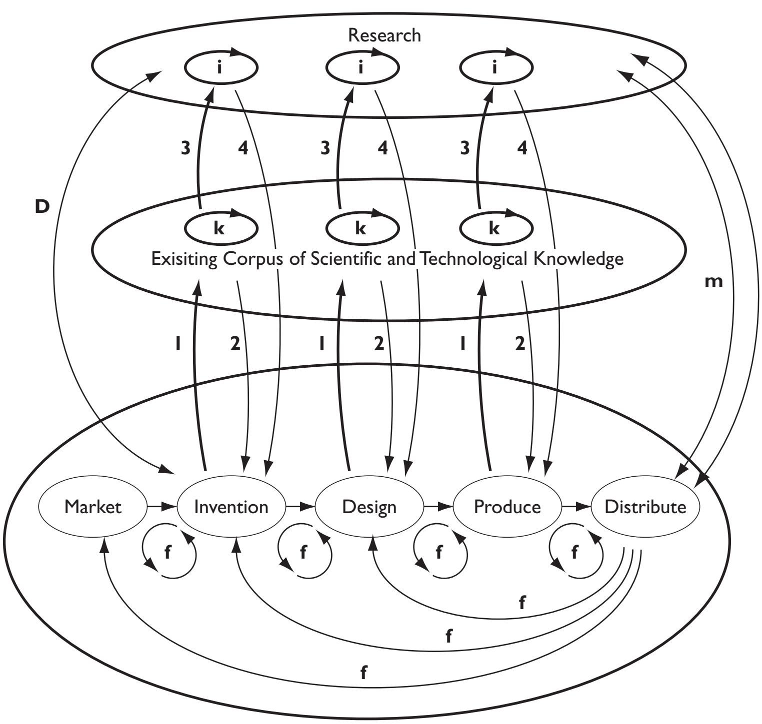


figure 4-3: Chain-linked model for innovation (after Conceicao et al 1995)

This chain-linked model allows us better to describe the interaction between the different 'layers' of research in the ecodesign innovation process. There are still some shortcomings of this model. The horizontal development process is still represented in a very linear way, despite the feedback loops (f) projected. Combination with the Delft product development model where production, product development and market development are separately depicted, solves some of these problems. From the work of Cooper (1983) it becomes very clear that product development processes are non-linear more often than not, and that some of the steps in many cases are very short or deleted altogether. The Delft model gives a more flexible and concurrent structure to include those variations. Further, industrial practice shows many ways to acquire or perform product development still not reckoned with in the chain-linked model. Technologies can be bought, or transferred by copying and reversed engineering. Reverse engineering involves trying to make a product similar or superior to one already available on the market, but without the complete pathway of new product development. It involves the skills of copying, imitation and adaptation. This copying or benchmarking approach is especially relevant for the situation of product development in Central America and is further discussed in section 4.1.4.

The chain-linked model in combination with the Delft model can be used in the analysis of our cases to find out what type of information and knowledge is or isn't being used, and what level of integration of the different necessary development processes is reached.

None of the models presented take into account the role of intermediates, public policy and other actor groups, and the way product developers can take these factors into account. As was showed in the Technology Assessment-approach of PROMISE, the first ecodesign project in The Netherlands, this influence is considerable (Crul 1994; Cramer 1994). Next to this, the effects of meso- and macroeconomic circumstances, non-technical obstacles and stimuli play an important role in the company's innovation process. These elements are also not clearly placed in the innovation models described above. In the innovation model as described by Buijs (1987), there is more attention for an external orientation: the interaction of the innovating entity with its surroundings in different phases of the innovation process. In an iterative and diverging/converging process, the external orientation is an explicit part of the process . This type of notions is of great importance for our study – the notion of internal and external research is an explicit part of all company case studies that will be analysed in this study. More detailed theoretical notions on innovation surroundings and networks are discussed in the next section.

4.1.2 Types of innovations

In our case studies, we can expect different types of innovation to take place. Miller and Morris (1999) have developed a conceptual division of innovation types and corresponding R&D approaches.

Continuous innovations are incremental and take place within existing infrastructures. They build on existing knowledge in existing markets, without challenging underlying strategies or assumptions. The ('3rd generation) R&D systems needed for continuous innovation take into account the R&D, marketing and production of the company, but stays within the boundaries of existing products or services. See figure 4-4.

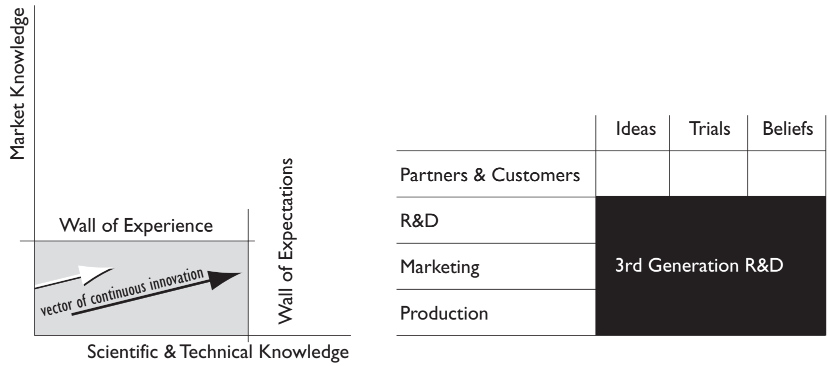


Figure 4-4: Continuous innovations (after Miller and Morris 1999)

Discontinuous (radical) innovation falls outside existing markets or market segments, and when successful applied, rapidly extends and re-defines the market, exposing new possibilities. More often than not, it is performed by companies who had their core-competence in other markets and are able to make the change-over more easily (car makers entering the horse-cart mobility market, 3M entering the note paper market with post-it, Sony entering the camera market with digital, Nokia entering the communication market with mobile phones).

Discontinuous innovation tends to be undirected and unpredictable. A way to prevent this is aiming at fusion innovation: by involving other, new disciplines in a very early phase (widening the total knowledge base on which the innovation is based) the change process is better understood and steered, thus avoiding unpredictable and counterproductive results. The R&D process used for fusion innovation includes the generation of new market knowledge and the creation of new scientific and technical knowledge, 'breaking' through the walls of experiences and expectations early. Customers and other partners are involved early in the entire innovation process (figure 4-5).

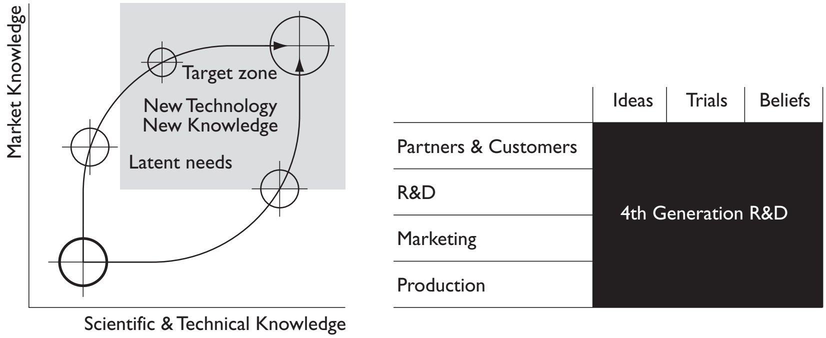


Figure 4-5: Discontinuous innovations (after Miller and Morris 1999)

In the ecodesign project, we can expect that most companies will start an ecodesign project cautiously, and that most innovation efforts will be directed towards continuous innovation. On the other hand, some elements of radical innovation can be expected, because of the connection of the Central American companies to local and European institutes (via DUT) and because of the conscious and integral involvement of the customers and markets in the design process.

An interesting connotation to this topic is that most existing learning theories are more suitable for continuous innovation. For discontinuous innovation, a special kind of learning is required: the unlearning curve (Jaffe and Scott 1997): the difficult process of accepting that old realities, old mental models and old paradigms are no longer valid and must be replaced. Rather than the gradual development curve suggested in the learning curve model, unlearning is a steep plummet that typically bottoms out with the insight that switches denial and resistance into exploration and commitment (figure 4-6).

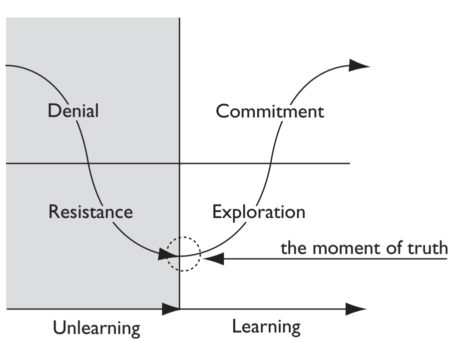


Figure 4-6: Unlearning curve (after Jaffe and Scott 1997)

Unlearning will certainly have to take place in the ecodesign projects. The new 'mental model' that sustainability must be taken into account in all steps of the product development process is a break of the old way of looking at their products for many companies.

4.1.3 Adoption and diffusion of innovations

4.1.3.1 Rogers' model for adoption and diffusion of innovation

The models introduced above all focus on the actual development of technical innovations by the innovators (in our case a company or network of companies). Just as important important for the analysis in this project are, of course, the actual adoption of the innovation by a company and the diffusion of the innovation towards other entities (companies). A standard work on innovation adoption and diffusion is still Rogers (1995), who defines diffusion as follows:' diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special kind of communication concerned with the spread of messages that are perceived as new ideas.

Innovation adoption process

Rogers develops the approach for the adoption of an innovation by another member of the system in five consecutive steps. First, the knowledge of the existence and gains of a certain innovation is received by the 'decision making unit' of the adopter. Then, the entity is persuaded (can be towards a favourable or unfavourable attitude towards the innovation) by the perceived characteristics of the innovation. This leads to a decision: engaging in activities to adopt or reject the innovation. In case of adoption, the entity then implements the innovation, putting the innovation into use. Last, the entity that has adopted in the first place, will seek confirmation that the choice to adopt was the right one. If this confirmation is not reached, the adoption can be rejected after all. Entities rejecting the innovation in the decision phase can either continue the rejection or come to later adoption. In figure 4-7 these steps are depicted with their respective prior conditions and characteristics.

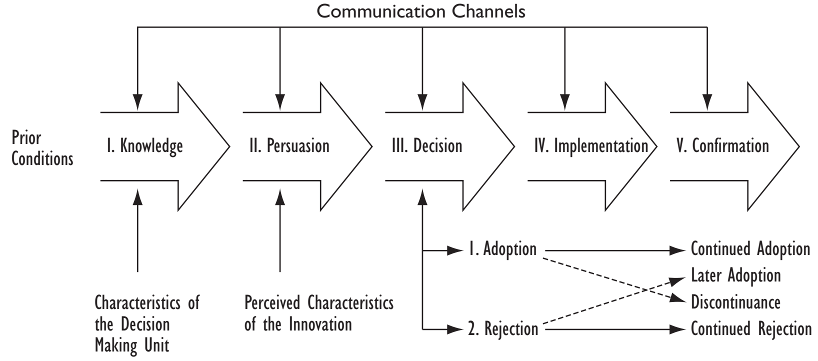


Figure 4-7: Adoption of an innovation (after Rogers 1995)

The adoption of innovations in larger entities, such as larger companies, will be different from the model for an 'individual' or very small company described above, because of the more complex system of decision making that marks a larger organisation. Small companies will have an adoption process that is still pretty close to the way an individual adopts an innovation. However, larger organisation will have a more formalised decision making process. Rogers discerns between two main activities: the initiation phase, defined as the process of information gathering, conceptualising and planning for the adoption of the innovation, and the implementation phase of that will include all action involved in putting an innovation to use (Rogers 1995). As in the case of individual adoption, the phases of the model can be taken iteratively and in a different order.

Diffusion: Adopter categories

Individual companies or entities in a social system adopt an innovation in an over-time sequence, thus forming a resulting diffusion pattern of the innovation. Companies can be classified in adopter categories on the basis of when they first begin to use the new idea. This pattern usually follows a normal, bell shaped curve plotted over time on a frequency base, or an s-shaped curve in cumulative numbers of adopters. In the beginning, only a few companies adopt the innovation, numbers quickly growing when the added value of the innovation becomes clear, and dropping again when the curve gets to saturation for this specific innovation. New upcoming innovations will further reduce the adoption to a minimum (figure 4-8).

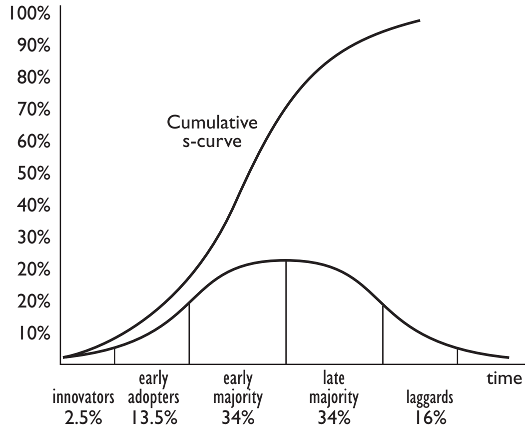


Figure 4-8: Typical diffusion pattern of an innovation over time.

Rogers characterizes the different categories typically as:

- Innovators: venturesome, cosmopolitan, daring, risky
- Early adopters: respected opinion leaders, localites, successful
- Early majority: deliberate willingness to adopt innovation, but seldom leading
- Late majority: sceptical, cautious, playing safe
- Laggards: Traditional, isolated from information, lengthy decision process.

Critics to the model

The adoption and diffusion model of Rogers that is described above is a conceptual, multidisciplinary paradigm that cuts across many fields. It also has a pragmatic appeal since it provides connections between research-based innovations and the potential users of such innovations.

Critics to the general model of innovation diffusion emphasize the pro-innovation bias of the model. Usually the actors involved in the projects/research want the innovation to be diffused and adopted by all members of a social system, want it diffused more rapidly and do not want rejection. As a result, much more is known about innovation successes and not enough about innovation failures. Overcoming this bias means that much more emphasis must be laid on acknowledging rejection and discontinuance behaviour as rational and appropriate, by studying the context of the innovation better, and by studying the actual motivations for the adoption better.

Another bias is the tendency towards 'individual-blame' in many innovation adoption models and studies. The variables used in many of the models are used to indicate the adoption success or failure of the individual within the system rather than as indications of success of failure of the system itself. For instance, late adopters or laggards (see below) are often 'blamed' for not adopting ('resistance to change, irrational'…), and 'punishment' systems are envisioned in the case of legislative and governmental involvement (such as command and control approaches in Cleaner Production). A more careful analysis could show very different reasons for not adopting the innovation, which are embedded in the whole system.

Rogers' adoption diffusion model is initially developed on the basis of experiences in agriculture, where there are many small companies that are producing identical products for commodities markets. This is not the market situation that we will find in most of the companies in our project. The total process of diffusion of innovation must be seen as a much richer and more complex process of change than the sum of all the individual adoptions in the system. Brown (1981) emphasises elements that have to be taken into account, such as the market and infrastructure, and the economic and historical context of the innovations studied. This market approach takes into account, that different adopters do not have the same access to the market, or access to the necessary infrastructure. The economical-historical aspect adds the continuous development of the innovation, while diffusion takes place. Market and price are adapting to that development, and so is the ongoing diffusion process.

For the application of Rogers' *individual* adoption model to the ecodesign project, it can be argued that it is still applicable. For the majority, the participating companies are small, family-owned companies that can be expected to show an individual adoption process close to that described by Rogers. There is a 'pro-ecodesign' (innovation) bias in this project as well by the selection process of the companies, but this is part of the case study design and does not invalidate the individual results as such. The systems focus is taken into account in numerous other, complementary criteria to do justice to the full complexity of the system. For the diffusion of ecodesign as an innovation, Rogers' diffusion model is not directly applicable, and we will have to focus more on evolutionary and institutional/networking models as described further on in this chapter.

4.1.3.2 Evolutionary and institutional models: focus on networks

Nelson and Winter (1982) developed a theory of economic change that included an evolutionary theory of technological change. The theory uses the biological evolution metaphor to describe the innovation process. The principles of variation and selection are taken into the realm of innovation: firms search for new ideas (i.e. technological innovations) to make changes. Some grow within the firm, other decline. R&D of the firm is generally directed to create something that did not exist before and is modelled as a probability distribution for coming up with new ideas. This distribution is considered to be a function of time, R&D policy, and local circumstances. Within these variations, selection takes place in the 'selection environment', a much broader concept than only the market: it encompasses institutional forces, legal regulations, government rules, financial institutes, consumer preferences and norms. This selection environment determines which technological innovations will succeed or fail. Since firms will try to influence their selection environment, selection is not random but steered. In order to deal with uncertainty and risk, firms tend to innovate along technological trajectories. Industries differ considerably in their ability to exploit these 'natural' trajectories. An important concept in evolutionary theory is path dependency: the standard technology or dominant design that exists depends on a path that is 'accidentally' chosen and followed, and eliminates the existence of other standards/designs.

Important for this study is the notion, prominently formulated in the evolutionary models described above, that many innovations will take place in a network of interdependent, involved actors, that is formed and re-formed parallel and in conjunction to the continuous technological development. Silvester (1996) names this total concept of connected actors that are involved in the generation and the adoption of an innovation the Innovation-diffusion network. This concept is close to the concept of a 'theatre of innovation' as developed by Engel (1997).

In later editions of his standard work on diffusion of innovations, Rogers (1995) also focuses more on the interpersonal network of individuals, and the communication patterns within. Opinion leaders influence informally other network members in the desired change direction, as an interim step from mass-media information flow (two-step flow model). Interpersonal diffusion in networks flows mainly via more similar (communicating) members of the network. Networks provide a certain degree of structure or clique formation. Individuals tend to be linked to others who are physically close to them and of relative same social characteristics. However, the information exchange potential of a network is negatively related to this proximity and similarity of its members, also called the 'strength of weak ties'. Reasoning behind this, is that similar, close members already have shared most of the information among themselves. The critical mass of innovation diffusion is reached when enough individuals have adopted the innovation that the further adoption becomes self-propelling. This is the case in non-interactive innovations, where each future user benefits more (e.g. lower price of the product) – so-called sequential interdependence. It is particularly the case with interactive innovations, where the addition of each new user increases the utility of the innovation itself (f.i. email) for both each future and each previous adopter – so-called reciprocal interdependence.

Mulder (1992) describes a number of characteristics of technology networks, consisting of organisations rather than individuals that are important in innovation diffusion:

- *Size*. The network will usually grow during the diffusion, being small in the beginning for competition reasons. However, a small network is more vulnerable for external influence, so to enhance the amount of diffusion of a desired innovation, the network involved should also grow.
- *Pluriformity*. The extent of pluriformity is twofold: many different actors, or much pluriformity within each actor group. More pluriformity means less steering possibilities, but usually higher stability of the network.
- *Prominence*. Prominent actors in the network will influence the directions taken in the network stronger, and often have more connections inside and outside the network.
- *Relational strength*. The relations between actors are strengthened when specific tasks are actually realised, and the chance of success is growing. Risk reduction also strengthens the relations, since in a network each partner is at risk when another partner does not realise its tasks.
- *Integration*. Stability of a network increases with integration, i.e. the extent to which actors have relations with other actors. A high integration level makes it more difficult for an individual actor to leave the network
- *Openness*. Technology networks are often very closed during technology development, due to sever competition. During diffusion of the innovation a much higher degree of openness is necessary.
- *Resources*. Knowledge, experience, funds, information, reliability, patents are all necessary resources in a network. The necessity to enlarge the network is reverse proportional with the availability of resources within the network. Resource-poor network are more outgoing and are more prepared to adapt roles and positions. Weak relations with outside actors can, however, be an important source of information (e.g. customers of the competitors).

Engel and Salomon (1997) found that the performance of innovation networks depended heavily on:

- The level of optimisation of *diversity* of actor groups involved
- effective internal and external *communications*
- *transparency and agreement* among different actors with respect to interests and objectives, formation of *resource coalitions*
- the degree to which tasks are *divided and coordinated* within the system, so that relevant knowledge networks are activated and people acquire a shared sense of direction.

Innovation networks are difficult to steer, but network management can influence the characteristics of the network in such a way, that the probability of a desired outcome are enlarged. De Bruijn et al. (1993) distinguish several strategies for network management:

- *Selective activation* or changing the networks composition: conscious in/exclusion of actors.
- *Stimulating 'role-play'*. Facilitating the actual fulfilment of certain necessary roles by certain network partners.
- *Stimulating interaction*. Improving information exchange about problems, targets and interests can contribute to changing perceptions and enhanced trust.
- *Influencing rules*. Conflicting interests can sometimes be brought together by agreeing on procedures en rules for the coming activities.
- *Strategic use of steering instruments*. Choice and use of steering instruments must be guided by the possibilities to influence the behaviour of network partners, with less emphasis than perhaps wished on the ultimate objectives.
- *Putting the resources to use*. Strategic (re)division of resources can be used to influence positions, power and dependencies in the network.

Another theoretical approach that can be used to analyse company's inclination or resistance to change, is institutional theory. Institutional theory (Powell and Dimaggio 1991, Oliver 1991, Zucker 1987, Meyer and Rowan 1977) emphasizes the pressure and constraints of the institutional surroundings on the behaviour of a company. Institutions are defined as rules, both informal rules such as norms, customs, habits, and formal rules such as laws, regulations, and standards. Institutions in this sense are connected to state and profession, such as regulatory structures, laws, courts, education, and governmental agencies, and next to this also to public opinion, pressure groups and other interest groups that influence industry. Two strands of reasoning on the influence of institutions are developed: One is, the organisation mirrors the existing societal conventions, traditions and values, the other one is that organisations copy each others behaviour and converge towards some norm: converging peer organisations, shaped by mimicry and compliance. In this last strand of reasoning, Powell and Dimaggio (1991) develop three different types of isomorphism - the process through which organisations in the same line of business become homogenous:

- coercive isomorphism: often mandated by government regulation,
- normative isomorphism: induced by performance benefits and development of professional understanding
- mimetic isomorphism, motivated by a desire to 'fit in', by copying or benchmarking of early or prestigious innovators.

The mechanisms for change that emerge from institutional theory take place in the institutional surroundings of the companies. These institutional surroundings overlap to a large extent with the innovation-diffusion networks mentioned earlier.

The focus on networks on ecodesign diffusion is of high importance in this study, since several of the key innovation diffusion mechanisms formulated in the networking and institutional theories above take place in those networks. These networks are taken into account in the analysis of the case study results. In Chapter 5, the network model for the case study companies will be further developed.

4.1.4 Benchmarking approaches for product development

In most industrialising countries, copying is the prevalent road to developing new products. Romijn (1996) finds for small sized metal companies throughout the developing world, that 'replication' of new, and increasingly complex products is the primary means through which new technological knowledge is assimilated in the firms. When firms advance, experimentation becomes a systematic activity, and copying is not only done from prototypes but also from blueprints, preceded by designing activities.

Imitation is a successful and prevalent road to business growth and profit (Schnaars 1994). Although the merits of innovation, such as first-mover advantages and order-of-entry effects, are indisputable, Schnaars claims that the benefits of innovation are grossly oversold, and shows many examples where imitation is the preferable choice of market entry. Imitation can both be practised as a pioneer (being the first bringing a (copied) product to the market) and, in most cases, as a later entrant with products that are at least in some aspects copies of pioneers. Note that later entrants can be innovators in some cases (f.i. VHS video system, entering after Sony's Betamax, but independently developed). Schnaars (1994) describes four types of copies: Counterfeits (f.i. in clothing, shoes, etc.), legal knockoffs/clones (sold at lower price, same or lower quality), design copies (f.i. Lexus cars) and creative adaptations (which improve some aspects of the earlier entrant). Imitators use – a combination of – the following strategies to enter the market successfully:
1. offer lower prices
2. make a better product "imitate and improve"
3. use their market power against a weaker pioneer

The ecodesign approach mainly facilitates the use of the second strategy to be combined with the low price strategy. It can be argued that ecodesign should be focused mainly on this improvement strategy – probably this is the area where there is more to gain than in the price reduction field.

Factors improving the chances for imitators can be focal points for (eco)design:
- Circumvent patents: modify designs in such away that patents are not infringed.
- Later entry still needs R&D efforts
- Imitators react to market potential, not to first movers
- Avoid copying too closely
- Stress continuity rather than radical technological change

Freeman (1982) describes six alternative innovation strategies of firms, of which several are connected to benchmarking and imitation approaches:
- *Offensive*: designed to achieve technical and market leadership. R&D plays a key role in this strategy.
- *Defensive*: avoiding heavy risks of being the first, neither wishing to be 'left behind' – catching up or leap-frogging is the strategy. The difference with offensive lies in the timing and nature of the innovation.
- *Imitative*: following (a long way) behind the leaders in established technologies, little R&D investments, using a low-cost or cosmetic improvement approach

- *Traditional*: based on craft skills, virtually no scientific input. Demand can be strong, but the strategy is vulnerable to exogenous technical change.
- *Opportunistic*: identification of new rapidly expanding markets, where quick 'in and out' strategies can work.
- *Niche*: Specialising in a specific niche market, with dedicated technologies and products, but often with limited growth potential after the initial phase.

4.1.5 Success factors for innovation

Can we predict if a certain innovation will be a success? Many empirical studies try to get a grip on this issue by defining the attributes and characteristics on the innovation system that contribute much to its success. It is of importance to our cases to select characteristics that we can use as criteria for the analysis of our case study result. Some relevant examples of such studies on general innovation are given below.

Several empirical studies describe critical success factors for successful innovation at company level. These factors are presented in table 4-2. There is quite a variety in the factors that the different authors are selecting, that can be traced back to the different viewpoint of the studies. Some of them are clearly connected to high-tech or large companies, which is less applicable in the situation of the cases in this study. Together with the specific ecodesign factors described in the next section, a clearer picture of key factors relevant for this study will arise, and the most important factors will be selected.

Table 4-2: Key factors for successful innovation as found in several empirical studies.

Source	Key factors for successful innovation
Cooper and Kleinschmidt (1995)	- High quality new product development process - Clear and well-communicated new product strategy - Enough resources available for the innovation process - Senior management commitment
Saren (1990)	- Strategy development and – selection - Economical factors - Social and behavioural factors - Information and communication factors - Organisation and management factors
Buys (1987)	- Healthy economic situation of the company - High rate on independency - Explicit marketing strategy - High technological level - Process-oriented consultancy approach (which was more successful than the technical or management-oriented approach)
Kleinknecht (1992)	- Export orientation - R&D expenditure (both absolute and per man-year) - Using of subsidies and joint R&D programmes - Applying for patents - 'Modern' sectors innovate more than traditional ones

4.1.6 Relevant findings from innovation theory

What theoretical insights from innovation theory can contribute to better understanding of the research questions in this study? Innovation theory as presented in this chapter is mainly connected to the research variable of adoption of ecodesign in the case study companies.

The application of the model for product innovation from Roozenburg and Eekels (1995) will be central in the cases, since it is already at the center of the approach detailed in the ecodesign manual. Analysis of the use of this approach will shed light on the level of systematic product development possible, and on the level of concurrent product and market development that is important for the life-cycle concept of ecodesign. The chain-linked model for innovation (Kline and Rosenberg 1986) will allows us to analyse the use of the different levels of information and knowledge that are used – or not used – by the companies. This is closely connected to the notion that benchmarking is a dominant type of product development, for which existing information and knowledge of competitors and companies outside the region is essential. The influence of intermediates and other actor groups on the innovation process is stressed by several authors (Buys 1987, van Hemel 1998). Active information seeking outside the direct surroundings of the company is therefore an important factor for innovation. The type of innovations as described by Miller and Morris (1999) that we can expect in our cases will be mostly of a continuous nature. The companies will start with ecodesign cautiously, most of them staring with redesign of existing products, staying within the boundaries of existing systems. Rogers' model for the adoption of innovations in an individual company is expected to be valid also in our case study companies. The level of adoption reached will indicate the acceptance of the ecodesign concept, and the possibilities for successful results of the ecodesign project. The diffusion model from Rogers is expected to be less applicable, because this depends on a variety of other factors besides the sum of the individual adoption processes. For this, we have explored evolutionary innovation models, showing the importance of innovation-diffusion networks (Nelson and Winter 1982, Mulder 1992, Silvester 1996). Connected to this is the notion that the institutional surroundings of a company influence its behaviour on change and innovation (Powell and Dimaggio 1991). Analysis of the networking behaviour of the company therefore is expected to be relevant. Benchmarking as the dominant product development approach can be found in most of the cases in less industrialised countries (Romijn 1996) – so this can also be expected in our case studies. The key strategies that can be observed will be on price competition and on product improvements.

4.2 Ecodesign

4.2.1 Ecodesign concept and approach

Ecodesign is defined in this study as the "design of products, processes or systems with the entire life-cycle (of the product) in mind, aiming at minimisation of the environmental impact". Ecoredesign is then defined as the redesign of products in such a way, expressing the fact that an existing product serves as starting point for the product development process. In practice, the term ecodesign is often also used for ecoredesign projects. Also, the term Design for the Environment (DFE) is considered here to be synonym to ecodesign. Sustainable Product Design has the concept of 'sustainability' inside and, therefore, goes beyond the definition of ecodesign: SPD also integrates social and ethical aspects of the products' life-cycle alongside environmental and economic considerations – aiming for the so-called 'triple bottom line' (Tischner and Charter 2001) In practice however, many projects where the inclusion of those additional social and ethical factors is not so obvious are also labelled as SPD projects. Also, operationalisation how to tackle those social and ethical factors is far from easy.

Surfing the s-curves

The key concept for ecodesign can be seen as part of a spectrum of s-curves of environmental innovation, describing the different levels of environmental improvement of products and systems (Brezet 1997) (figure 4-9):

- eco-(re)design of products, typically resulting in a maximum factor 2 improvement (50% reduction of environmental impact)
- function innovation: sustainable product innovation, aiming at a factor 4-8 improvement of product systems on a functional level
- system innovation: efforts to reach a sustainable society, aiming at factor 8-20 improvements on a systems level

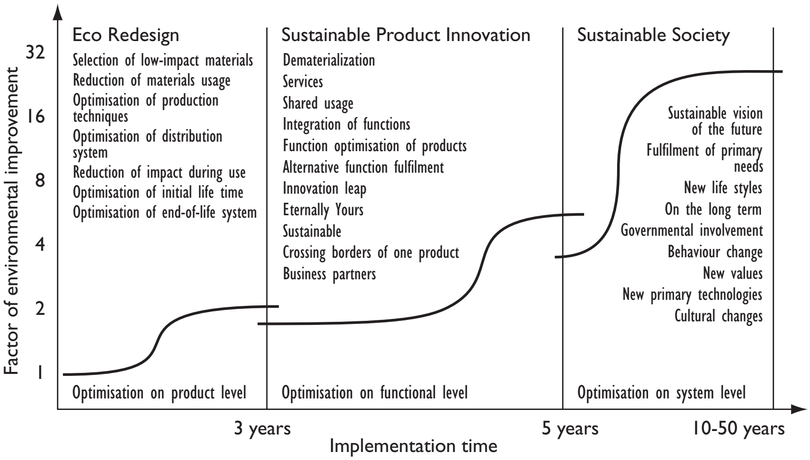


Figure 4-9: S-curves Spectrum of environmental improvement approaches (after Brezet 1997)

There are many examples of company cases that yield a factor 1,1 (or 10%) environmental improvement to factor 2 (or 50%) of improvement of products. (te Riele and Zweers 1994, Brezet and van Hemel 1997, van Hemel 1998, Gertsakis et al. 1997). In many of those the environmental impact improvement is not calculated integrally using an extended LCA type of assessment, but some key topics such as materials use, energy use and use of toxic substances are estimated. Sometimes, the improvement factor is calculated on the basis of one key topic, such as total weight of materials or energy use. After this first 'wave' of product-oriented cases, the focus shifted to product-service systems in the mid-nineties. The first experiences on this level of functional change, so including the service system and aiming at factor 2-4 improvements, were gathered, many of those studies still being more on the conceptual than on the practical level (Mont 1999). Methodologies for this type of function approaches are under development, see f.i. van der Zwan and Bhamra (2003). It appears that getting to factor 4 environmental improvements is complex, although von Weizsacker et al. (1997) show some interesting cases in various stages of development. Also Manzini and Vezzoli (2003) come up with a number of cases of product service systems in Italy, although the environmental improvement factor is not specified in those cases. Overall, experiments with dematerialization and product-service systems until now show that it is not yet easy to reach high improvement levels. There are many environmental effects related to the (new) service system that replaces the existing product, including new products and use of products in delivering the service, as well as unexpected side-effects (f.i. car-sharing on top of unchanged car ownership) and increased consumption of the function delivered by the new product-service system.

In a review on these types and order of strategies, Ehrenfeld and Brezet (2001) put questions at this 'conventional' wisdom stating that the differences between products and services are far less obvious than assumed, thus clouding the basic design issues aimed at finding more sustainable ways to satisfy demand. They propose to drop the notion of stages since an orderly procession in terms of sustainability has not been established. In their scheme, the relevance of institutional behaviour (rather than 'services') and user behaviour are stressed as more important determining factors.

As a choice for our study, we will focus on the basic concept of ecodesign of products, since all cases but two are focused on this level. The service approach is taken into account in one case – the tourism service of offering rafting trips. A wider systems view, including production steps, is taken in the case of an agro-food project.

Developments in ecodesign praxis

Stevels (2001) describes the development of applied ecodesign in industrialised countries as a shift from demo projects following manuals (mainly the UNEP manual) in 1990-1995 towards integration of ecodesign in organisations by identifying generic drivers (1995-1998). Modern applied ecodesign (1998-2001) is dealt with as a strategic management approach, embedding it in the total business of companies. In addition, models for systematic product-oriented environmental management systems have been developed and tested (Rocha and Brezet 2001). Integration with

Environmental Management systems is sought, as well as compliance with ISO 14000 standards. Integration is needed both in the operational cycle of environmental management as in the overall strategic vision, policy and planning.

In a survey of the status of ecodesign in Europe, with special emphasis on SME's, Tukker et al (2000) find three clusters of countries according to the nature of support they offer for Eodesign and SME's. They range from countries with a diverse system of support structures (The Netherlands, Germany) to countries with a limited system (f.i. Italy, Ireland). For this last category, probably most comparable with our region of research, specific policy is missing, the regulatory context is on a basic level and there is no redundancy in networks and expertise to cover Ecodesign. It is also stated that under these circumstances, more local/regional, cultural and social aspects have to be taken into account to create awareness for the problems and the solutions offered.
In a literature survey on the green product development field, Baumann et al (2002) note that less than 10 % of the 650 articles surveyed is empirical, most of the rest being conceptual and normative or prescriptive in nature. They note the following shortcomings in the current body of knowledge in this field: little practical relevance, too much tool development, too little linkage between strategic intent and content, too little about the larger context and too little attention for system's perspectives. The authors plead for a systemic perspective including ecodesign to other processes in the firm, and external processes of competition, cooperation and policy development.

In relation to the predominant European context described above, the project in Central America can clearly be described as an initial effort in ecodesign for this specific region. The advanced level, both in company management and in government policy that can be found in Europe, is not yet encountered in this project. This further justifies the focus on developing local case studies and local networks in the region first, while policy development and legislative instruments development will have to follow in a later stage.

4.2.2 Empirical findings on ecodesign and environmental innovation approaches

The application in industry of the UNEP Ecodesign manual was never formally tested and evaluated. Practical experience with the approach has made clear however, that for the first project in a company in most cases a brief version of the total approach is used. The company integrates the ecodesign approach into their own development process, using the manual more as a reference book. More detailed information on the use of the UNEP manual itself is not available.

However, there is empirical work done in Dutch projects that uses approaches very similar and closely related to the UNEP approach. From this work some key factors that stimulate ecodesign and some barriers can be identified.

Success factors

Van Hemel (1998) tested the approach taken in the ecodesign dissemination project in The Netherlands. This project used an ecodesign approach that is directly related to the UNEP manual approach, and uses the same key tools. Van Hemel finds the following internal and external stimuli as most important for the start with ecodesign in a survey of 74 companies that participated in the project:

Internal stimuli top-three:

- environmental benefit
- cost reduction
- image improvement

External stimuli top-three:

- environmental demands of customers
- governmental regulations
- new developments at suppliers

Van Hemel found, that the actual influence of internal stimuli on the success rate of an ecodesign project was much higher than that of external stimuli.

Lentz (2001) gives a description of conditions at company level for sustainable product design, focused on less industrialised countries. The growing need for exporting companies to comply with international standards is seen as a key opportunity for environmental improvement. For local oriented companies, the still inefficient resource flow (and additionally needed high-cost imported technology and chemicals) can be a good starting point for basic cleaner production, ecodesign and good housekeeping measures, giving quick and low-investment returns. With the current expensive import of materials, there are opportunities for basic local recycling systems.

Barriers

The three most important barriers for ecodesign in the research of Van Hemel (1998) are the potential for conflict of ecodesign options with functional requirements for a product, the absence of a clear environmental benefit, and commercial disadvantages. Crul (1994) presents an overview of the specific barriers found for ecodesign in the practice of 11 companies in the first Dutch ecodesign project. He finds a lack of innovative attitude and vision of companies, combined with insufficient knowledge, experience and expertise. The companies are also uncertain of market possibilities for eco-redesigned products. The government provides industry with an unclear regulatory framework, and overall there is a low societal pressure for environmental improvement of products. The obstacles Lentz (2001) sees for companies in less industrialised countries are lack of environmental consciousness, and the international labour and industry division, forcing companies towards high-energy and high-waste primary production. Companies do not have a choice to change towards higher value production. Also, local legislation is not providing incentives for companies to reduce waste generation or energy and materials use.

Company characteristics

For the Dutch ecodesign companies, Van Hemel (1998) found the following characteristics connected to ecodesign-success. The highest success rate is found in companies:

- belonging to a certain branch of industry
- having product development as core activity
- having innovation potential
- having an environmental management system
- having a positive attitude towards ecodesign

Next, the following product characteristics have a relation with ecodesign success:

- products that are under environmental pressure
- products that have increased commercial opportunities by ecodesign
- export products
- industrial rather than consumer markets
- products needed to be redesigned
- newly launched products

Key respondent (manager's) characteristics that enhance the chance of success are:

- positive attitude towards ecodesign
- enthusiastic about project
- high innovation ambitions

General Eco-innovation characteristics

Next tot the ecodesign-oriented studies, more empirical work is done on the success/fail factors and characteristics of broader eco-innovation in industry, so not restricted to the product of the company.

Cramer (1990) identifies three generic key problem clusters for environmental innovation in industry. First, there is a general lack of expertise and know-how, and a limited willingness and capacity for innovation in industry itself. On the demand side, there is a lack of clear (societal) demand for environmental innovations.

An extensive empirical study into environmental innovation in the printing industry was executed by Groen (1994): Four clusters of 'capital' for a company were identified: political, cultural, social, economical capital. In this study, the correlation with innovation success appears weak for all clusters; there is some connection with social and cultural characteristics of the companies.

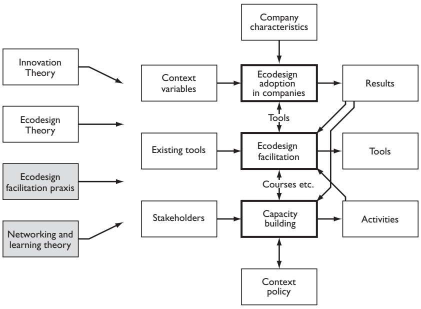
Fussler (1996) emphasizes the need for network-oriented companies, in a changing world of geographical transitions, environmental stress and restructuring value chains. Characteristics of this type of network of companies are the unifying purpose the network has, the independence of its members, and the voluntary links between the members. The network is further characterised by multiple leaders and multiple integrated levels.

4.2.3 Concluding remarks on ecodesign praxis

Eco(re)design of products can be seen as the lower and intermediate part of the spectrum of environmental improvement stages for product-service systems. Typically, environmental impact reduction factor 2 is the maximum to be reached in this type of projects. Higher factors are expected to be reached with product-service and systems approaches, but empirical data available until now show that this is a complex undertaking. In the case studies, we will mainly encounter eco(re)design cases. A start is made in Europe with integration of product aspects in environmental management systems, which ensures the continued attention and efforts in this direction.

For our case studies, the most important stimuli and characteristics (internal and external for a company) found for ecodesign by Van Hemel (1998) seems to be the most relevant to use in the analysis. Several of these factors are replicated in other studies cited, such as environmental benefit/improvement, market/customer demand, regulatory pressure and economical factors. Also, the generic characteristics of company leaders are of great influence to the success rate, and can be of interest for the further analysis of the cases. This factor is also encountered in empirical studies on non-environment related innovation.

Chapter 5: Facilitation and learning



In this chapter theory and experience with several facilitation and capacity building approaches will be described that can be of importance for the analysis of ecodesign facilitation. The central facilitation approach in the project is the application of an ecodesign methodology, which is described in the first section. In the next section, a number of facilitation and capacity building approaches and concepts are described, and in section 3, attention is given to learning theories as this can be seen as the unifying process in all facilitation and capacity building efforts in the project. Last, Learning in local networks as are being formed in the project is dealt with in section 4.

5.1 Methods and tools for Ecodesign

In the practice of the first part of the Central American project, the approach of the UNEP manual "Ecodesign, a promising approach" (Brezet and van Hemel 1997) was used, which will be detailed below. This manual is based on the original Dutch PROMISE manual (Brezet et al. 1994). There are many more ecodesign methods developed from 1990 on, and several efforts have been made to categorise the available methods.

An overview of the methods published until 1998 is given in the 'Ecodesign Navigator (Simon et al 1998). The Navigator is not a consistent ecodesign method itself, but analyses most of the existing methods and tools for ecodesign, and categorizes them according to their main emphasis on one of the ecodesign stages (analysis, reporting, prioritisation or improvement), and on the level of detail (systems, products or components). In the overview in figure 5-1, the categorization of tools as defined in the Navigator project is given.

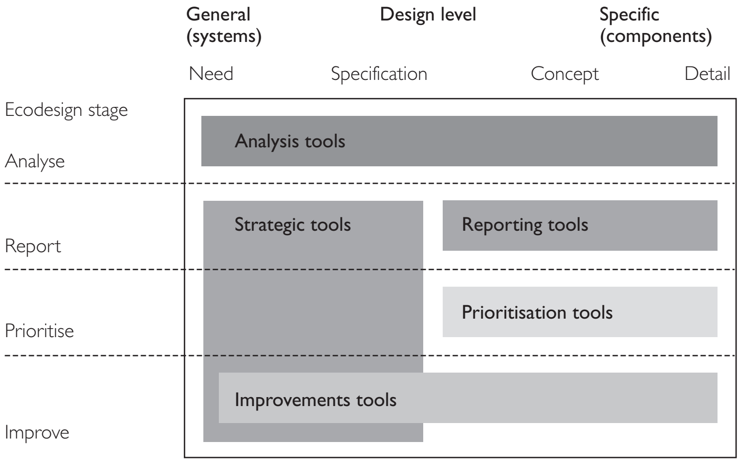


Figure 5-1: categories of tools in ecodesign manuals (Simon et al 1998)

The Analysis tools are separated into two groups, those based on LCA or those more focused on particular environmental issues such as disassembly, restricted materials or regulatory issues. The strategic tools are more relevant to management issues than technical issues. They aim to improve interaction within the design team and between design, environmental specialists, management, marketing - indeed, all subdivisions within a company. Hence, a number of the tools are based on workshop sessions or seminars. Prioritisation tools are necessary in order to determine which environmental issues are most important to product development, tools such as environmental performance indicators or prioritisation workshops. Improvement tools are required to actually take action in Ecodesign, these tools have been divided into guidance tools such as handbooks and project based tools (concept demonstrators and pilot projects).

Diehl and Brezet (2003) analyse the ecodesign manuals published since 1997. In addition to eight translations and adaptations of the UNEP manual, eight other manuals were taken into account. Over 60 ecodesign tools were presented in the manuals. Most of the tools focus on environmental analysis. Far less tools are available for generating design improvements for the environmental problems encountered. Also, tools for financial aspects of ecodesign are very scarce. The autors recommend that the current approach of the UNEP manual for eco(re)design should be extended with eco-benchmarking and eco-innovation approaches such as product-service systems, new technologies and emerging markets.

Baumann et al (2002) describe the 'engineering perspective' on green product development, in which they include research on environmental design strategies, methodologies and tools/techniques, of which over 150 were identified. They divide the tools into six categories.

- Frameworks contain general ideas about what should guide the product development process, supplemented with toolkits and (strategic) guidelines.
- Checklists and guidelines are qualitative tools, listing issues to consider in the development process.
- Rating and ranking tools are simple quantitative tools, typically giving a pre-specified scale for assessment.
- Analytical tools include comprehensive quantitative tools for evaluating and measuring environmental performance, such as LCA.
- Software and expert systems are designed to systemize and handle large amounts of information.
- Organising tools give direction on how to organise the process of ecodesign in and outside the company.

The authors conclude on the engineering perspective that there most references are conceptual. There are few references that describe the diffusion and experience with the tools.

So in terms of these descriptions, what is the place of the manual used as an initial methodology in the Ecodesign project in Central America, the UNEP manual?

The UNEP Ecodesign Manual

The ecodesign approach as described in the UNEP manual, is categorised by Simon et al. (1998) as an 'improvement' tool. Although this is indeed the key focus of the manual, there is more. It includes simple analytical tools, strategic tools and prioritisation tools. Baumann et al. (2001) nominate the UNEP manual to be the reference material on ecodesign. In their typology, the UNEP manual is a framework tool, and includes an organising tool, checklists and guidelines tools and analytical tools. Diehl and Brezet (2003) take the UNEP manual as point of departure, since their paper is focused on possible recommendations for an update of this manual. They list 10 manuals that are directly derived from the UNEP manual, and 8 other manuals. Key tools of the UNEP manual are found widespread in other manuals as well.

The approach in the UNEP manual describes a step-by-step method that allows companies to initiate and carry out their own ecodesign projects.
The seven steps are

- organizing an ecodesign project
- selecting a product
- establishing an ecodesign strategy
- generating and selecting improvement ideas
- detailing the concept
- communicating and launching the product
- establishing follow-up activities

Each of these steps has a number of detailed activities, see figure 5-2.

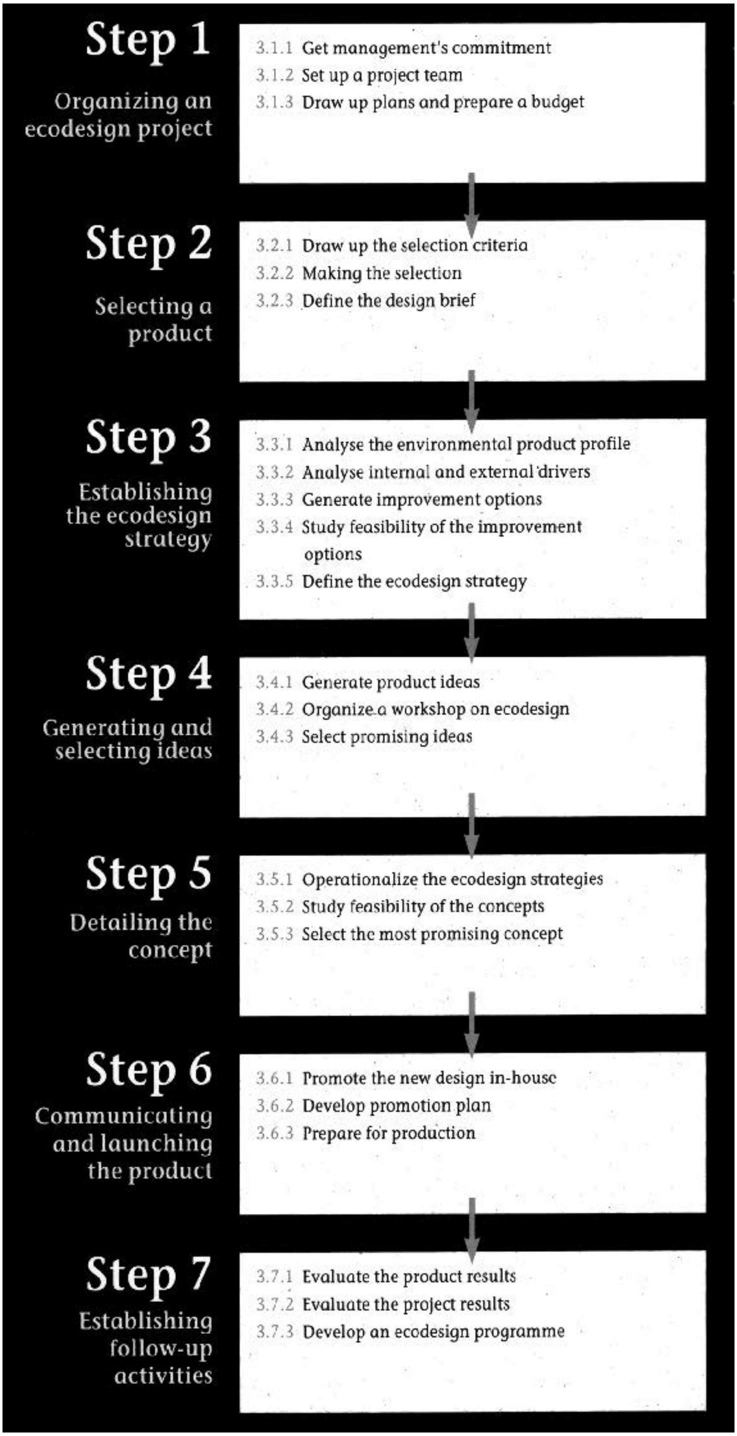


Figure 5-2: Steps of the UNEP Manual (Brezet and van Hemel 1997)

The manual is designed to stay close to a number of key standard approaches: it follows the common steps of the product development approach: target & strategy development – idea generation – detailed design – realisation (see section 4.1). Also, an effort is made to make it as much as possible compatible to many Cleaner Production assessment approaches, to facilitate integration of both process and product oriented environmental approaches. Next to the step-by-step approach, a number of tools are integrated in the manual. Key tools are the Eco-portfolio matrix - a strategic tool for selection of the right product to start the project with, the MET matrix - a simplified analytical tool, the ecodesign strategy wheel - an improvement tool that is used on various levels. Prioritisation tools such as the eco-indicator are included in the additional modules of the manual. Two key tools that are used extensively in the cases are the MET matrix and the Strategy wheel. The MET matrix analysis all the types of environmental impacts that a product can have in its life cycle (see figure 5-3 for an example).

		Material cycle Input/Output	**Energy use Input/Output**	**Toxic emissions Output**
Production and supply of materials and components		• copper (exhaustible material) • zinc (exhaustible material)	• high energy content of materials	• fire retardants in printed circuit boards • flow improvers for injection moulding • PS: benzene emissions • PUR: isocyanate • emissions due to painting and gluing
In-house production		• metal waste • plastic waste	• process energy	
Distribution				
Utilization	**operation**	• plastic cups (1.472 kg PS)* • filter paper (90 kg)* • used coffee (2.944 kg)* • plastic spoons (110.4 kg PP)* • cleaning materials • polluted water (4.160 l)* • water filters (20)*	• ***inefficient energy use by boiler*** • transport energy	
	servicing	• easily broken parts	• transport of service providers	
End-of-life system	**recovery**	• ***no reuse of valuable parts such as boiler*** • ***disposal of coffee machine (37 kg)*** • ***packaging*** • ***no recycling of plastics*** • ***plastics (5 kg)*** • ***print plates (0.5 kg)***		
	disposal			• ***printed circuit boards (0.5 kg)*** • ***copper*** • ***zinc***

* Figures are calculated for a consumption of 4 cups of coffee daily by 40 persons, during 10 years

Items requiring attention

Figure 5-3: MET Matrix applied to a professional coffee machine (source: UNEP manual on Ecodesign (Brezet and van Hemel 1997)

The environmental effects are grouped in three key areas: Materials, Energy and Toxic substances. The other axis of the matrix is divided into five main stages of the product life cycle: materials and components supply, production, distribution, use and end-of-life. The product is analysed in detail with regard to all cells of the matrix, and the environmental effects are determined. Next, the environmental bottlenecks are determined and highlighted. In European projects, this tool has proved to be a useful, relatively easy-to-use tool that can bring clarity to environmental priorities with regard to the design process. It avoids time-consuming use of more quantitative tools such as LCA in the initial phases of a project.

The ecodesign strategy wheel (also called Life Cycle Design Strategies – LiDS wheel) is a model showing all fields of interest for ecodesign, clustered in eight ecodesign strategies:
1. selection of low-impact materials
2. reduction of materials use
3. optimisation of production techniques
4. optimisation of the distribution
5. reduction of impact during use (incl. lower energy consumption)
6. optimisation of initial lifetime
7. optimisation of end-of-life
8. new concept development

The first seven strategies are typical improvement options that can be implemented on the short to medium term and will lead to stepwise improvements. The last strategy (new concept) is a longer term strategy for new product concepts. The first two strategies are related to the components of the product, the strategies 3-5 with the product structure, and the strategies 6 and 7 to the product system. On average, the complexity of the strategies increases with the numbering. See figure 5-4 for a more detailed overview of the strategies.

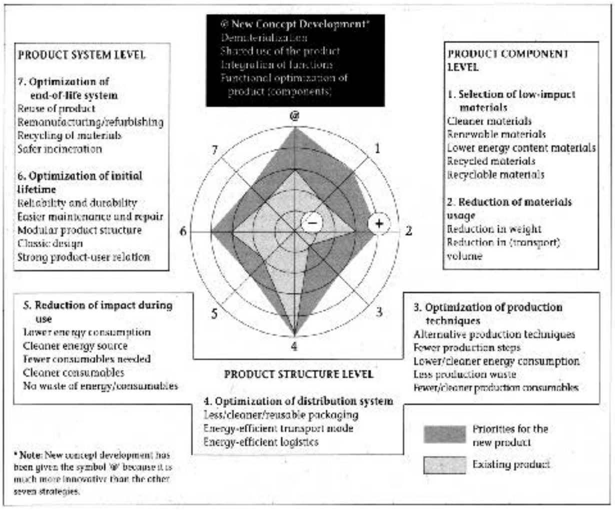


Figure 5-4: Ecodesign Strategy wheel (source: UNEP Manual on Ecodesign (Brezet and van Hemel 1997)

The spider web inside the strategy wheel is showing to assessments: first the scoring of the existing product to the eight strategies, secondly the assessment of the new product – the enlarged area is an indication of the overall improvement.

Shorter and quicker methods based on the UNEP manual have been developed several times, like the environmental innovation scan that was developed in the ecodesign dissemination project of the Dutch Innovation Centres (proprietary to the Innovation Centres, not published). The scan was carried out with 600 companies. The scan starts with a strategic business, product and market analysis. Directly after this, improvement strategies are developed for the product, and the scan is finalised with an advice to the company. Fast, but also the scan is not a do-it-yourself tool, a consultant is needed. After the scan, the company can go into a full-fledged feasibility study.

The target group of most methods described above is industry. However, almost all methods are depending on the support of a facilitator – consultant, expert. Especially the first ecodesign project that a company performs will depend on external assistance. Some methods are clearly defined exclusively to be used by advisors, such as the proprietary environmental innovation scan of the Dutch Innovation Centres. But also the UNEP manual, though designed as a stand-alone manual for industry and other users, is known to need expert advice in first use.

5.2 Facilitation and capacity development in Environment

5.2.1 Tools for Capacity Development in Environment (CDE) and Technology Transfer (TT)

The ecodesign project as it was executed is a form of development cooperation between The Netherlands and Central America. Some relevant theoretical and practical notions on this type of project are found in the concepts of Capacity Development in Environment, and in Technology Transfer literature.

The OECD (1996) describes the status of initiatives towards co-operative development of capacity for environment in developing countries as follows: "Acceptance of a partnership model in which development co-operation does not try to do things for developing countries and their people, but with them. It must be seen as a collaborative effort to help them increase their capacities to do things for themselves. Paternalistic approaches have no place in this framework. In a true partnership, local actors should progressively take the lead while external partners back their efforts to assume greater responsibility for their own development. (...) In short, partnerships should lead to locally-owned development strategies, based on the development of partners' capacity." This 'U-lead' position is clearly in line with the position taken in the case of ecodesign development in Central America.

Capacity development for Environment (and so, for ecodesign) includes numerous factors, such as organisation, human resources, technology, stakeholders, industrial and economical context, and international markets. Many of the projects undertaken in this field build on 'quick successes' to prove the approach is valid in the specific situation. Also, the importance of a good design of the CDE initiative is stressed: case studies that were reviewed by the Canadian International Development Agency (OECD 1996) showed the importance of committing sufficient time and resources to the conceptualisation phase. Thus, the (non)-existence of the necessary preconditions for success could be determined, and management approaches were identified that that help foster trust and local ownership and that create an explicit accountability framework.

The following generic phases or steps can be identified in most CDE initiatives:
- Design: Project identification
- Formulation
- Appraisal
- Initiation
- Implementation
- Monitoring
- Evaluation

This approach is comparable to a large extent with the product development process within the company cases.

The design steps and tools that are found to be used in CDE initiatives are the following (Table 5-1)

Table 5-1: Tool use in CDE initiatives (source: OECD 1996)

Project step/tool type		Tools
During the Project identification:		- Contextual analysis: donor/project/recipient analysis - Stakeholder analysis - Supportive preconditions analysis - Risk analysis
During the Formulation phase:	-Management approaches	- Accountability - Search conferences - Joint design - Pilot projects
	- Analytical tools:	- Contextual analysis - Needs analysis - SWOT - Social mapping
	- Participatory methods:	- Roundtables - Email networks/websites - Rapid appraisal methods

Most of those tools are applied in the current project as well. The focus of CDE initiatives is on all actors and stakeholders involved in the context of the initiative. Networking and partnership building take central positions, and often it is explicitly called a communicative or continuous learning approach. In general, it can be concluded that the current project is in line with what is currently seen as a sound approach for this type of projects.

A different, but connected approach to capacity development is taken in models on Technology Transfer (TT). Modern TT is no longer a unilateral forced transfer of western technology to developing countries. It is seen as a broad set of processes covering the flows of know-how, experience and hardware amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organisations and research/education institutes (IPCC 2000). It encompasses diffusion of technology and technology cooperation across and within countries: between developed countries, developing countries and countries in transition, and amongst these types of countries. It comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technology.

Pathways through which stakeholders can interact to transfer technology vary, depending on sectors, country circumstances and type of technology. They may be different for 'close to market' technologies and for technology innovations in development phase. Thus, different types of TT can be distinguished (see figure 5-5), such as vertical technology transfer from research to development to production and distribution. This is the dominant type in industrialised countries. As we seen before, in less industrialised countries, the process is often reversed on the basis of imitation and benchmarking (also called 'exnovation'). in addition to these vertical types, many forms of horizontal technology transfer exist, between development or production in the different countries. All these types can be of importance for developing countries, but often the exnovation path (vertical, bottom up transfer) and the horizontal transfer (often within the production step) are dominant (Steenhuis and de Boer 1997, De Boer 2000).

The (horizontal) transfer of technology can take different forms. An important distinction is the packaged or unpackaged form of the technology. Packaged means, that all the technological elements (like capital goods, materials, and know-how) are tied together and transferred as a whole. Unpackaged implies, that the parcel is broken down in its constituent parts, which makes it possible for the recipient to import only part of the total (Djeflat 1988).

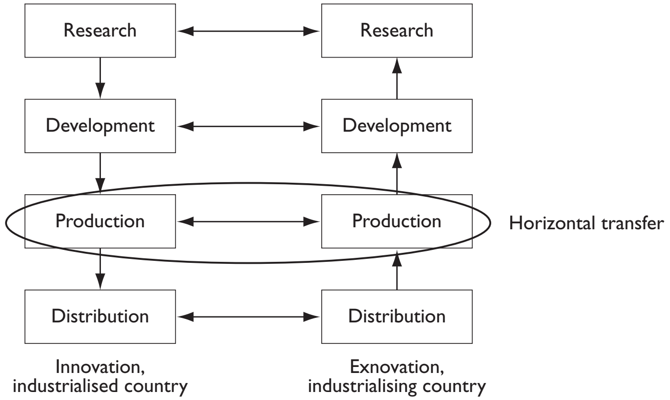


Figure 5-5: Technology Transfer types (after Steenhuis and de Boer 1997)

Unpackaged technology gives the recipient the opportunity to learn and build up the necessary local capacity, as well as to utilise more of the local resources. Also, the recipient is more involved in the total decision making. This is clearly in line with the approach chosen for the ecodesign transfer to Central America. Disadvantages of the unpackaged philosophy are the often long project times, and high costs due to the use of local resources and the lack of standardisation of the (newly) constituent parts. Also, unpackaged technology may sometimes be more apparent than real, since the 'core' technology stays in the hand of the supplier, and the recipient only makes peripheral and secondary additions.

Typically, TT models focus on the industry-owned process, and describe all macro/meso factors and actors as influences on that process. TT processes can be complex but usually include identification of needs, choice of technology, assessment of conditions of transfer, agreement and implementation, evaluation and adjustment to local circumstances, replication of the technology.

5.2.2 Global Value Chains

As part of the still accelerating globalisation of the world's economy, the importance of integrating companies from industrialising and developing countries into Global Value Chains (GVC) is also growing rapidly. UNIDO has stressed this integration in and is developing a sound conceptual and practical support approach for this (Kaplinksi and Readman 2001, Memedovic 2002).

Value chains represent the links among companies spread across several locations over the world, performing a sequence of related and dependent activities required to bring a product or service onto the market, through the different phases of production in the broad sense. These value chains include activities such as design, production, logistics, marketing, consumption and recycling. Note that there is a close resemblance and connection between this GVC concept and the Life Cycle concept that is central in ecodesign. The key difference between the two is that the GVC follows the value, or money, through the chain, while the Life Cycle follows the materials and energy, and their environmental impact, through the cycle. This means the two concepts are to a large extent complementary, and a joint application can lead to synergy and additional improvements and benefits. The key element for application of Value Chain thinking is the possibility for local companies from developing countries to get involved as 'latecomer firms' in those value chains. Currently, many poor producers and SMEs cannot participate in them and are facing falling economic returns, even with enlarged outputs and employment. A key approach to avoid this negative spiral is to innovate and upgrade, both individually and in networks with other SMEs and larger corporations. Four trajectories that firms can adopt are:

- process upgrading
- product upgrading
- functional upgrading
- chain upgrading

It will be clear that ecodesign enters into the same aspects: product improvement, process improvement, function/service improvement and improvement of chain aspects. The environmental, quality and value aspects are closely integrated in this. The ecodesign approach therefore gives a practical and proven approach that will tie in closely with the Value Chain thinking. From the side of Value Chain thinking, elements such as networking and cooperation between companies as well as upgrading approaches (process-first approaches for upgrading), can be of great support to ecodesign efforts. Also, programmatic issues of GVC's, such as targeting value chain efficiencies, rationalisation of the vendor/customer base and supply chain learning can bring new insights in ecodesign projects. For economies to formulate catching-up strategies to be more included in Global Value Chains, following attention points have proven to be crucial:

- Linkage in new networks, finding thus opportunities;
- Learning; specifically learning as a network; systematic learning to make full use of opportunities;
- Leverage of the above; make fullest use of opportunities and learning.

The dynamics of the above points can be taken into account performing the case studies in the Central America project. The direct relevant link is the involvement of NCPCs (National cleaner Production centres) in ecodesign activities. NCPCs exist in all countries of Central America, and are coordinated and facilitated by UNIDO. Synergy of the Global value chains and ecodesign approaches therefore is very plausible and practically applicable.

5.2.3 Constructive Technology Assessment and Innovation Configurations

Constructive Technology Assessment (CTA) can be described as broadening the decision making process about technological innovation by including as many relevant societal actors as possible, aiming at an optimal alignment between technological and societal processes. (Van der Ende et al. 1998) Practioners of this approach (mainly public and academic research institutes) explicitly aim at shaping the course of technological development into socially desirable directions. CTA tries to influence strategies of different actors involved to have them develop common perceptions of a specific problem, and develop and adopt joint strategies for solutions. The first Dutch ecodesign project PROMISE can be seen as a successful example of CTA.

A central approach in CTA is the layout and execution of planned interventions. Some types are described as follows (Van den Ende et al 1998):

- Interventions in innovation networks , f.i. organising interfaces between research and other societal actors. R&D companies might stimulate network formation for better corporate performance.
- Connecting separate networks, f.i. government agencies, companies and research, into better exchange and co-operation
- Demand articulation: adaptation of the socio-institutional system to adopt new technologies, or, make manifest the latent societal demand for new technology.
- Participatory Technology Assessment, including interested actors in an innovation process, mostly by discussion meetings or workshops.

In line with the original theory of Mintzberg (1983) configurations are defined as 'mental and spatial arrangements of organisational parts that help us to understand the behaviour of the whole.' Innovation configurations can then be defined as 'the agreed management structure that is socially constructed by a set of social actors, enabling them to make decisions and act collectively. As such, it forms the basis for collective forms of agency in complex innovation situations. A related approach developed by Engel (1997) is the 'innovation theatre'. He develops a conceptual framework on innovation that will enable us to perceive and contemplate events and ideas on innovation networks in a coherent matter. It is not aimed at an 'objective' account, but tries to provide perspectives useful for understanding of complex 'theatres of innovation'. The metaphor 'theatre' (actors coming together in synergy) accommodates concepts such as individual agency, growth and sense-making, as well as diversity, multiplicity and interdependency. Theatres are places were partly premeditated, partly improvised actions take place. Directors, managers, designers, stage builders, actors and audience interact intensively to produce both structure and serendipity. The metaphor also emphasises the socially constructed context of human behaviour. Theatres are also learning environments, through acting, looking, listening, feeling and reflection on what has happened. Moreover, introducing this metaphor instead of arena, system or network attempts to avoid – at least initially – an explicit a priori reference to struggle or harmony. All roles and positions are possible, from passive observer to actor on stage.

To analyse better the role and added value of the different actors in the field of technology diffusion by the Dutch Innovation Centres, Coehoorn (1995) developed a system of 'basic configurations' that are involved in the actual networking and diffusion. A configuration is described as a network-like setting of relationships of the key actors involved, whereby it is assumed that in each configuration one (type of) actor is dominant with regard to technology development, thereby determining the course of action in that configuration. Six basic configurations are defined for industrial technology:

- R&D driven-configuration, key actors knowledge institutes
- Government-driven configuration, key actors policy makers
- Sponsor-driven configuration, key actors specific sponsor organisations, often linked to the government (agencies, institutes etc.)
- Leading companies-driven configuration, key actors (large) market leading companies
- Following companies-driven configuration, key actors small companies and their organisations
- Society-driven configuration, key actors social and environmental organisations.

The configurations should be interpreted in behavioural or functional terms: same organisations will play a role in different configurations, but from a different position, role or interest. The basic configurations are then analysed with respect to interventions, knowledge transfer, roles, interest, performance, results, policy influence.

The initial type of configurations in the Ecodesign project will be sponsor and R&D driven, because of the sponsorship of the Dutch Embassy and the leading role of knowledge institutes such as TU Delft. However, in developing local networks, other configurations can be formed, depending on the type of actors involved. One can imagine that an industry organisation taking the lead will aim for a companies-driven configuration, involving companies and industry organisations.

5.2.4 Relevant findings from facilitation theory

From experience in Capacity Development in Environment and Technology Transfer projects, it becomes clear that the facilitation should be adapted to the local circumstances, and that local actors should gradually take the lead in the execution of projects and implementation of ecodesign in industry. To be able to do so, the technology – in our case methodology – introduced should be as much as possible in an unpackaged form, as to stimulate local partners to use those parts that are most feasible under the local circumstances, and to add local knowledge and approaches. To successfully facilitate ecodesign in industry, there is a need to construct a dedicated configuration for ecodesign on the regional and local level, which can be seen as socially constructed by a set of key actors. Because of the original design of the project, it can be expected that initially this will be a sponsor and research driven configuration.

5.3 Learning in Networks

5.3.1 Learning theory

Learning is seen as a central issue in developing local capacity for ecodesign. Local organisations should gain experience and develop expertise, and thus form a nucleus for further local ownership and dissemination. A short definition of learning is the following: learning is the process of acquiring knowledge. Knowledge is the ability to connect external information with already acquired information (= codified knowledge), and experience, skills and attitudes (=tacit knowledge), leading to new action or understanding. Information arises when a person allocates a meaning to acquired data (Weggeman 1997): learning takes place at individual, group, network, organisational and societal level.

Two basic types of learning that are commonly distinguished are
- Operational learning – acquisition of skills or know-how, which implies the physical and intellectual ability to perform some action.
- Conceptual learning means acquisition of know-why, implying the ability to articulate a conceptual understanding of an experience.

A related typology, mainly on the organisational level, is:
- Single loop learning is solving problems in a given organisation and a fixed set of rules. It leads to an immediate improvement of a given situation, without implications for the conceptual level.
- Double loop learning is aimed at changing norms, strategies and/or conceptual frameworks, usually in a more ambiguous and undefined situation that makes single-loop learning meaningless (Agyris and Schön 1996).

Organisational learning in an enterprise of network can be seen as a process in which several individuals of that organisation within a certain timeframe are, both collectively and individually, acquiring knowledge within a certain domain (Weggeman 1997). Additional to this and typically for enterprises, organisational learning can be purposefully focused on strategic renewal of the enterprise, by exploration of new ways while concurrently exploiting what is already learned.

A common used division of learning into different types is connected with the transition from tacit to codified and back to tacit knowledge: see table 5-2.The transition route starts upper left and goes clockwise.

Table 5-2: transitions from tacit to codified learning

	To tacit knowledge	To codified knowledge
From tacit knowledge	1. Socialising, imitate, master/journeyman trial and error	2. Externalising express what has been learned
From codified knowledge	4. Internalising learning by doing, integrate automate	3. Combining study, reconstruct find new combinations

Working with the concept of a Knowledge Information Systems (see Röling and Jiggins 1998 and Engel 1997) means
- focusing on soft systems thinking
- focusing on qualitative research, generating images that can be communicated and debated, leading to new insights

- facilitating social learning and involving stakeholders in new forms of organisation.

Learning is more complex than assumed by early research. Not only is it completely individual, it is also not a conscious, analytical process, but to a large extent influenced by the subconscious and the short term and long term emotional stage people are in. This is confirmed both on the physical level of brain research as well as – for a long time – by psychological research. Therefore, learning both in individuals and in organisations, is much more 'messy' and complex than earlier assumed, and the direct steering influence on it much smaller. Also, learning about environmental issues, as in ecodesign, is very complex. It is not only technological or scientific, but is about interactions of people and groups of people, and about the way we relate to our surroundings. People and organisations will also not learn if they do not want to learn, do not take rational decisions, and will not take action on the basis of rational best interest for society on a longer term, or even on their personal best interest on the longer term, if their construct of short term interest is different.

One way of managing this longer term societal change is by facilitation of learning, enabling people to adapt and respond to problem situations as they arise. – One particular learning approach for this is referred to as social learning. One particular powerful facilitation approach seems to be the process by which perception, action and emotion on an issue tend toward mutual consistency, resulting in learning (King and Jiggins 2002). Röling (2002) describes social learning as a move from multiple to collective and distributed cognition. Multiple cognition emphasizes the existence, in one situation, of different actors with multiple perspectives – tending to maintain their isolation. Collective cognition emphasises shared theories, shared values and collective action. Distributed cognition emphasises complementary contributions that allow for concerted action. A key factor for actors to go from multiple to distributed and collective cognition seems to be their perceived interdependence – at least in the ecological challenge we are faced with.

A related way of thinking is formulated by Maturana and Varela (1992), who start from the analysis of living ecological systems for their definition of knowledge: Knowledge is effective action in the domain of existence. Translated to social systems (Röling and Jiggins 1998) that are compared to cooperating organic systems, the system will develop cognitive capacity, with the basic interactive elements perception, emotion and action. This action results in feedback as new perception, etc. In this 'ecological' paradigm, quality and validity of knowledge is completely dependent on the actual situation, and attention is shifted towards the interaction between people, in which this knowledge may emerge. In this perspective, instead of dealing with the knowledge and learning, dealing with the interaction and networking of the people involved becomes more relevant.

5.3.2 Learning in Local (National) Networks

Learning and networking are closely related. A learning/networking model is described below that defines the different levels at which continuous learning in local networks takes place, and which can be applied to the ecodesign project. 'Local' in our case equals national networks, since industry in the countries of Central America is heavily concentrated in the capital of a country. In a company, most of the ecodesign learning is aimed at a cycle of externalising the tacit knowledge that can be of value in the process, combining it into new combinations (mainly management work) and internalising the resulting knowledge again into the tacit knowledge base. In a network, learning will be also on these levels, but also on the more complex level of social learning, moving towards collective understanding because of interdependence perceived with other members in the network. Companies are located in different types of networks, but most of the concepts and theories look at companies in either production process networks, or, when looking at the value chain, directly involved stakeholder networks. For an issue such as ecodesign or sustainable development, these networks are still too limited, and miss the dynamics and societal influence of other actor groups needed (Fadeeva 2003). The full network perspective concentrates on a web of relations including all relevant actor groups or organisations. Central nucleus in the learning model is therefore the local network for ecodesign (in the project, the national networks in each country) – since inside local networks information flows freely and knowledge is acquired. Local networks are the 'right' level since both innovation and fruitful personal networking can take place. Ideally, local networks are characterized by reciprocity, interdependence of actors, mutual trust, conformity of goals, additional gain for all actors, dynamic learning situations, availability of both 'strong' and 'weak' ties, and adequate communication patterns. The quality of the network can be assessed on these points, see table 5-3.

Table 5-3: Network Quality checkpoints.(Derived from: Grabher and Lettmayer 2000)

"Network Quality" Checkpoints	Characterization by keywords
Goals Are there jointly accepted (meta) goals?	Jointly accepted 'meta-goals'and joint perception of problem Discussing and agreeing on goals (content) for intrinsic motivation Good time horizon of goals (step-by-step-goals)
Participants Are the 'core actors'for this goal in the network?	Core-actors taking part, diversity of actors, relevant background-network of actors Involvement of actors for promoting process, power and subject
Gain for Actors Is there a visible additive gain for participants?	Can be on both open and hidden goals of participants Depends on complexity of different goals, individual goals fit to 'meta-goals', any conflicts on different goals Costs: resources for participation: time, money, knowledge, matter, access
Learning Process Is there a joint learning process going on – orat least possible?	Can be: Individual learning, group learning, organizational learning Learning by doing, learning by communicating, learning by learning
Power Is power between the actors distributed fair?	Non-hierarchical structures Decentralised (poly-centralized) Transparency and openness of process Equal power distribution on the longer term
Trust Is there a basic trust and inter-dependence between the actors?	Interdependency on shared resources Reciprocity: 'long-term' give and take Trust, reliability, honesty
Ties Do both strong and weak ties exist?	'Strong ties' offers the network close co-operation and continuous improvement 'Weak ties' are flexible bridges into new networks and keep the system open for new actors
Communication Is there an adequate communication pattern?	Quality of meetings Quantity of contact, meetings Jointly accepted ground rules Communication – facilitating processes Culture of conflict solution Feedback and rethink – controlling functions, indicators for developments

Local networks are constituent of the actor groups involved in the national projects and other related groups and at this moment have an informal organisation. The following five interconnected levels describe the system of learning, facilitation, institutional support and conductive policies necessary for the network-oriented diffusion of ecodesign (adapted from Röling and Jiggins 1998):

1. The industrial practice for ecodesign; the actual industrial level on which the adoption and implementation of the innovation takes place.
2. The knowledge gathering and learning process for ecodesign of the industry people involved – both on the individual company level and in industry networks
3. The facilitation of learning by the web of consultants, researchers, governmental organisations, sector organisations and other institutions involved in the regional networks
4. The development of the institutional support framework needed for the transition to sustainability, linking networks and exploring new institutional arrangements

5. Conducive policy contexts for the stimulation and support of environmental innovations, provoking innovative and sustainable behaviour of companies.

This learning framework not only has the advantage of being able to integrate the relevant theoretical models and empirical findings in this study, at the same time it is an action-oriented framework with suits our purpose of the analysis of the emerging local ecodesign networks as envisioned in the next phase of the project. It is open enough to accommodate most of the praxis we want in, but is concise enough to discern well between the different activities that are needed for each learning level. The model can be depicted as follows (figure 5-6):

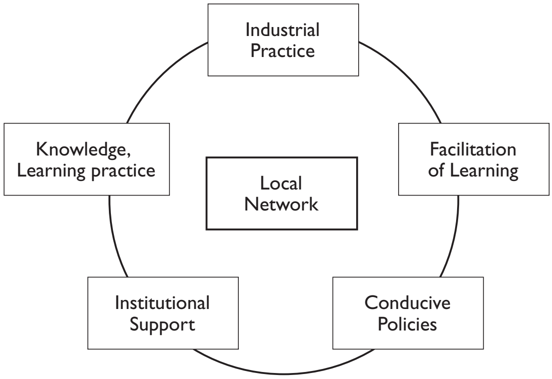


Figure 5-6: Model for learning in local networks (after Röling and Jiggins 1998)

This model allows for analysis of the case studies on various factors:
- the composition, quality and status of the local networks
- the actual implementation of ecodesign innovation in industry
- the variety and elements of the learning process on each of the levels
- the type of learning (and the adequacy of that) on each of the levels.

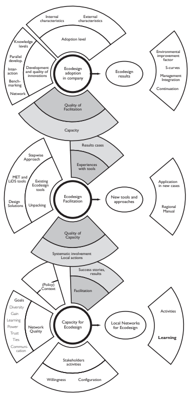
5.3.3 Relevant findings on learning and networking

In this section, key concepts from learning and networking theory have been described that can be used in the analysis of the case studies. Learning is defined as the process of acquiring implicit (tacit) or explicit (codified) knowledge. The knowledge can be acquired in manifold ways, such as study, instruction, practice or experience. It includes operational (know-how) and conceptual (know-why) learning, or looking from another angle, single loop, double loop and deutero learning. All different forms of learning take place in the process of introducing ecodesign. The 'manual' knowledge can be seen as explicit, it adds up with the tacit knowledge inside the company or network. Ecodesign clearly involves both operational learning and conceptual learning, for different parts of an organisation in different combinations. Learning processes we can discern include socialisation, externalisation, internalisation and combination, which can be done both individual and in teams or groups. Also, the enabling factors such as resources, opportunities and culture to enable for organisational learning possibilities are to be considered.

A number of central quality elements for local networks are defined, including goals, core actors, power, trust and communication, which can be used as checkpoints for the quality of the emerging local networks for ecodesign in this study.

An overall model connecting learning to network elements is developed, which is action-oriented and can be used to analyse the interconnected levels of a network where learning should take place.

Chapter 6: Research methodology



In this chapter the research methodology is established. First, the theoretical and practical propositions are selected that are the most relevant to the case studies since they contribute most to the insight, explanation and evaluation of those cases (6.1). These propositions are then operationalised into a number of factors to be used for the analysis of the cases (6.2). Next, based on the selected independent variables the research model is refined. (6.3). Last, the data collection methods (6.4) and analysis strategy (6.5) are determined.

6.1 Key propositions from theory and practice

The three variables, *adoption, facilitation and capacity* are influenced and formed by a large number of other factors. Key propositions from relevant theories and practice can be selected for the further analysis of the cases. A selection of theories most important was given in the concluding paragraphs of the theory Chapters 4 and 5, and is summarized below.

Adoption

Basic theories for Innovation (Chapter 4.1) are the chain-linked model of innovation (Kline and Rosenberg 1986), the Delft product innovation model (Roozenburg and Eekels), and the innovation adoption theory from Rogers. These theories shed light on the mechanisms for adoption of innovations such as ecodesign in an individual company.

The essence of the chain-linked model, the interaction between the different levels of information and knowledge, seems to be highly relevant in the project because of the apparent lack of detailed and connected information for SMEs in the region. This relevance is supported by the findings for ecodesign in European SME's, stating that missing special know-how and tools are key barriers (Tukker et al 2000). The concurrent development of product, process and market is a dominant factor in the Delft model, and therefore the level of integration should be analysed for the cases in

Central America. From several sources (Buys 1986, Kleinknecht 1992, van Hemel 1998) we distil the notion that an active information-seeking behavior of the company is an important factor for successful adoption of innovations. Although to a certain extent, the information comes to them 'automatically" in the case of the facilitated project companies, this is certainly not a sustained situation, so their own intentions in this field are far more important for continued efforts in ecodesign. Basic innovation adoption theories (Rogers 1995) show to what extent successful adoption of innovation is embedded in the system of the company and thus makes it more plausible that innovative behaviour will be sustained by the company. This level of adoption has to be established therefore in the case studies. More recent findings of the complexity of innovations show the importance for the company to be part of an active innovation-diffusion network (Mulder 1992, Silvester 1996). This is seen as a key factor for the case study companies. Benchmarking is by far the most feasible and successful road to new product development for most companies (Schnaars 1994), and probably for all of the case study companies (Romijn 1996). Benchmarking can be learned and can be consciously applied – the benchmarking strategy of the case study companies therefore has to be analysed.

The internal and external key stimuli and (related) barriers for ecodesign as found in empirical studies of van Hemel (1998) are of great importance for the evaluation and analysis of the case studies in our project, and cover most of the characteristics that are found in other empirical studies on (eco)innovation. There the following factors are taken into account: cost reduction, image, environmental benefit and positive attitude as internal stimuli, regulations, market demand and supplier demand as external stimuli.

Results of the ecodesign adoption

The results of the adoption of ecodesign by the companies initially can be measured by the results of the pilot project. Key factor in the concept of ecodesign (Chapter 4.2) is the actual environmental improvement factor reached with the approach. Since we are dealing with a pioneer project for the region, the improvement levels reached in the first Dutch ecodesign project (te Riele and Zweers 1994) are to be considered a good point of comparison. As in our project, a full quantitative measurement was never done in these Dutch cases, and the case study results are estimated on the level/factor of improvement. Theory (Brezet 1997) says that eco(re)design projects results are generally in the range of factor 1.1 – 2 improvement (10-50% impact reduction). For future development of the concept, 'jumping the curves' from redesign to product innovation to product/system innovations is considered the way forward. It can therefore be analysed what systemic level is tackled in the case studies. Another element of the success rate is the level of integration of ecodesign into the company's management system – experience shows a need for both operational and strategical integration (Rocha and Brezet 2001). Last, the intention of the companies towards continuation of ecodesign in new projects or integration in related activities can be seen as an important practical criterium that determines the long-term success rate of ecodesign adoption. Another factor determining the level of success on ecodesign adoption is the quality of the facilitation on company level. This brings us to the second variable: success of facilitation.

Facilitation
Key factor that initially determines the facilitation effort in the project is the basic facilitation approach (Chapter 5.1 and 5.2) for introducing ecodesign in a company, as described in the UNEP ecodesign manual (Brezet and van Hemel 1997) and backed up by the empirical data on tool and method use in ecodesign projects, mainly from Europe. This is the best available basis for analysis of the methodology development in the project in Central America. Next to the generic structured stepwise process that is necessary for a good project execution, two key tools that are necessary for the development of ecodesign are an environmental analysis (in our case represented by the MET matrix) and a kind of improvement analysis (in our case the ecodesign strategy wheel).

The first two years of the project, it is also a form of development co-operation. Therefore it is analysed from the angle of Technology Transfer to an industrialising region. Key issue from theory is the notion of 'unpacking' the available technology/information complex that is being transferred to be able to adapt and apply it optimal in the local situation (Djeflat 1988). Also, the intention to have local actors progressively take the lead, and the proper design of the projects (OECD 1996) are important factors to explain the success or failure of the project.

The facilitation itself is influenced by both the results of the company projects and the level of capacity in society to support training and expertise building, as well structural institutional support.

Capacity
In the development of capacity (Chapter 5.3) in local networks during the second phase of the project, elements from learning and networking theory and are important. Essential factors for good networks such as joint goals, key actor involvement, gain for all actors, joint learning, fair power distribution, basic trust, different types of contacts (ties) and adequate communication in the network (Garbher and Lettmayer 2002) have to be evaluated. Learning types such as single/double loop learning are determining the overall success of the process of change taking place. Also, the level of organisational learning taking place is of key importance. Capacity building and the societal involvement of key actors in the region will also be described using the model of Basic Configurations (Coehoorn 1995 after Mintzberg 1983) : dominant configurations of actor groups lead to different types of developments, which can be less or more adequate for the overall objectives stated. From the model for learning in local networks (Röling and Jiggins 1998) it is derived that learning has to take place throughout all levels of the system.

Next to this, the level of positive results from the company case studies and the facilitation further influences the quality and results of capacity building. A further detailing of the research model based on this selection of factors is made in 6.3, first the operationisation of the factors for the analysis of the case studies is given.

6.2 Operationalisation of the factors for analysis

To be able to analyse the data of the case studies related to all the factors stated above, the factors are operationalised in a semi-quantitative way. A detailed research question is formulated for each factor – see table 6.1. Next, for each of the factors the scoring scale is determined.

The scoring system used is a four level scale:
A = full compliance with the research question,
B = 2/3 compliance
C = 1/3 compliance
D = no compliance.
'Full compliance' means the situation encountered in the company closely resembles the ideal situation as formulated in theory (f.i. for factor F1: "the company uses all the levels of knowledge necessary for product innovation"). 'No compliance' means none of the elements mentioned are found (F1: "no use of any knowledge"). The intermediate scores 1/3 and 2/3 are chosen in between the two extreme positions (F1: "only product development knowledge" = 1/3, "that + existing external knowledge base" = 2/3) The scaling is carefully designed per factor to be distinctive, meaning it is designed in such a way that it is expected to find differences in scoring of the factor between the different case studies. For instance, in the operationalisation for the environmental improvement factor resulting from the individual projects, if the project would score higher then factor 2, the highest score A is given. The theoretical expectation is, that eco(re)design projects will usually have a maximum improvement factor around 2. This makes it possible to discern three categories below factor 2. If a maximum of f.i. factor 4 would have been chosen, the differentiation between scores of the case studies can expected to be less.

The operationalisation in scaling for each of those factors is given in the table 6-1. For each factor, the background (theoretical proposition) is briefly stated, the source and the actual research question developed from it. In the next column, the scaling system is described. The factors and their operationalisation are grouped per dependent variable, so adoption, facilitation and capacity, and are connected to the research questions Q1 – Q10.

This operationalisation of these 30 factors, although a practical and powerful analytical tool, is still a limited system of analysis, only covering part of the information represented by the full richness of the data coming from the case studies. Therefore, in addition to this analysis system, additional qualitative analysis of all data is at least as important and will be performed in the case study analysis.

Table 6.1: Operationalisation of factors for analysis

Theoretical Factor	Source	Detailed research question	Scaling
1. Variable: Adoption of ecodesign in individual company			
Q1) How does the adoption of ecodesign – seen as a product innovation process – take place in participating companies in Central America?			
DEVELOPMENT OF INNOVATIONS			
F1. Innovation is a 'chain-linked' system with different knowledge/info levels.	Kline & Rosenberg (1986)	1. How well did the company use the different levels of knowledge necessary for product innovation?	D. none C. product development knowledge B. that + existing knowledge base A. that + scientific knowledge
F2. Innovation is a parallel development of the technical product and of the market.	Roozenburg & Eekels (1995)	2. Did the company include both the technical and the market development in the project?	D. none C. market or technical development only B. both developments but separated A. both developments integrated
F3. Innovation needs constant interaction with the surrounding entities such as suppliers, research etc.	Buijs (1987) Kleinknecht (1992)	3. Was the company actively searching information from its surroundings?	D. none C. some, passive B. some, active A. much, active
ADOPTION AND DIFFUSION OF INNOVATIONS			
F4. Adoption of innovation goes through phases (knowledge – etc – confirmation) to be complete	Rogers (1995)	4. What is the phase of adoption in the company?	D. none C. knowledge/persuasion B. decision A. confirmation
F5. Innovation takes place in an innovation-diffusion network	Mulder (1992) Sylvester (1996)	5. Is the company part of an active innovation-diffusion network?	D. no C. unconscious B. yes, passive A. yes and actively engaged
F6. Benchmarking /copying are the most successful strategies for pr. development in industrializing countries	Romijn (1996) Schnaars (1994)	6. Did the company use benchmarking/copy strategies to enter the market?	D. none C. lower price B. better product A. both
Q2) Are the ecodesign projects in the companies successful, is the approach continued and does the approach diffuse to other companies?			
ECODESIGN RESULTS			
F7. Factor 2 environmental improvement can be reached in eco(re)design project	Brezet (1997)	7. What improvement factor has been reached by the company?	D. 1 – 1.1 C. 1.1 – 1.33 B. 1.33 - 2 A. > 2
F8. Surfing the S-curves: higher improvement factors when moving to higher systemic levels (scope) in project	Brezet (1997)	8. What scope did the company take into account in the ecodesign project?	D. product redesign C. new product design B. product/service A. product/system
F9. Integration of ecodesign in operational and strategic company management is necessary	Rocha and Brezet (2001)	9. Did the company integrate the ecodesign concept into their management system?	D. no C. mostly operational B. mostly strategical A. completely
F10. Continuation of ecodesign after first pilot project	UNEP manual (1997)	10. Did the company continue /expand with Ecodesign projects?	D. no C. one more similar project B. one or more project higher level A. several new projects
Q3) What are the key company-internal variables that influence (positively and negatively) this adoption of ecodesign?			
STIMULI FOR ECODESIGN			
F11. Company characteristics that are the most significant stimuli for ecodesign	V Hemel (1998)	11. Does the company have the following 4 internal characteristics: cost reduction, image, env. benefit, positive attitude?	D. none C. 1 of those B. 2 A. 3-4
Q4) What are the key contextual variables (stimuli and barriers) that influence the ecodesign adoption?			
F12. External characteristics that are the most important stimuli for ecodesign	V Hemel (1998)	12. Is the company stimulated externally by these stimuli: Regulations, demand market, demand to supplier?	D. none C. 1 of those B. 2 A. 3

Theoretical Factor	Source	Detailed research question	Scaling
2. Variable: Quality of Facilitation			
Q5) How was the initially provided ecodesign methodology handled?			
FACILITATION: ECODESIGN METHOD (UNEP MANUAL)			
F13. Structured process of UNEP Manual is important	UNEP manual	13. Did the company use/ accept the structured process (complete or in simplified form) for an ecodesign project?	D. not C. little bit B. fairly good A. complete
F14. Environmental tools/information of UNEP manual – MET and LiDS are important	UNEP manual	14. Did the company apply the environmental tools MET, LiDS and did they get the env. information for that?	D. none C. MET B. LiDS A. All
F15. Design solutions can be found in various, complementary and sequential categories (8 design strategies	Van Hemel (1998) UNEP manual	15. Did the company find and include solutions on the various design strategies for the environment (8 LiDS options)?	D. 0-1 C. 2 B. 3 A. 4 or more
TECHNOLOGY TRANSFER			
Q6) What elements of the ecodesign approach can be optimised for use in Central America?			
F16. Unpackaging of technology enables recipient of technology to adapt to local needs	Djeflat (1988)	16. Did the company supplement their own tools/additions to the methodology supplied?	D, no C. few additions made B. several additions/improvements A. complete reworking for dedicated use
Q7) How does the translation to local facilitation of ecodesign develop in Central America? Is it optimised?			
F17. U-lead: Local actors progressively should take the lead in technology transfer programme	OECD (1996)	17.Was the programme performed in a co-operative way, local actors progressively taking the lead in the company projects?	D. No, lead was with Dutch counterpart C. Dutch counterpart dominated B. Local actors had to do things without much support A. Co-operation, lead with local counterpart
F18. Programme steps need to be followed	OECD (1996)	18. Were the programme steps 'design, initiation, implementation, monitoring, evaluation used?	D.Only design and initiation C. No monitoring - evaluation B. No evaluation A. All

Theoretical Factor	Source	Detailed research question	Scaling
3. Variable: Capacity Building			
Q8) How did the process of capacity building and awareness raising on ecodesign develop in Central America? Q9) Who are the key actors in this process and what is their role and involvement? Q10) Is building capacity and awareness on ecodesign successful? Can/should it be optimised?			
NETWORKING			
F19. Goals of network should be known and accepted by all participants	Grabher Lettmayer (2000)	19. Is there a joint perception of the goals, and are the goals accepted by all partners?	D. no C. some discussion B. joint perception of problem A. yes
F20. Diversity of actors is important, inclucing key relevant actors	Ibid.	20. Are all relevant actors involved in the network?	D. None C. One important actor (takes lead) B. Some important actors involved A. All involved
F21. There should be gain for all actors to participate in the network, either for open or hidden goals of actors	Ibid.	21. Is there a visible additive gain for all actors involved?	D. No C. Some hidden goals achieved, some conflicting ones B. Some goals achieved, no conflicts A. All goals of all actors achieved
F22. Different types (from individual to organisational) learning opportunities should be available in the network	Ibid.	22. Is there a joint learning process between actors going on, or at least possible?	D. Not possible C. Possible, but not happening B. individual learning going on A. Group and organisational learning going on
F23. Non-hierarchical, transparent power structure necessary	Ibid.	23. Is power distributed fairly between the actors?	D. No, hierarchical structure C. poly-centralized structure B. uneven distribution, but transparent and open A. Fair and transparent power distribution
F24. Interdependency on shared resources, reciprocity and basic trust is necessary	Ibid.	24. Is there basic trust and interdependence between the actors?	D. No C. Some interdependence, no trust B. Trust, no interdependence A. trust and interdependence
F25. Strong ties offer close co-operation, weak ties are flexible bridges into new networks, keeping the system open. Both are necessary	Ibid.	25. Do both strong and weak ties exist in the network?	D. None C. Weak ties, no strong ties B. Strong ties, no weak ties A. both strong and weak ties
F26. Adequate and open communication is necessary	Ibid.	26. Is there an adequate communication pattern in the network?	D. weak communication C. infrequent communication B. Frequent but unmanaged communication A. Frequent, high quality communication
CONFIGURATIONS			
F27. Type of configuration determines the course of action of a network, should be in line with goals of network.	Coehoorn (1995)	27. Is there conformity between the configuration and the goals/activities of the network?	D. No conformity C. Some B. High A. Full conformity
LEARNING			
F28. Double loop learning	Agyris (1983)	28. Is double loop learning taking place in the organisations of the network?	D. No learning C. Single loop learning only B. Double loop in one/some organisation A. Double loop learning in several organisations
F29. Organisational learning	Weggeman (1997)	29. Is organisational learning taking place in the network organisations?	D. No org. learning C. Partial org.learning only B. Full cycle learning in one org. A. Full cycle learning in several org.
F30. learning in local Networks on all five systemic levels from industrial practice to conducive policies.	Röling & Jiggins (1998)	30. Is learning taking place through all levels of the system?	D. No learning C. Some – 1 or 2 levels B. much – 3 or 4 levels A. Full system

6.3 Refining the research model

The initial research model as it was presented in Chapter 2 can now be refined on the basis of the selection of the key independent variables or factors, and the interrelation between those factors. The refinement of the research model is done for each dependent variable, so for adoption, facilitation and capacity. Because of the complex interrelations between the various factors and variables, the initial linear depiction of the model in Chapter 2 is changed into a depiction of a series of partial, concentric circles surrounding the dependent variable. This does more right to the complexity of the system, and the fact that several of the factors are grouped or have strong interrelations and act their influence of the dependent variables on different levels. These models are of a qualitative and descriptive nature, and should be seen as an aid for the further structuring of the analysis.

Adoption

In figure 6.1., the refined research model for the ecodesign adoption in companies is given. The adoption level of the company (F4) is influenced to a large extent by the sets of internal (F11) and external (F12) characteristics that stimulate ecodesign. Next to this, a series of factors that influence the actual development and quality of the innovation itself are grouped together (F1-3,5,6). These factors are influencing the overall development and quality of innovations, that in turn influence the adoption level. Compared to the initial research model (figure 2.1), the model is extended with the quality factors, and the content variables, as explained, are restricted to the external characteristics.

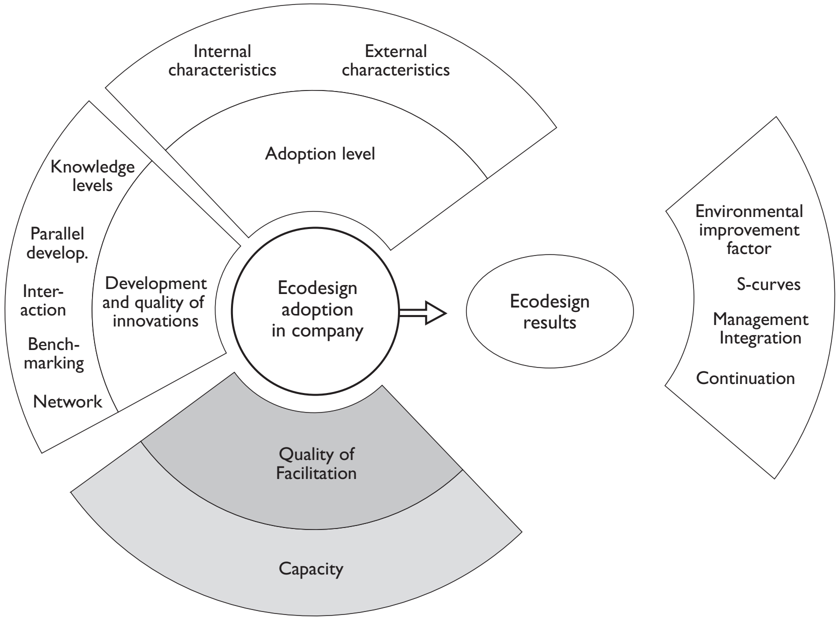


Figure 6.1: Refined research model for ecodesign adoption in the company

Facilitation quality is an influencing factor in the actual adoption process, on its turn influenced by the capacity for ecodesign. Because these factors themselves are dependent variables in the study, this is depicted in the grey layers. Emerging from the adoption process are the actual ecodesign results in the company. A number of factors are operationalised in this respect (F7-10): Improvement factors, system level of improvements, integration of ecodesign in management and follow-up and continuation in the company. These factors can be seen as part of the full set of implications and effects that form the actual results of ecodesign adoption in the company.

Facilitation

In figure 6.2, the refined research model for the ecodesign facilitation is given. The overall quality of facilitation is determined by the existing ecodesign tools with which the project started. As a refinement of the initial model in figure 2.1, this is detailed in three factors: the integral stepwise process (F13), the dedicated environmental tools (F14) and the strategic design solutions that are offered (F15). Overall, the level of unpacking of the transferred approach by the company (F16) also determines the quality of local facilitation.

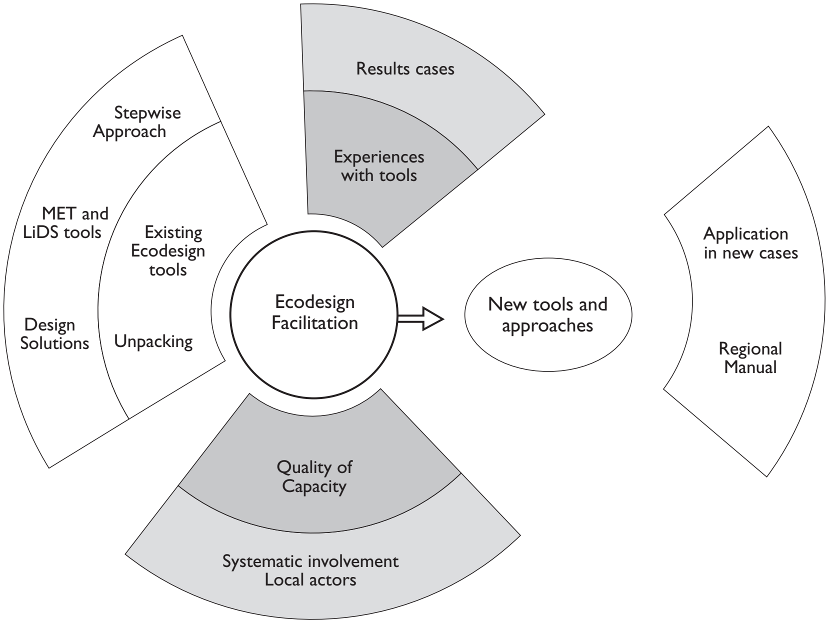


Figure 6.2: Refined research model for ecodesign facilitation

On the local level, the facilitation quality is determined by the systematic involvement of local actors, which gradually take the lead in the process (F17-18). This is closely connected to the overall existence and quality of the capacity, again a dependent variable itself, and depicted in the grey area below in the model. Also, the results of the industrial case studies and resulting experience with the tools applied is of influence. This is the dependent variable adoption, and depicted in the upper grey area. Key outcome of facilitation efforts are new tools and approaches for ecodesign, adapted and made suitable for the region. These can be directly applied in new cases, and also are established in a regional manual on ecodesign.

Capacity

The third variable, capacity building for ecodesign in the region, is modelled in figure 6.3. Direct factors influencing the actual capacity are the activities undertaken by the stakeholders in the region. The orientation and dedication for this depends on the willingness and suitable configuration of the stakeholders (F27). Another key factor that determines the overall quality of facilitation is the quality of the local (national) network that is involved in ecodesign activities. This quality is operationalised in eight different factors (F19-26). These factors are a new addition compared to the initial model (figure 2.1) Although not investigated directly, the overall context of policy and institutional climate is also determining the capacity building success. The results of company projects, especially the existence of success stories, and the results of the facilitation efforts are in their turn influencing capacity building (dependent variables – so depicted as grey area). Key outcome of the capacity building efforts are the local networks for ecodesign, which develop activities for continuation and follow-up. Learning (F 28-30) is put in the model as an important attribute for those networks.

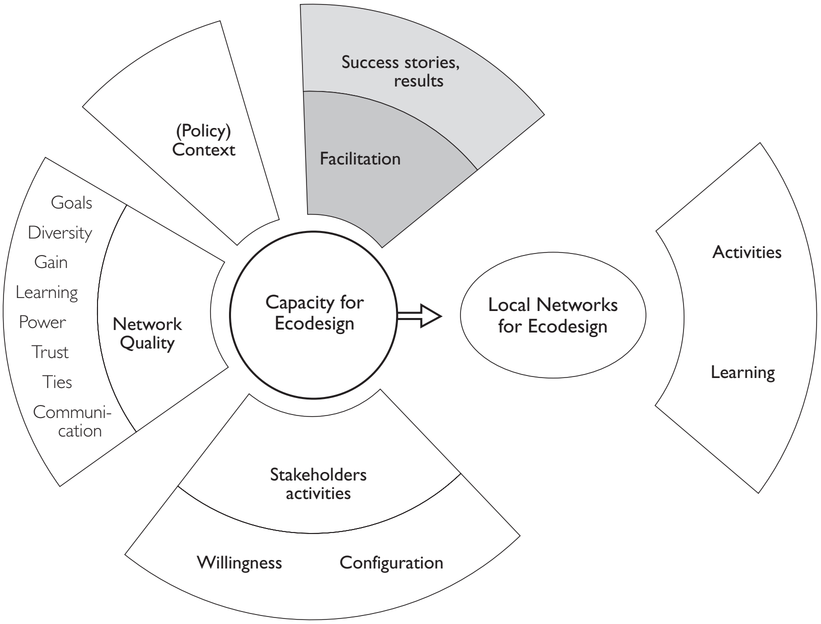


Figure 6.3: Refined research model for ecodesign capacity building

The overall research model is shown in figure 6.4. Note that the grey areas of each of the concentric submodels are essentially the input of the dependent variable in the 'neighbour' part of the model. The research questions Q1-Q10 can be placed in the model as seen in figure 6-4. The position of the 30 factors F1 – F30 developed from theoretical propositions is specified in detail in the description above. As can be seen in table 6-1, all detailed F questions detail a part of the overall issue stated in the research questions Q1-Q10. For the variables adoption and facilitation, the detailed research questions (Fs) are usually connected to one of the initial research questions (Q). For the variable capacity, this one-on-one pattern is not so clear, and many of the detailed research questions relate to several research questions. The analysis of the factors, derived detailed research questions and research questions will therefore be executed in close connection with each other. An overview of the research questions and connected detailed research questions derived from the factors is given in table 6.2. However, the total set of factors do not replace the research questions, since other more descriptive analytical elements should be added to the case studies analysis to answer the research questions in full. The numbering of the research questions (Q 1-10) and detailed questions (F 1-30) is not integrated for several reasons: because in the case of capacity the relation is not always one-on-one, because additional analytical elements are added in the analysis of the Qs, and to avoid 'losing' the connection of the Fs to the original research factors.

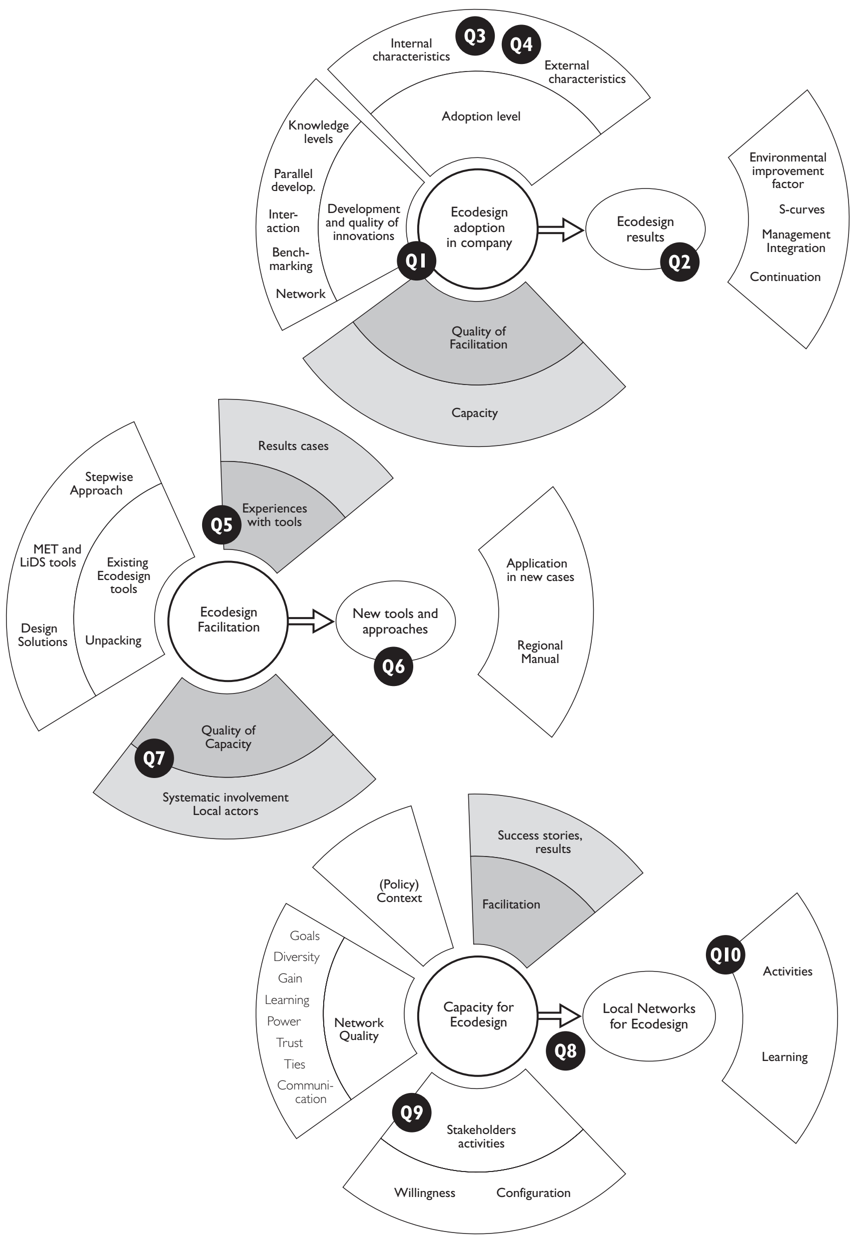


Figure 6.4: Overall research model with location of research questions.

Table 6-2 Research questions (Qs) and connected detailed research questions from research factors (Fs)

ADOPTION:
Q1) How does the adoption of ecodesign – seen as a product innovation process – take place in participating companies in Central America?
F1. How well did the company use the different levels of knowledge necessary for product innovation?
F2. Did the company include both the technical and the market development in the project?
F3. Was the company actively searching information from its surroundings?
F4. What is the phase of adoption of ecodesign in the company?
F5. Is the company part of an active innovation-diffusion network?
F6. Did the company use benchmarking/copy strategies to enter the market?
Q2) Are the ecodesign projects in the companies successful, is the approach continued and does the approach diffuse to other companies?
F7. What improvement factor has been reached by the company?
F8. What scope did the company take into account in the ecodesign project?
F9. Did the company integrate the ecodesign concept into their management system?
F10. Did the company continue/expand with ecodesign projects?
Q3) What are the key company-internal factors that influence (positively or negatively) this adoption of ecodesign?
F11. Does the company have the following 4 internal characteristics: cost reduction, image, env. benefit, positive attitude?
Q4) What are the key contextual variables (stimuli and barriers) that influence the ecodesign adoption?
F12. Is the company stimulated externally by these stimuli: Regulations, demand market, demand to supplier?
FACILITATION:
Q5) How was the initially provided ecodesign methodology handled?
F13. Did the company use / accept the structured process (complete or in simplified form) for an ecodesign project?
F14. Did the company apply the environmental tools MET, LiDS and did they get the environmental information for that?
F15. Did the company find and include solutions on the various design strategies for the environment (8 LiDS options)?
Q6) What elements of the ecodesign approach can be optimised for use in Central America?
F16. Did the company supplemented their own tools/additions to the methodology supplied?
Q7) How does the transition to local facilitation of ecodesign develop? Is it optimised?
F17. Was the programme performed in a co-operative way, local actors progressively taking the lead in the company projects?
F18. Were the programme steps 'design, initiation, implementation, monitoring, evaluation used?
CAPACITY:
Q8) How did the process of capacity building and awareness raising on ecodesign develop in Central America?
Q9) Who are the key actors in this process and what is their role and involvement?
Q10) Is building capacity and awareness on ecodesign successful? Can/should it be optimised?
F19. Is there a joint perception of the goals. Are the goals accepted by all partners?
F20. Are all relevant actors involved in the network?
F21. Is there a visible additive gain for all actors involved?
F22. Is a joint learning process between actors going on, or at least possible?
F23. Is power distributed fairly between the actors?
F24. Is there basic trust and interdependence between the actors?
F25. Do both strong and weak ties exist in the network?
F26. Is there an adequate communication pattern in the network?
F27. Is there conformity between the configuration and the goals/activities of the network?
F28. Is double loop learning taking place in the organisations of the network?
F29. Is organisational learning taking place in the network organisations?
F30. Is learning taking place through all levels of the system?

6.4 Data collection

Data collection of case study research can rely on multiple sources.
Yin (1994) distinguishes 6 generic sources:

- documentation of different types
- archival records
- interviews
- direct observations
- participant observation
- physical artefacts

Documentation includes letters, agendas, minutes of meetings, written reports of events, analytical reports, all administrative documents such as proposals, and progress reports, and formal studies, websites, reports and papers. A*rchives* include organisational records, survey data and lists, websites, maps, charts and the like. The strength of documentation and archives is the exact and stable nature; a weakness can be an –unknown- bias of the author. *Interviews* include structured and unstructured open interviews. the strength of interviews is the targeted nature, directly focused on the case study topic. Weakness can be reflexivity – the interviewee giving what the interviewer wants to hear. *Direct observation* includes site visits (with or without checklists), observation of meetings and courses etc. The advantage is the 'reality check' and the addition of contextual information. Again, the weakness is reflexivity and selectivity of the observant. *Participant observation* is unavoidable in action-integrated research , and is the special mode of observation where the observant is actively engaged in the case study. Additional weak point compared to observation is the manipulation of the events by the observant. Additional advantage is that the active engagement enlarges the potential to retrieve insightful information (as in interviews). *Physical artefacts* – in our case actual products and connected process equipment – enhance the insight into technical, esthetical, ergonomic and material aspects.

Data collection in this study

In this study, all types of sources mentioned above are used. More specificly, the following sources were used: *Documentation* included: Minutes and reports of company meetings, training sessions, report of the regional conference and reports of the national workshops, all analytical reports of the research team on sector and company selection, company analysis reports, environmental analysis of the products, product/company fact sheets, etc. Formal reports included all graduation reports based on the case studies, all expert reports that were written during the study, and analytical reports from research sessions of the team. The administrative documents included the proposals of the project, the interim reports, end report, mid-term evaluation reports. Papers included scientific papers published on the project and popular articles published in the region. Also included is the regional manual and all other materials published in the region. A*rchives* include all documentation, internet and literature surveys generated, all secondary material (such as the Regional Competitiveness Agenda and pertaining studies), all data from sectors, companies and institutions. In each company, archive materials included details on production and products, organigrams etc. *Interviews* were held on several occasions during the case studies, both structured (with the company management in the selection, start-up and project evaluation phase and one year after the project had finished to check continuation and follow-up) and unstructured interviews with company management during the project phases. Structured interviews were held with all institutions and organisations contacted during the study. Exit-interviews were held with the graduation students, and with the project partners in the various countries. *Direct observations* and *Participant observations* (from the researcher – all indirect observations by other research team members are documentation) took place all through the project, and included company site visits – at least four, in most case more visits per company – participation in all start-up workshops, conference, national workshops, meetings with organisations, scientific and additional workshops in the project, and a large number of project team meetings. *Physical artefacts* included all existing products of the companies, the newly developed ecodesign products (prototypes and/or final), a variety of materials, production process equipment etc. analysed during the study. Clearly, this wealth of information needed to be collected in a structured way. This was done by following a data collection protocol in each of the case studies. The generic structure of this protocol is described in table 6.3 for the different type of case studies. References for the key sources are mentioned, see Annex B for the B1-B33 numbering referred to in table 6.3.

Table 6.3: Data Collection protocol for all case studies

Data Collection Protocol		
Case study phase	Data sources (reference to sources and reports as numbered in ANNEX B)	Persons involved in gathering the data
Company case study data collection		
1. Sector/company selection	Analytical reports, literature, survey data, interviews , site visits (ref. Athie et al, 1995, B16, B20, B21, B22)	Research Team (RT)
2. Case study contracting phase	Site visits, interviews, meeting, letters, negotiation (ref. B16, B20, B22)	RT, company
3. Start-up phase project	Workshop, site visit (refs. B1-14, B16, B18, B20, B22, B23)	RT, company, student
4. Project phases	Analysis reports, minutes, reports, students reports, surveys, literature & internet, artefacts, meetings, site visits, observations, formal graduation sequence reports, expert input, interviews, project team meetings (ref. B1-14, B16-23)	RT, company, add. experts, students
5. Overall project results	Meeting reports, graduation report, product, workshop, (environmental) analysis, fact sheet, publications, site visits, interview, administrative documents (ref. B1-14, B16-23, B25, B26, B30)	RT, students, company
6. Evaluation	Site visit, interview, analysis report (ref. B17,B21,B23)	RT.
7. Follow-up analysis	Site visit, interview, analysis report, product(s) (ref, B17,B21,B23, B26)	RT.
8. Scientific factors (see 6.2) analysis	Analysis meeting	RT.
Data collection on Facilitation		
9. Structured use of manual	UNEP manual, data gathered during company case studies (ref. Brezet, 1997, B16-23)	RT., students, company, other facilitators
10. Evaluation of use manual	Interviews, analytical report, student reports (ref. B1-14, B16-23)	RT., company, students
11. Adaptation of manual	Report, regional manual, analysis (ref. CEGESTI 1999, B 17,B18)	RT. add. experts,
12. Testing of regional manual	Data gathered during case studies (ref. B1,B10, B11, B20-23)	RT, company
13. Evaluation of manual	Interviews (ref. B20-B24)	RT.
14. Courses (Delft 2x and National 3x)	Observations, report, evaluation (ref. B27-B29)	RT., add. Experts
Data collection on Capacity		
15. Stakeholders contacts	Meetings, interviews, surveys, analytical reports, observations (ref. B16-B23)	RT., students
16. Regional conference	Reports, minutes, observations, papers, evaluation (ref. B30)	RT., all participating Org.
17. Building local networks	Observations, meetings, interviews with stakeholders (ref. 16-23, B27-32)	RT., stakeholders
18. Learning at universities	Observations, presentations, articles, student reports (ref. B16-B23)	RT, universities
19. Promotion, extension	Articles, conference proceedings, newspaper clippings, website (ref. B16-B23)	Stakeholders, RT

The key rationale to use this variety of data is the principle of triangulation that is used in this study (see Chapter 3): multiple sources of data to build a stronger case at determining fact or phenomena in the case studies.

6.5 Analytical strategy

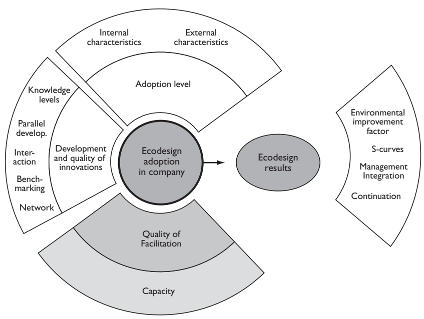
The main strategy to analyse the data of the cases in this study is to follow the theoretical propositions that led to the case studies, and that are reflected in the research questions and in the operationalisation of key factors as described in 6.2. The dominant mode of analysis that is followed is one of pattern-matching (Yin 1994). Within the explanatory part of the study, so mainly within the company case study analysis, the empirically based findings, or patterns, are confronted with the predicted or expected ones that are derived from theory and praxis. In each of the company case studies, the patterns of the operationalised independent variables or factors as they exist in the case are analysed on the basis of the empirical findings in the case study and connected to the outcomes of the case. Overall, the level of adoption and the influence on that by the factors can then be cross-analysed through all case studies. This analysis is complemented by another type of pattern matching analysis that is more suitable for a number of factors difficult to quantify or specify in great detail: explanation-building. On the basis of findings in the case study, explanations that reflect some significant theoretical proposition are given on certain phenomena that occur in the case study, trying to find relations between them. An example is the 'network quality' set of propositions, that can be analysed against the actual performance of the network by explanation building: to 'explain' the quality of the network, some of the quality factors that are operationalised (see 6.2) are linked to the empirical findings – difficult to measure in a precise manner, but giving insight on how the quality of the network is formed.

In addition to pattern-matching as dominant mode of analysis, a qualitative and narrative analysis of additional data and insights emerging from the cases is performed as well. This type of analysis is more applied to the exploratory research parts (mainly on the capacity building topic and to a lesser extent on the facilitation topic) where a strict pattern-matching analysis cannot be executed, because of the lack of detailed (quantifiable) data.

The analysis of the case studies is described in the next sections. In the following chapters on case study findings (Chapters 7 and 8), the findings and results of the case studies are presented in a descriptive way. In the analytical chapters (Chapters 9 – 11) the empirical findings connected to the research factors are first briefly described per case study, then scored according to the scaling system presented in paragraph 6.2. In addition further qualitative analysis of the case study findings is performed.

Part III: Case study findings

Chapter 7: Ecodesign adoption in the industrial case studies



In this chapter, the results are described of the adoption of ecodesign in the industrial case studies that have been executed. In 7.1 the selection process and results of the first phase cases are presented. In 7.2 the transition to the second phase is described, followed by the results of the second phase cases (7.3). In 7.4, the continuation of ecodesign in the companies is described.

7.1 Results of the first phase industrial cases

7.1.1 Selection of the companies

Sector pre-selection

The first step in the selection process of companies was the selection of relevant sectors within the region. Available data were formulated in a study into a sector analysis for sustainable industrial development in Costa Rica (Athie et al 1995). In that study, the agro-food, plastic and metal sectors had the highest score. However, this analysis did not analyse product development as a key element. Therefore, a qualitative analysis was done by the research team on the different sectors within the manufacturing industry. A number of criteria were applied, the most important ones are noted in table 7-1. The sectors that were selected on the basis of these criteria are presented in table 7-2.

Table 7-1: Criteria for sector selection

	Criterium for sector selection
1	Representative and important sector for the country/region
2	Large share of Small and Medium sized companies in the sector
3	Relevant environmental impact
4	Proven potential for ecodesign in the sector

Table 7-2: selected sectors

SIC code	Sector
20, 26, 28, 30	Agro/food and related packaging
34, 35	Metal working/machine manufacturing
36	Electronics
25	Furniture
30	Plastics

As service-oriented sector, the option of tourism (eco-tourism) was kept open, due to the large potential of tourism for the region and the proven opportunities for Ecodesign.

Selection of companies

Next, a number of general criteria were developed to select suitable companies within the sectors (table 7-3): On the basis of the selection criteria, and in dialog with all counterparts, shortlists of companies (10-15 per country) were generated to be visited by counterparts and DUT staff. After the visits, the general selection criteria were assessed to a more precise level, and the specific criteria (see table 7-3) were assessed.

Table 7-3: Criteria for company selection

	General and specific criteria company selection
General	
1	Small or medium sized company
2	Representative company for the sector
3	National or regional owned company, so not part (financially depending) of a multinational company or group of companies
4	Interest/willingness to participate in an ecodesign project
5	Own product development function in the company
6	Necessity and opportunities for environmental improvement of the product
Specific	
7	The company has the ability to execute the ecodesign project (management, focus on product development, actual plans for product(re)design).
8	There are possible business opportunities with eco-(re)designed products
9	There is an organised and structured production process.

On the basis of the assessment of the selection criteria, four companies in Costa Rica, two in Guatemala, two in El Salvador and one in Honduras were selected. Since the project in Honduras was suspended in 1998 due to the problems caused by hurricane Mitch, a total of 8 companies was selected. A contract was formulated for the participation of the companies in the project, which detailed all obligations and rights of both the company and the project team. The company had to pay a moderate fee for the external facilitation provided.

The projects were phased in time (per country, first Costa Rica, followed by Guatemala, followed by El Salvador) to focus the work and all assistance as good as possible. A ninth project was executed in Costa Rica in 1999, as a quick-starter in a follow-up project of CEGESTI with the metal association ASOMETAL.

7.1.2 Execution of the company projects

Each of the projects has been executed according to the following phases:
- 2 months preparation and desk research by DUT staff and student in The Netherlands for relevant available ecodesign information in Europe; preparation from local counterpart with company;
- 2 day start-up workshop at the company with all people involved in the specific demonstration project;
- 4 months ecodesign project by the company and DUT student in Central America with each two week a project meeting with local and CEGESTI consultants, back-up from DUT staff. The project followed the whole sequence of phases that is described in the methodology of the UNEP Manual. This includes market research and a full SWOT and strategic analysis of the company;
- 1 day final workshop to summarise the results and to discuss follow-up activities;
- 2 months finalisation of report and research by DUT student and staff in the Netherlands follow-up of the project in the company (undefined time) by company, CEGESTI and local counterpart.

The companies that have participated are listed in table 7-4

Table 7-4: Participating companies in first phase projects.

Company	Country	Product
Waiman	Costa Rica	Refrigerator for small shops (pulperias)
Heliconia	Costa Rica	Export packaging tropical flowers
Panel Ex	Costa Rica	Office furniture (office desk)
Mafam	Costa Rica	Packaging and distribution cookies
Talleres Rea	Guatemala	Coffee processing equipment (depulper)
Venus	Guatemala	Packaging and distribution candies
Industrias Bendig	Costa Rica	Coffee processing equipment (dryer/sieve)
Kontein	El Salvador	Plastic bottles for medical products
Mobelart	El Salvador	Kitchen cabinet

7.1.3 Results per company project

In the overview on the next pages, details the project are described for each of the companies. The description gives brief and systemised information about
- the company
- the product

- the environmental context
- the design propositions
- the results

The complete fact sheets on all companies can be found in annex A. These fact sheets (in Spanish) were extensively used in the dissemination of the project results, and also integrated in the regional manual. The analysis, including descriptive analysis, of the case studies is presented in Chapter 9.

7.1.3.1 Industrias Waiman

Location: San Jose, Costa Rica
Products: Refrigerators, kitchen equipment
Project: EcoRedesign of a commercial refrigerator by benchmarking
Reference: Hoornstra 1998

Industrias Waiman produces metal products and especially appliances to heat, cool and prepare food and beverages. The company consists of a manager, who is the owner of the company, and eighteen employees. The main goal of this company demo project was to develop a product that offers opportunities to improve business with less environmental impact compared to the reference product. In order to come to an effective product improvement the project started with a product selection. The product selected was the vertical commercial refrigerator, which is sold to small shops and restaurants to cool and display their products and to other bigger clients such as the government and producers of meat and beer products. Cost reduction, cooling efficiency and the manager's environmental consciousness were the main drivers in order to design from environmental point of view.

The main points for attention and priorities for the redesign have been:

- improvement of the cooling quality;
- reducing the energy use during life-time;
- facilitation of maintenance.

Improvement options on cooling quality have been generated with a benchmarking approach. The concept with the best results, tested on the refrigerator of Waiman, has been applied in the final prototype, the improvements included:

- less time needed to lower the temperature;
- better distribution of the cooled air by repositioning of the ventilator;
- less energy needed to reach the same temperature.

In order to reduce the energy use during lifetime further, a substitution to eliminate the resistance in the door has been developed. The resistance is used to heat the outside window in order to avoid condense on this side of the window. Another adjustment to use energy more efficiently has been the repositioning of the TL inside the refrigerator. This adjustment has been applied successfully. Some small improvements, orientated on the facilitation of the maintenance, could be applied directly and had also been achieved by benchmarking during the external analysis.

These improvements resulted in improvement of cleanability and reparability. The product improvements have been implemented in the production directly, some improvements even during the development phase.

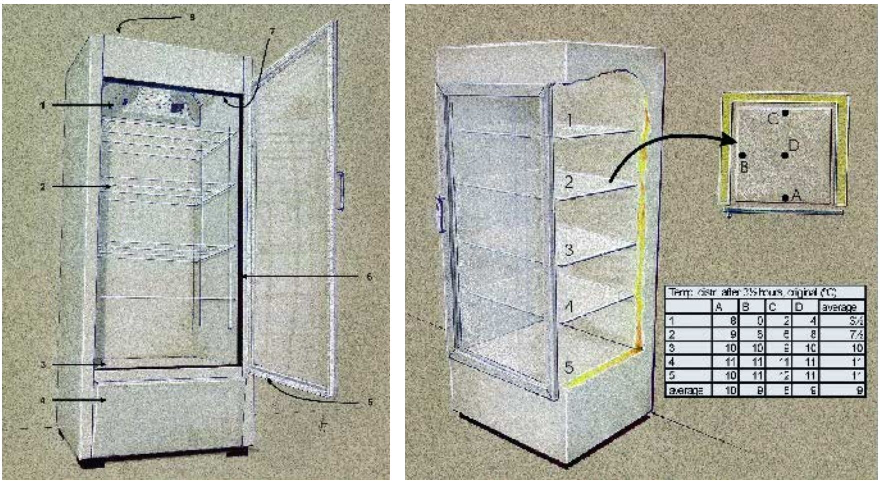


Figure 7-1: Improvements options and testing of the redesigned vertical refrigerator of Waiman.

7.1.3.2 Heliconia del Caribe

Location: Siquirres, Costa Rica
Products: Tropical flowers for export
Project: Eco-Redesign of the Export Packaging for tropical flowers
Reference: Verveer 1999

Heliconia del Caribe is a flower farm (finca) with 12 employees, that grows and exports tropical flowers to Europe and North America. The manager of the finca and his customers are interested in strategies to improve the environmental impact and business of flower export. Heliconia produces about 100 different species and combinations of flowers, for which they use three types of packaging of own design.

The outside packaging of the reference product is made of single corrugated cardboard existing of two halves, which fit like a luncheon box. In order not to separate the halves during transport, two tie wraps are being used, made out of PE with an aluminium clip. Inside, the flowers are protected by a blank newspaper sheet, LDPE foil wraps (to protect the flowers from cold damage) and paper confetti or newspaper sheets, in order to protect against shocks, bumps and throwing around during transport.

The scope for the redesign of the packaging of the tropical flowers is:
- The application of low energy content materials in the new packaging.
- The reduction of the amount of used materials and weight, so the transport costs decrease, in order to improve market positions and decrease the environmental load during air cargo.

- Better protection of the flowers during transport. Rough treatment during change of mode of transportation damages the flora, which is the reason why vast amounts of cardboard and paper are being used in order to protect the flowers.

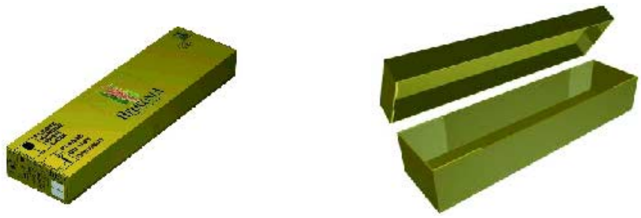


Figure 7-2: Concept for new packaging for tropical flower transport.

Ten new concepts have been developed with less material use and better protection of the flowers. Five selected concepts have been tested on their suitability for tropical flower distribution. The best solution has been selected and is in use now as packaging for the flowers of the company.

The results of this project are:
- 14% reduction of packaging material
- 18% reduction of transport costs
- 9 % reduction of total costs
- Improved protection conditions for the flowers
- Better communication on transport conditions and content (ISO 780)

7.1.3.3 Panel-Ex

Location: San Jose, Costa Rica
Products: Office furniture
Project: Development of an ecodesign approach, redesign of office furniture.
Reference: Baas, L. 1998

Panel-Ex is a company that develops office furniture systems. The motivation of Panel-ex to join this project is the need to enter new markets and to differentiate from their competitors. Furthermore the general manager of Panel-ex is environmentally aware and wants to have a product-line that has less impact on the environment. The main objective of this project was to develop an appropriate ecodesign approach for Panel-Ex and to test the ecodesign approach on a product with less environmental impact compared to current product. Simultaneously local capacity for ecodesign at Panel-Ex will be enhanced.

The product selected is for the market of small and medium offices. This product is a desk-system that is easy to adjust and install. Key environmental issues to be considered are the type of materials selected and the energy consumption during production. Also use of materials during the production, such as glues and solvents, is investigated.

The design scope of the project is to develop
- a flexible system, in which the legs of the desk can be used in various modular settings
- optimise the space use
- optimise the materials use
- use materials with a lower energy content
- ergonomic design

Two concepts are developed: one with wooden legs, one with metal legs.
The desk with wooden legs has a desktop of chipboard with melamine and is supported by a frame of eucaplac. The wooden legs are placed outside the desk to make it possible to connect desktops using the same pair of legs. The version with the metal legs uses standard metal legs.

Figure 7-3: The new modular concepts for office furniture concept for Panel-ex.

Results of an environmental comparison between the current furniture and the proposed desk-system with wooden legs are:
- 22 % weight reduction
- 6% reduction of energy content
- 57% reduction of formaldehyde use
- 27% reduction of melamine use

7.1.3.4 Mafam

Location: San Jose, Costa Rica
Products: Cookies for the local and export market
Project: Eco Redesign of packaging and logistics of cookies
Reference: Wijnans 1998
Industrias Mafam is a privately owned company. It is a medium-sized company in Costa Rica with 32 employees. It produces and distributes cookies and corn-based snacks for the consumer market, which makes it a market organisation with a product function. Mafam has its own distribution infrastructure, as the local market required a high level of service.

Figure 7-4: The product of Mafam, and the transport packaging

The ecodesign project at Mafam has been focused on the total distribution system and not only the packaging itself. Environmental improvements and cost benefits have been generated for several steps in the distribution process by developing two separated systems for supermarkets and small shops (pulperias). Examples of the improvement options are:

- Reusable plastic crates for transport to the small shops instead of disposable plastic bags;
- Smaller sealing and holes by developing a new display method;
- Use of thinner cardboard boxes for supermarkets and higher refunds for pulperias;
- Special nets for displaying products in pulperias instead of plastic bags.

Results include 3% reduction of primary packaging material, 20 % reduction of secondary packaging, 5% reduction of card board.

7.1.3.5 Fabrica Venus

Location: Guatemala City, Guatemala
Products: Candies
Project: Eco Redesign of packaging and logistics of candies
Reference: Augustijn and Uijttewaal 1998

Venus is a medium-sized Guatemalan company that now produces 150 different kinds of candies in the factory that is situated in Guatemala City. They sell most of their products on the Central and Latin American market and a smaller amount to the USA and South America. Venus wants to sell her products on new markets and especially on the European market. Because of the different kind of requirements on the European market, product development is needed and Venus decided to use ecodesign for this innovation process.
Hard-boiled candies have been selected for the project because of the great variety and flavours of the product and because this product is the biggest and cheapest production of the company (80% of the turnover). To reduce the environmental impact, options have been generated to reduce the use of packaging material, to use environmental sound materials, to reduce the printed area and to design a package

that will be easy to print for the machines within the company. Pillow pack for wrapping the candies has been chosen as packaging solution, since a pillow pack saves more than 40% material compared to the current used single and double twist. Besides, the machine to make the pillow pack is much faster than the other machines for the twist wraps and produces less material waste. Cast PP material has been selected for the bags instead of laminate BOPP (which has problems with recycling and use of glues) for the wrappings. In Central America, there is a possibility to recycle PE. Therefore, the company has been recommended to start gathering the used transport PE, gathered by the trucks on their (empty) return trip. The company can earn money from selling the PE bags to the recycler.

The final outcome of the project at Venus were two products for the European market and two new, smaller bags that will be implemented in production for the local market. The new pillow-packaging with more than 40% material reduction has been released on the market. Besides the company has implemented some of the other improvement options related to the distribution system which can result in interesting cost savings.

Figure 7-5: The smaller packaging on the left is the new packaging for Venus products.

7.1.3.6 Talleres Rea

Location: Guatemala City, Guatemala
Products: Coffee processing equipment
Project: Ecodesign of a new Despulpador
Reference: Garvik 1999

Talleres REA is a family company of 35 employees with 50 years of experience in producing machinery for coffee plants. REA produces all the products necessary for converting the red coffee berries into the brown bean that ends in cups all over the world. The company is situated in Guatemala City, and has a workshop with traditional machines for working with metals.

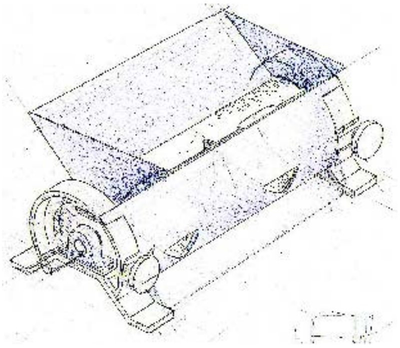
The government in Guatemala is releasing a new legislation dealing with the massive use of water in the wet-processing of coffee. Further, awareness is growing on ecological issues of coffee producing, both in Guatemala and the countries that import the coffee. Ecological grown and processed coffee receives a higher price, and this is a strong motivation for the REA clients to change in the direction of more ecological solutions.

The selected product was a depulper: The depulper is central in the coffee processing. The depulper of REA has a good reputation, but uses old technology and traditional materials.

The directions for improvements are:

- Low impact materials: changing copper parts to stainless steel will be better for the environment because the steel will last for 4-5 years before it has to be replaced.
- Reduction of material usage: by executing a functional analysis of the different parts it will be possible to discover where the massive cast-iron actually is needed, and which parts that can be changed or eliminated.
- Production techniques: by decreasing the number and size of components, better production-techniques and less waste are expected outputs.
- Impact during use: a design with the whole system in mind could open possibilities to for example share power between several machines. This project starts this process.

Results:
Talleres Rea has produced a prototype of the new concept, resulting in a 70% reduction in weight, 50% savings in production time, less energy and 50% less expenses. The product is sold on the market. In cooperation with UTEPYMI, Talleres Rea has executed a second ecodesign project on one of their products (Criba or sieve) as a follow-up project.



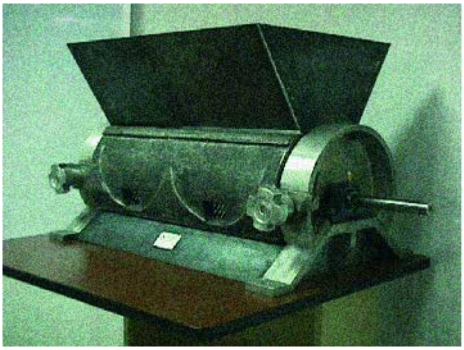


Figure 7-6: Concept and the new depulper of REA.

7.1.3.7 Industrias Bendig

Location: San Jose, Costa Rica
Products: Equipment for coffee processing companies
Project: EcoRedesign of a dryer/sorter "oreada de cascada"
Reference: Cegesti and Prop 1999

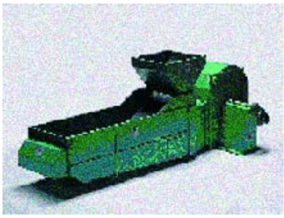


Figure 7-7: On the left the traditional dryer/sorter, on the right de Eco-Redesigned machine.

Bendig is a medium sized company with about 60 employees. In total they produce 60 different kinds of machines for the processing of coffee after the harvesting process. Bendig exports 75% of their products to various countries. The project in Bendig was performed as part of an environmental programme of the metal association in Costa Rica (Asometal). To stimulate this type of initiatives by sector organisations, additional support from the Ecodesign project was granted.

The dryer/sorter "oreado de cascada" has been selected as the subject of the demonstration project within Bendig. This machine is used for the pre-drying process after the washing of the coffee beans. A big part of the costs (65%) depends on the assembly costs.

To produce the dryer, a lot of materials are used. Because of the high weight, big volume and long distances to the customers (Mexico, Hawaii etc.) the transport of the final product causes a serious environmental impact. The environmental analyses of the total life cycle of the product showed the best opportunities in the field of the optimisation of the material use and the production. For this reason improvement options have been generated related to the elimination of unnecessary elements, simplification of the functional parts, easier assembly and less production waste. The outcome of the project is a simplified, more compact and easier to transport "oreadora de cascada".

The main improvements are:
- The product contains 20% less material.
- The assembly time has been improved by 20%.
- The production costs have been decreased by 25%.
- The machine is easier to operate by the customer.

7.1.3.8 Kontein

Location: San Salvador, El Salvador
Products: Plastic bottles, containers and packaging
Project: Ecodesign of a plastic medicinal bottle
Reference: Baas, M. 1999

Kontein is division of the national Sigma group which produces mainly plastic bottles and caps for the food, medical, cosmetic and agricultural industry. The company possesses modern equipment and produces its own moulds. The "Farma" bottle, one of the best selling products, made out of PVC showed several opportunities to improve the environmental impact of the product. Yearly about 285.000 pieces of this product are sold in Central America.

At the moment there are no possibilities in El Salvador to recycle the PVC waste. This causes environmental problems at the end-of-life stage of the bottle but also for the production waste generated inside the company (each year 800 kg). The challenge of the product development process was to create a plastic bottle with a lower environmental impact and a better design (bigger front surface which is important for the marketing in supermarkets). A first step has been to look for an alternative material for PVC with still could fulfil the requirements for medical packaging purposes. PP showed to be an appropriate alternative material with a lower environmental impact and costs. The cap was already produced out of PP, for this reason the new bottle can be recycled together with the cap (mono material). As a next step, the material use in the bottle has been optimized.

The main improvements related to the product are:
- Reduction of the weight by 30-72% (depending of the design).
- Use of only one kind of plastic (PP) in the product (easier to recycle).
- All production waste can be recycled.
- Reduction of the production costs by 54%.
- Less corrosive impact on the production moulds.

Figure 7-8: The old and the redesigned plastic bottle for Kontein

7.1.3.9 Möbelart

Location: San Salvador, El Salvador
Products: Refrigerators, kitchen equipment
Project: Ecoredesign of a commercial refrigerator by benchmarking
Reference: Ruyter de Wildt 1999


Figure 7-9: On the left the traditional kitchen cabinet and on the right the redesign

Mobelart is small furniture producing company in El Salvador. Mobelart produces high quality and tailor made furniture for offices and kitchens. The management of the company feels responsible for the environmental impact caused by their production processes and products and is looking for new innovations on the market. Both motives have been the reason for the company to join the Ecodesign in Central America project.

The selected product for the project is a kitchen cabinet for middle market to be sold by a big warehouse in San Salvador. This new product for Mobelart tries to meet the cost, comfort and quality requirements of the middle class people in Central America.

Design focus:
During the production process the wood dust is already absorbed and taken care of. However still there are several waste streams which could be prevented by changes in the product design such as less glue waste, less wood waste etc. Besides the improvement of the production process there has been a focus on the total design of the product. Some parts were redundant and could be left away or could be minimized.

The most important benefits obtained by the project are:
- 15 % reduction of the weight of the product;
- 12 % reduction in costs;
- Easier to install and to transport;
- Less waste and energy use during the production;
- A modular design, easy to adjust and to upgrade.

7.2 Designing the transition to the second phase of the project

For the second phase of the project, the project team decided to put more emphasis on the functional and system level and on product chain approaches in the new company case studies. These levels were not included in the first period, but are expected to enlarge the possibilities for environmental improvement and economical feasibility of improvement projects. Sector initiatives were (re)introduced. This was tried before with the metal sector in Costa Rica, but only one company (Bendig) finished the project. This approach both creates a possibility for a multiplier mechanism, especially in homogenous sectors. Also, support is gained from sector organisations, thus enlarging the institutional capacity. The sector approach also fits well within larger funding opportunities of financial institutions. The metal sector showed good results in the individual case studies of the first phase. Also, the need to involve service-oriented projects (such as sustainable tourism activities, systems and products) was expressed several times, since they promise a potential for improvement. There are good opportunities for this type of projects in the region because of the growing importance of the tourism sector in the region.
An ecodesign project in 2-3 companies being part of the same chain was started, where the methodology was applied and ecodesign products were developed in co-operation with different partners in the production chain.

The transition can be depicted as follows (figure 7-10):

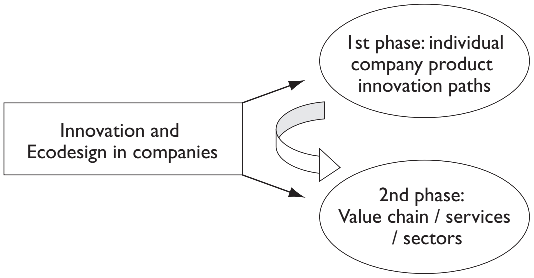


Figure 7-10: transition from first to second project phase

7.3 Results of the second phase industrial cases: sectoral, chain and service innovation

The selection of sectors/chains/services and the connected selection of companies for the second phase industry projects were executed in a number of steps. In addition to the general information that was available in the project, new insights were available from the Regional Competitiviness and Sustainable Development Agenda (INCAE 1999). In that Agenda, as high-potential cluster are mentioned: the tourism sector, the textile sector, high-value-added agribusiness, and the electronic and software sector. This information was taken into account in the design of the second phase. See annex E for a brief description of this Agenda.

First, a general SWOT analysis was made for the opportunities to work in certain areas in the three countries were industry projects would take place (El Salvador, Guatemala, and Costa Rica). On the basis of this, the combinations were chosen as shown in table 7-5.

Table 7-5: combining approaches and sectors for the second phase

Country	Approach	Sector
Costa Rica	service approach	tourism
Guatemala	sector approach	metal sector (SME's)
El Salvador	chain approach	food chain

Secondly, a selection of potential counterparts in each of the countries was invited to submit proposals for this type of projects to the project co-ordinators. The proposal needed to include a description of the project approach and of the companies to be selected. Based on this, a number of visits were made to the companies to assess the proposals and the best project proposals were selected. The criteria for the selection were:

- Quality of proposal
- Suitability of the companies proposed
- Quality of the counterpart organisation

The following projects were chosen (table 7-6):

1. Service approach, Costa Rica: together with the tourism organisation Aventuras Naturales, with suppliers of the tourist resort in and transport companies transporting the tourists. Leading counterpart is CEGESTI.
2. Sector approach, Guatemala: collaboration with three small/medium sized metal companies: Turbomac, Inmepro and Executiv. Leading counterparts are Fepymi and Universidad de Landivar.
3. Chain approach, El Salvador: In the view of the expected higher risk to get a successful chain approach projects, it was decided to select the vertically integrated corporation Hacienda El Jobo (milk production) with their raw materials and packaging suppliers. El Jobo has a cattle farm and a milk production site. Leading counterparts are AG Tech and ITCA.

Table 7-6: Second phase projects

Company	Country	Product
Aventuras Naturalis	Costa Rica	Tourism service: rafting tour
Turbomac	Guatemala	Stove for small restaurants
Inmepro	Guatemala	Industrial stove
Executiv	Guatemala	Office furniture
El Jobo	El Salvador	Cream

7.3.1 Service project

Aventuras naturalis
Location: San Jose and Pacuare River, Costa Rica
Products: Tourism services: rafting, hiking, biking, canopy tours.
Project: Improvement of 2 day rafting trip
Reference: Raangs 2001

The company Aventuras Naturalis offers rafting, biking and hiking trips. On the Pacuare river the company has its own lodge with bungalows for multi-day rafting trips. The services Aventuras offers are connected to nature, and many of the trips are in sensitive natural areas. The company is very much aware of its responsibility in this respect. Although the company was already working on environmental issues from the start of their activities, and was familiar with most of the improvement opportunities that came from the project, the project had a large impact on the activities in this field.

Figure 7-11: Advertisement and lodge of Aventuras Naturalis

The focus of the study was one of their key services: a two-day rafting trip to Pacuare River. This service includes most of the key features of Aventuras' activities, including transport, stay at the lodge, rafting, meals etc. The full spectrum of activities during a trip was studied, and improvements were made.

The following results have been achieved:
Short-term options:
- Biodegradable cleaning products for lodge
- Biodegradable soap and shampoo for tourists
- Recycled paper for tourist information and office paper
- More nature information in the lodge and on internet pages

Medium-term options:
- Products from the area (f.i. fresh tilapia fish from a near fish farm)
- Separation of wastes at lunch on riverbank
- Recycling of glass and aluminium cans
- Energy saving at the office

Long-term options:
- Generation of hydro power
  45 – 60 kW can be produced, which is more than enough for the basic water heating, cooling, light and power needs. Cooking will continue on gas.
- Eco-certification for lodge: Aventuras has applied for certification.

An option under consideration is improvement of the transport situation. It became clear from the project work, that the company alone cannot solve this, and that a much broader network of actors is necessary to be involved in this. Probably, the company is not the right one to take the initiative here, since many of the competing firms are suspicious of cooperation in this field. Probably a more 'neutral' actor should take the lead, which will be considered in future activities.

7.3.2 Sector project

In Guatemala, in 3 SMEs in the metal-mechanic sector projects were performed:
- Executiv, a producer of metal desks/office furniture
- Turbomac, a producer of comales (tortilla cookers, pan integrated with burner), burners, cookers
- Inmepro, a producer of stainless steel kitchen furniture for hotels/restaurants

In all three companies a team, consisting of company people, Landivar University and FEPYME staff, and students of Landivar have worked on the project. CEGESTI and DUT had a coordinating and advisory role. At Fepyme, two Delft internship students have supported the projects during three months by organizing joint and company workshops (f.i. on MET and LiDS instruments), and delivering information to the company project teams.

The individual results per company are as follows.

Turbomac

Location: Guatemala city, Guatemala
Products: Stoves, tortilla cookers (Comales), fruit dryers
Project: Ecoredesign of a semi-industrial stove
Reference: van Dijk and Dresselhuys 2001

Turbomac is a small family-owned company already active many years on environmental issues, especially energy efficiency. The company has a patent on a energy-efficient burner. The ecodesign approach gives excellent additional input, since now not only energy efficiency but also other environmental aspects such as materials selection and materials reduction are taken into account.

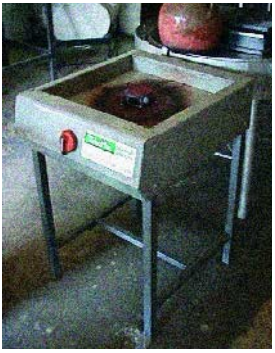


Figure 7-12: New Turbomac stove

The product is a stove that is used in shops and small restaurants. The old product is heavy, not standardized and not ergonomically and aesthetically designed. The design perspective is to reuse materials, improve standardisation and modular design, and apply the most energy-efficient burner possible. The new stove is modular and easy to transport, and has a shorter production time. Clients can decide to take from one to four modules depending on their needs. The use of the efficient burners reduces the energy use. The use of standardised parts reduces the materials use. The company is planning on using the ecodesign principles also in the development of other products.

Inmepro

Location: Guatemala city, Guatemala
Products: Stainless steel industrial kitchen equipment
Project: Ecoredesign of industrial stove
Reference: van Dijk and Dresselhuys 2001

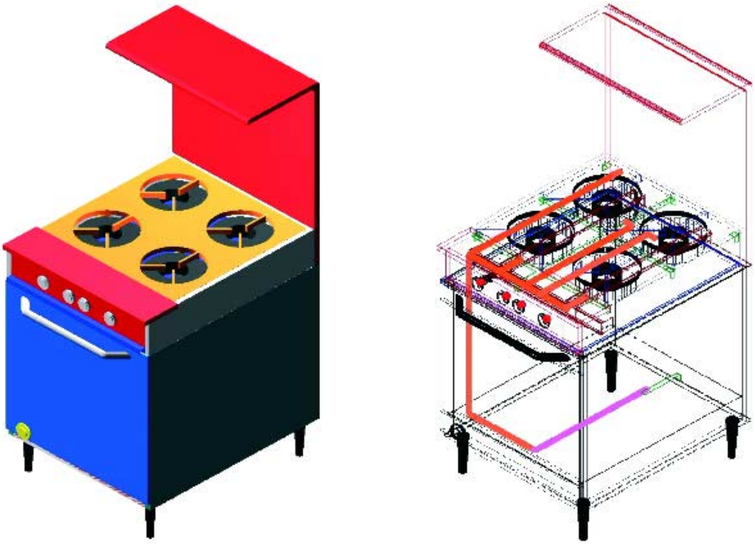


Figure 7-13: Design of new stove of Inmepro

Inmepro produces and imports kitchen equipment (mainly of stainless steel) for restaurants and large-scale kitchen in office buildings etc. Until now, the industrial stoves are only imported by Inmepro, and they want to compete also on this market by producing these stoves themselves. The scope of the design included reduction of costs, materials, weight and reduction of the use of solder materials. The gas pilot that is standard in this type of kitchen should be avoided, and the design should be modular. in addition to these points, the possibilities to buy more energy efficient burners are also investigated.

The proposed design has the following advantages:

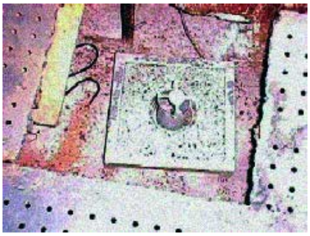
- reduction of materials used in the kettle supports, switches, pipes and frame
- modular design
- lower weight, easier transport
- reduction of solder use

Inmepro did not yet produce the new stove (status 2002) because they were waiting for a bulk order to do so.

Executiv

Location: Guatemala City, Guatemala
Products: Office furniture
Project: Office desk, drying chambers
Reference: van Dijk and Dresselhuys 2001

Executiv is a middle sized company on office equipment. In the ecodesign project a proposal was made for a new office desk with use of less and recycled materials. The project did not lead to a prototype model, because the type of materials used and the production technology needed was at that moment not available to the company. However, as a spin-off the project has concurrently led to new ideas and the development of several other creative environmental activities in the company, such as energy efficiency in the drying chambers of the paint lines.



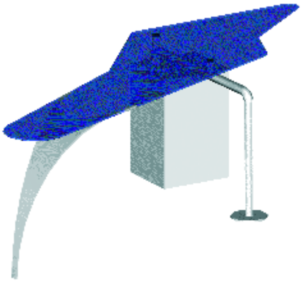


Figure 7-14: Energy-efficient burner in dryer cabin Executiv; proposed design for office desk

One of the objectives of this sector- oriented project was to develop a 'multiplier' factor for rapid introduction of ecodesign in similar companies. Also, the idea was that capacity building would be stronger because of the joint learning done by the sectoral organisation and the company. A third goal was to strengthen strategic alliances between the different metal companies. The experiences show, that it is indeed possible to work simultaneously in three companies, thus reducing the per-company time for the consultants and supporting organisations. Several activities, such as workshops, can be done in conjunction. Parts of the information transfer necessary can be given to all three companies at the same time. Capacity building is indeed strengthened by the joint projects. Mainly in the first phases of the project, interesting information was gathered on the strengths and weaknesses of the companies. This led to a better insight of the organisations involved.

A positive result is found in the formation of strategic alliances between the three companies. During the project, three possible strategic alliances between the companies were detected. Two of those are already formed: Turbomac can use the production facilities (steel sheet cutting and bending) of Executiv. Executiv has bought and installed the energy efficient burners of Turbomac in the drying cabins of the paint street, thus reducing energy use with at least 30%. A third logical alliance, the use of the energy efficient burners of Turbomac in INMEPRO stoves, is not feasible due to bureaucratic problems between the boards of directors of the companies. These problems are not connected to the ecodesign project as such, and hopefully will be resolved in the future.

7.3.3 Production chain project

Location:	El Salvador
Products:	Cheese, milk, cream, meat
Project:	Chain project: Improvement production site, design new cream and packaging
Reference:	Sagone 2001

Figure 7-15: Hacienda El Jobo (left) and the cream product (right)

Hacienda El Jobo in El Salvador (Sociedad Cooperativa Yutathui) is a modern agricultural company with 324 hectares of land. Daily milk production is 5000 – 7000 litres. The cooperation has a production plant with 20 employees. It was a challenging project for the company, aiming at completely new products (milk cream) and markets. Also, there is an already strong emphasis, in addition to the product orientation, to elements in the beginning of the chain, such as manure/energy issues and cleaner production issues in the chain. The development of a low-fat cream can lead to a direct increase of income, since the bulk of the costs made in the production of milk and cream are more or less linear to the fat content, a relation that is decoupled in the selling price.

The company was assisted by a doctoral student from Landivar University in Guatemala, thus starting a new type of cooperation in our project.
The practical results are as follows:
- overall water use reduction of 30% in the production site
- development of two entirely new products: Creams with 30% and 18% fat content, in addition to the existing 45% cream.
- 20 % improved use of primary materials due to the new product formulation
- Better product image with a new design
- Savings on the electricity bill of 1000 USD/month
- Reduction of ink use for packaging

It is expected that the new product diversification will lead to a bigger overall market for the company and to an increased production (status end 2001). The project already has led to better insight in the environmental situation of the company, and also to a renewed effort to get the necessary entry into new markets. Regarding the chain aspects of the project, until the time of reporting the cream product has been redesigned, and improvement in the production unit has been realised (not only related to cream production). Future projects considered are the use of biogas generated from the manure.

7.4 Continuation of ecodesign activities in the case study companies

In 2001, contact with the first 9 demo companies was renewed to find out what has happened after the demo project. To follow the actual implementation and continuation of ecodesign activities, a number of topics were defined:
- Was the eco(re)designed product actually introduced at the market (all 14 companies)?
- Is the redesigned product (or an improved successor) still on the market?
- Did the company redesign other products according to ecodesign concepts?
- Did the company start other related environmental projects on cleaner production like ISO 14.000?

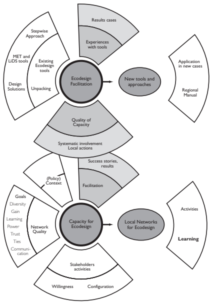
For the second phase companies, which had finalised the projects just recently, only the question related to market introduction and capacity can be answered.

In total, from the 14 products, 9 are actually introduced on the market, and in 4 of the companies (Mafam, Panel-ex, Kontein and Executiv) only prototypes were developed – although in the case of Executiv other environmental innovation did come out of the project. 1 product (of Kontein) was not actually introduced on the market, but ecodesign activities as such were integrated into their ISO system. The INMEPRO stove is still planned for market introduction (status 2002). So in 2 companies out of 14 there was no concrete result from the project on the market (Mafam and Panel-ex). See table 7-2 below for details. Eight of the products, or their improved newer versions, are still on the market (status 2002). Due to the total collapse of the regional market for coffee machinery in a time of strong recession in the coffee sector, one product (REA) is still on the market but with almost no sales, the other (Bendig) is no longer on the market. Exactly those two coffee machinery producers also produced new eco(re)designed products for other markets. Two companies introduced the ecodesign principles also in other products, but did not start a full project on it. Four companies engaged in related projects, such as development of 'ecological' coffee processing, environmental sound farming (reduced use of pesticides etc.), and ISO 14.000. This last company (Kontein) is the only company where ecodesign is formally integrated into the management system. However, technical and organisational capacity for ecodesign is structurally available in 8 of the companies. See table 7-7 for a summary of these findings.

Table 7-7 Continuation of the ecodesign activities in the case study companies

Company	Country	Product	Result	Capacity ecodesign
Waiman	Costa Rica	Refrigerator	On market	No
Heliconia	Costa Rica	Export packaging flowers	On market	Yes
Panel-ex	Costa Rica	Office furniture	Prototype only	No
Mafam	Costa Rica	Packaging and distr. cookies	Prototype only	No
Venus	Guatemala	Packaging and distr. candies	On market	Yes
REA	Guatemala	Coffee processing equipment	On market	Yes
Mobelart	El Salvador	Kitchen furniture	On market	Yes
Kontein	El Salvador	Plastic bottles	Prototype only	Yes
Bendig	Costa Rica	Coffee processing equipment	On market	Yes
Av. Naturalis	Costa Rica	Rafting tour	On market	Yes
Turbomac	Guatemala	Household stove	On Market	No
Inmepro	Guatemala	Industrial stove	Planned	Yes
Executiv	Guatemala	Office desk	Design only	No
El Jobo	El Salvador	Cream	On market	No

Chapter 8: Facilitation and capacity building cases



In this chapter, the results of the facilitation and methodology application (8.1-8.2) are presented, and the transition towards a continuous learning effort in the second phase (8.3). Next, the efforts on capacity building in the project are described. In the first phase, this was mainly focused on the counterpart organisations (8.4), in the second phase aimed towards local networking (8.5 and 8.6).

8.1 First phase: Facilitation at company level

The ecodesign process in the companies was facilitated directly by the following persons and activities:

- Start-up workshop with managers of several companies.
- 1 or 2 day workshop at the company with project team and all involved personnel
- Regular meetings with the project team from CEGESTI, TU Delft and local counterpart
- Project of graduation student (design engineering) from TU Delft – 6 months involvement, of which two months preparation in The Netherlands
- 1 day final workshop
- delivering of final report by the student, 2 months after project involvement.

Figure 8-1 Companies start-up workshop at CEGESTI (l.) and in-company workshop at REA (r.)

This high-level and high intensity involvement in the ecodesign process within the company can be described as a ‘flying start’ for the company: a six months full-time involved of an almost graduated Delft engineer, consultancy from a local expert, advice from Delft experts ensuring transfer of existing knowledge in similar publicised cases in Europe. All this almost for free, only a moderate fee had to be paid.
The companies reacted different to this ‘launch’. Most companies, after a watchful start, became very enthusiastic, several of their staff got involved more and more, learning from the project and taking the lead in it. Others reacted more cautiously and ‘followed’ the developments within the project, with less extra involvement, and the initiative was left with the external project team. This was the case f.i. in Waiman and Panel-ex. One expects that in the second type of company, the end of the demo project also means that ecodesign activities slow down to a full stop quickly. That was indeed the case in those companies. On the other hand, it is difficult for the enthusiastic companies to keep up the speed and initiate follow up activities. For instance, in Mafam, Venus and Mobelart, all very positive about the approach and project- external factors slowed down follow up.

The facilitation not only included the typical environmental approach, but also a market analysis, benchmarking of the products, analysis of the competitors and a full SWOT analysis of the company. From this work, the non-environmental arguments for product improvement came forward.

Integrated in the project, all companies received 2 days of introductory workshops. In Costa Rica, the first one-day workshop was with all companies together – explaining the concept, approach and tools, and having hands-on exercises for the company experts on their own situation. The second day workshop was held in each company separately and dedicated to the specific company project including organisation and planning. With the experience of the full first phase of the project executed, in which several of the company staff were involved, and with the support of CEGESTI, DUT and counterparts in the follow-up activities a first nucleus of capacity in industry is developed.

8.2 Methodology application – towards a regional manual

As a starting point, in all companies the UNEP Ecodesign manual (Brezet and van Hemel 1997) was used as a basic methodological tool for the ecodesign project. See Chapter 5 for an overview of the steps taken in this methodology. The experiences of applying this approach with the companies were as follows.

(Eco)design approach

Most the companies did not have a structured and formalised design process – exceptions are Bendig, Kontein and Mobelart. Strategic planning is only done in those companies and the food companies Mafam, Venus. This means that this project also was the first experience for many companies in a structured and formalised product design process.

We saw in Chapter 7 that in all case companies the basis of product development is copying from products of other companies, mainly from outside the region. Products of the competitors are bought and (if applicable) dismantled. Pictures/catalogues are used for design features. This means that the (Eco)design approach as used in Europe is probably too much focused on the innovation type of product development, while in Central America there is much more need for (intelligent) copying approaches. 'Intelligent', because it should be remarked that some focus on innovative elements in product development, integrated into an overall copying approach, will be of great extra value to the company. This was exactly what happened in some of the pilot projects: innovative elements were introduced in the product development. Examples are the use of steel and aluminium parts in the depulper of REA, new design features in the refrigerator of Waiman, material choice in Panel-ex' desk.

None of the companies did take environment into account during their previous product development activities. Some of the companies see good environmental performance as part of product quality (a.o. Mafam, Mobelart). For only a few of the companies, environment is already an issue: REA and Bendig can expect that (wastewater) policy developments push them to more environmental friendly products. To a lesser extent environment is on the agenda for Venus, Kontein and Heliconia, since they have to comply with international standards due to export. This 'low urgency level' of environmental issues meant, that when introducing ecodesign for product development in the region, environmental arguments had to be coupled with cost reduction, market growth and quality improvement arguments.

Tool use

As stated, almost all (eco)design tools that were introduced during the pilots were new to the companies. They were received in a variety of ways. General strategic/analytical tools, such as SWOT analysis and market surveys were applied without much problems. Tools for the environmental analysis were more difficult to apply. It was possible to fill the simple MET matrix, but any attempt to get more detailed information was difficult. Partly, the in-house information on materials, quantities and chemical substances was partial at best, but also external data on environmental impact, energy data etc, are hard to get. Estimates were made using European systems (such as the Dutch Ecoindicator) which use generic (European) data, but results have to be presented with care. The experience however is, that the improvement potential of the products in most cases was still so large, that problems with f.i. trade-offs on environmental effects did not (yet) occur.

The ecodesign strategy wheel or LiDS (Life Cycle Design Strategies) wheel, a key tool aimed to generate product improvement options, was received positively, but in some cases companies found it difficult to apply. The use of the tool requires some skill in the use of abstract and 'integral' tools, in which many elements are interconnected. If people are not trained to look at a problem in this way, it is difficult to use. Another problem encountered is, that the terminology used in the LiDS wheel is not understood easily in the companies, since it deals with the life cycle of the product on a detailed level. Therefore, solutions were generated by using additional tools, such as checklists of 'instant' options, and by analysing existing products on the market on the solutions chosen.

Marketing

Although the threats to the natural surroundings are known in the region and to a certain extent play a role in Central American policy and society, this is not the case regarding environmental aspects of products. There is no awareness on this topic in industry, nor are customers sensitised to green products. This means that, in principle, there is no market for environmental improved products per se. The same situation is found for The Netherlands (Santema et al. 1995, De Lange et al. 2002) – There is, however, a market for environmental improved products in combination with quality improvement and/or cost reduction. Some recent policy development (like on wastewater reduction from the coffee industry) will eventually push bad products out of the market, but this is only the case in specific sectors now. The situation can be different for the export products, depending on requirements and environmental issues in the recipient market: for some of the export product there are requirements for the environmental attributes of the product.

Management systems – let alone environmental management systems - are not required nor generally used in companies in the region producing for the local market. Exporting or international companies (Heliconia, Kontein, Venus) do have ISO 9000, and/or ISO14000 certification, but not the 'local market' companies. The European idea and focus on embedding ecodesign approaches in available or new management systems doesn't yet work here. Other approaches are therefore needed to anchor and expand the experiences of the first pilot in the company.

Simplified tools.

It was clear from the beginning of the project, that the tools presented in the European approach required insight into both environmental problems and product development. Insight that will be lacking in the beginning of the process. Conceptual tools that present the broad array of improvements for products over their complete life cycle (Like the LiDS –Life Cycle Design Strategies – tool) were sometimes difficult to use Therefore, a number of simplified tools were developed in several of the case studies, and tested in the companies. Usually, those tools included checklists, rules-of-thumb and questionnaires for the company to use. One example of such an experimental tool is the Product Improvement Triangle (PIT) tool (Diehl et al. 2001). The PIT tool follows a sequence of steps, all in the form of questions and simple checklists. First an analysis of the product is made, followed a life cycle costing estimation. Next, all the ecodesign strategies are presented through a set of questions, first the ones that deal with cost reduction, then quality improvement and finally environmental improvement. At the end, an action matrix is filled. See figure 8-2 for an overview of the structure.

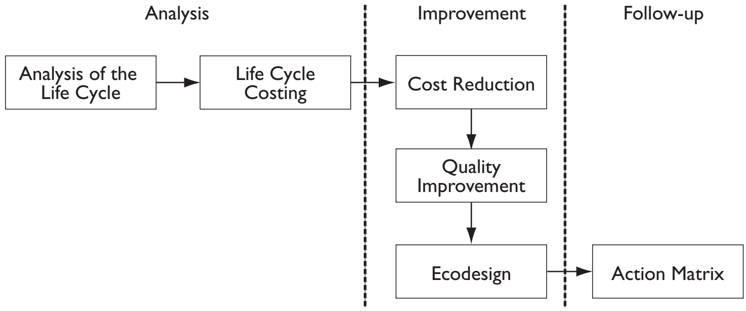


Figure 8-2: structure of the Product Improvement Triangle (Diehl et al. 2001)

Regional Manual Development

The starting point for the adapted regional manual was the use of the UNEP manual. As preparation for the regional manual development, a number of actions were performed. First, product development and innovation approaches from a selection of Costa Rican companies were analysed and systemised, thus giving more insight into the necessary adaptations for the Central American Ecodesign manual. Next, some of the key tools from the European manual (Brezet and Van Hemel 1997) were adapted to the local situation and tested in a number of companies – see Chapter 10 for an analysis of the necessary changes that were integrated. On the basis of the experiences with the demonstration projects and the other preparations described above, the manual and integrated training guide were further developed.

Figure 8-3: UNEP manual (l.) and Regional manual (r.)

A basic cyclic 'six steps' approach was defined and elaborated as central focus of the manual. This step-by –step approach suits both the generic product development process, and is similar to ISO 9000 and 14000 type of working –procedures. In this way, the data gathered can have multiple uses in the company.

The six generic steps were:

- Organisation and company strategy
- Product selection
- Product analysis

- Creation of new ideas
- Detailing the concept
- Evaluation and continuation

In figure 8-4 the overall six steps and the graphics used for that are shown (first step as example). This design is followed through the complete manual (CEGESTI et al. 1999).

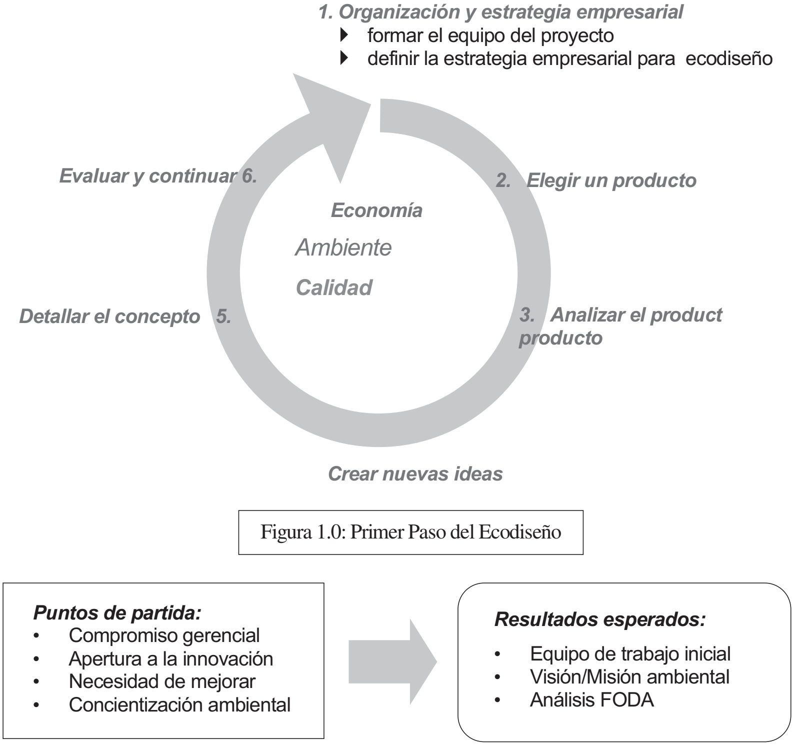


Fig 8-4: Example of the depiction of the first step in the Manual (after CEGESTI et al. 1999).

The additional elements that were outside the central line of the manual, were added in a series of modules: A number of worksheets that can be used both in training activities and in actual projects were composed. The worksheets are expected to be useful in the further capacity building training activities. A module on environmental legislation (trends) and a module on quantifying environmental costs were added. Similar tools on environmental costs for SMEs can be found in literature in Europe (Schnitzer and Taferner 2002). Although the information in the modules is too generic to be directly applied by the company, at least it gives a first introduction into the topics. Also, the relation of ecodesign with Cleaner Production was explained in greater detail in a separate module. The closely related concept of CP is introduced at the same time in the region as Ecodesign, using many of the same intermediates and addressing many of the same companies. To avoid confusion and strengthen co-operation, the topic was explained.

8.3 Second phase facilitation: from external facilitation to local leadership

A number of professionals in the counterpart organisations had been successfully trained in ecodesign during the first phase. This was by far not enough to cover the needed capacity in the region. Also, from this group several people changed jobs and were no longer available for ecodesign projects. The use of external facilitation from Delft University (and from CEGESTI for other countries than Costa Rica) needed to be further reduced and replaced by local capacity. Therefore, during the second phase of the project a larger group of professionals was trained, both by doing 'hands on' training and by application in projects. The first part of the project allowed developing single pilot projects in the region, which are going to be used as "success stories", but in the second phase it was important to train local professionals in the next steps: how to develop a local capacity that includes several actors and networking. This should be focused on industrial professionals and university professors and is intended to be done in a continuous learning process, using a 'learning by doing' approach.

Target group were young professionals in industry and institutions in Guatemala, Honduras, El Salvador, Nicaragua and Costa Rica, as well as university professors in relevant disciplines. The industrial young professionals will be the future ecodesign champions in industry. The aim of the course was to introduce them in ecodesign with the purpose to involve them in the ecodesign implementation activities, which were developed in the project. Vice versa, their practical industrial experience will be valuable input for further development of concepts and methodologies. Participation of university professors opens the possibility to involve regional students in the projects, as well as the initiation of curriculum development that includes ecodesign. The transition in facilitation is depicted in figure 8-5.

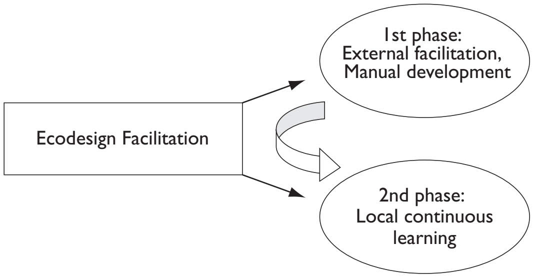


Figure 8-5: transition for facilitation from first to second project phase

Target group for the professionals in the course was the group of young professionals in industry and institutions in Guatemala, Honduras, El Salvador, Nicaragua and Costa Rica. A pre-selection of institutions and organisations was made that qualified for the participation in the course, on the basis of professional expertise, good track-record and feasibility to be involved in the further selection of companies and pilot projects. These organisations were invited to apply for participation in the course and to present CV's of suitable candidates for the course. On the basis of this list, a selection procedure and finalized a list of participants, with a mixed group of experts working with consultants, government institutions or universities. Because of the high interest in the course, it was decided to accept many more participants than initially planned, in total 38. The division over the countries was: El Salvador 16, Guatemala 6 (course San Salvador), Honduras 4 Nicaragua 2 and Costa Rica 14 (Course San José). The gender division was: 20 men 18 women. The focus in this first module of the course was on concepts, methodologies and application of ecodesign.

On the basis of the results of the first module and in combination with the possibilities of the participants to be actively involved in the industrial projects (see 7.2.), a group of 10 participants were selected for the advanced course module in Delft. Complemented with the CEGESTI project leader, the total course group in Delft existed of 11 experts. All participants successfully performed individual 'homework' for the course. Division over the countries of this group: El Salvador 3 Guatemala 3 Costa Rica 2 (+1: project leader CEGESTI) Honduras 1 Nicaragua 1. Gender division: 4 men, 7 women. The focus in this module was on practical industrial experiences with the implementation of ecodesign in The Netherlands, examples of sector, chain and service approaches and how to make use of these experiences in their own setting of the projects.

In review meetings with several of the participants, it became clear that this course, in combination with the ongoing work on ecodesign projects, was an important incentive for them to continue or start working with Ecodesign. Also outside the current projects, new activities are started by them. Some examples from the organisations of the participants: UCA, El Salvador started an ecodesign project with a company. The National Cleaner Production Centres in El Salvador and Guatemala took ecodesign into their internal training programme in the near future. University of Don Bosco integrated ecodesign in the internal course of the NCPCs in the region. FEPYME started an initiative next year in the field of sustainability and tourism in Guatemala. The Ministry of Economic affairs (section SMEs) of Guatemala organised a workshop on ecodesign. So, much more than in the first project phase, activities outside the project are initiated, with the course participants as the most important actors.

To organise facilitation for the second phase company projects, a selection of potential counterparts in each of the countries was invited to submit proposals for this type of projects to the project co-ordinators. The proposal needed to include a description of the project approach and of the companies to be selected. Based on this, a number of visits were made to the companies to assess the proposals and the best project proposals were selected.
The criteria for the selection were:

- Quality of proposal
- Suitability of the companies proposed
- Quality of the counterpart organisation

On the basis of this competition, the second phase projects were selected in connection to the local facilitation group that would perform the work. The results of these projects were described in Chapter 7.

In principle, the second phase projects should be supported more by local graduation students, and less Dutch students, as to further strengthen local capacity. For Costa Rica, UCR students have participated in some specific parts of the follow-up projects, but the main project was supported by a Dutch internship student. In Guatemala, the projects were supported by Landivar graduation students, with 'second line' methodological support of two Dutch internship students. In El Salvador, in addition to undergraduate ITCA students, the project was supported by a Guatemalan Landivar graduation student.

8.4 First phase Capacity building: counterpart organisations

Key capacity building in the first phase of the project was aimed at the participating counterpart organisations, which were involved in the execution of the company projects. A central activity in this field in the two-week intensive training that took place in Delft with 12 participants of all counterparts, beginning of 1998. This train-the-trainer course was focused on the concept, methodology and practical experiences with ecodesign, and gave the counterparts the capacity to perform ecodesign projects in industry independently. All counterparts directly involved in the project received the training. All counterparts (in countries with demo companies) were involved directly in the demonstration projects by participation in the project team, exchange of relevant information and further development of ecodesign tools. This way, the people that were trained in Delft (see 8.3) added 'hands-on' experience in the actual application of ecodesign in industry and can be considered a first nucleus of experts in the region. This expertise is also being translated into action in other projects or activities of the counterparts. CEGESTI has started up several other projects in industry since the inception of the ecodesign project in which the ecodesign approach plays an important role. ITCR has introduced ecodesign into the curricula for product design students and the first students have graduated on ecodesign projects (see examples in annex A).

The Chamber of Industry in Guatemala has organised several meetings for a wider audience of companies, in which ecodesign concepts and approaches were presented. Also several articles were published on the topic. Don Bosco University (UDB) in El Salvador has published several articles on the approach. Also, in cooperation with the Industry Association (ASI), a general seminar on ecodesign was organised. Within the UDB, a one-day course on ecodesign was organized for the students.

Stakeholders for ecodesign in Central America

To start the formation of a wider network in the region, contacts were established with several organisations in the region that could play an important role in the dissemination of ecodesign. With the results of the demonstration projects becoming available in the next period, several type of societal actors were targeted already in the first phase of the project. During1998 and 1999, among others the following organisations were contacted by the research team:

- ITCR/TEC – Technical University (Costa Rica)
- Institute for Tourism (Honduras)
- Anacafe - Coffee sector organisation (Guatemala)
- CIG – Guatemalan Chamber of Industry (Guatemala)
- UDB - University Don Bosco (El Salvador)
- FIDE – Trade and Export organisation (Honduras)
- CONCYT – National council of Science and Technology (Guatemala)
- CONOMA - National Environmental Commission (Guatemala)
- CONACYT – National council of Science and technology (El Salvador)
- MARENA – Ministry of Environment (Nicaragua)
- NCPCs – UNIDO National Cleaner Production Centres (Costa Rica, Guatemala, Nicaragua, El SAlvador)
- University San Carlos (Guatemala)
- University Del Valle (Guatemala)
- University Rafael Landivar (Guatemala)
- UNI - Universidad Nacional de Inergia, (Nicaragua)
- SICA/CCAD – Regional Commission on Sustainability and Development (Head Quarters in El Salvador + Regional)
- ASOMETAL – Metal Sector organisation (Costa Rica)
- ASI – Chamber of Industry (El Salvador)
- GTZ - German Technical Development organisation (El Salvador) SME+Environment programme

Most of these organisations were already involved or potential new partners in the process of introduction and implementation of ecodesign.

The Regional Conference 1999

As a key event for capacity building, on 28th and 29th of October 1999, a regional conference on ecodesign was organised in San Jose, Costa Rica. (CEGESTI 1999). It can be seen as the presentation of the results of the first two project years for all involved parties and interested persons, as well as the start of the discussion and formulation of future plans and activities in the field of Ecodesign. Over 100 participants attended the conference. Looking at the affiliation of the participants some things must be considered: all countries of the region were represented, but over 80% of participants were Costa Rican 'real' industry participation was only 30%, this included the demonstration companies (10%) Despite these imbalances, it can still be considered as a kick-off for network development in the region, specially because of the 'work conference' character (see below). After to the obvious presentation of the project approach, demonstration company representatives presented the successful results of the redesigned products. The manual for Ecodesign was handed symbolically to company representatives from all Central American countries involved in the project. Next, a number of topics were dealt with during the conference: an analysis of barriers and incentives was presented and discussed with a panel of counterpart representatives. An international expert forum highlighted the various motivating elements for ecodesign. SICA/CCAD presented the new plans for the region on development of the natural resources, agribusiness and tourism, and the role of ecodesign in these fields was discussed. Integration of ecodesign with other environmental approaches (CP, ISO 14000) and integration in university curricula was presented and discussed. Throughout the conference, the participants worked several times in discussion groups on specific topics, such as 'new complementary projects', 'interaction industry/government' 'capacity building in ecodesign' and 'technological innovation'.

8.5 From individual counterparts training to local networking and university cooperation

Based on the current insight in the existing stakeholders in the region, during the second phase of the project, awareness and capacity building activities were undertaken focused on national configurations. Specialized national workshops were organised in the three countries, introducing the ecodesign approach to relevant stakeholder configurations, such as national and local governmental organisations, financial organisations, consumer organisations, universities etc. per country. The aim of these events was to make stakeholders aware of the existence of the ecodesign methodology and the obtained results of applying this methodology in the region. So the transition with regard to capacity building is as follows:

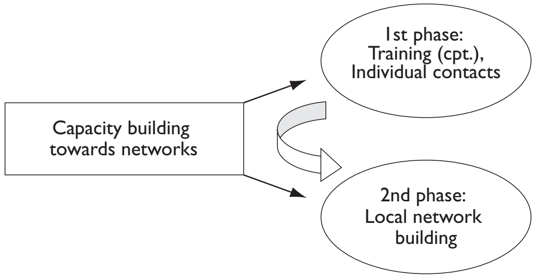


Figure 8-6: Transition for capacity building from first to second project phase.

The transition mentioned fits well within the ideas of the regional Competitiveness Agenda (INCAE 1999): The focus shifts from individual company competitiveness to highly relevant clusters such as the food cluster and the Tourism cluster. The focus on national networks also fits within the search for local competitive clusters of companies.

8.6 Creating Local Networks for ecodesign in Central America

Compared to the first project phase, the new element of the selection process for the second project phase was that both the counterparts in Guatemala and El Salvador and the company projects (sector for Guatemala, chain for El Salvador) were selected in an iterative process (see 8.3). Although there was some resistance to this approach by the counterparts that were performing the projects in the first two projects years, overall it worked very well. The approach to select the counterparts both on the quality of their proposals (project approach and companies) and on the capacity of the counterpart itself, has led to a high quality and motivation of the projects in both countries. In combination with the stronger local (country by country) orientation in the project, it can be seen as a starting point that facilitates local network building. This approach is certainly not common in development co-operation projects, where counterparts are often selected early on in the process. In our case, it enhanced some healthy competition during the selection phase, and boosted quality of the resulting combination of project, companies and counterpart. Actually in both El Salvador and Guatemala, the selected counterparts were different from the first project years. Their active search for companies that fulfilled the criteria for project proposals has increased the involvement of both the companies and the counterpart. Costa Rica takes a different position, due to the continued strong involvement of CEGESTI as lead counterpart, being the nucleus for ecodesign activities In Costa Rica from the start of the project. In the case of the Sustainable tourism project, in addition to CEGESTI and ITCR/TEC, a new organisation entered the project (UCR - University of Costa Rica) because of the specialized knowledge they have in renewable energy systems, one of the key topics in this project.

An important development was the active deployment of ecodesign activities by Landivar University in Guatemala. In the three metal company projects, six graduation students of Landivar were involved, tutored by three staff members. Landivar is also actively involved in the workshops taking place in Guatemala. In 2001, several graduation projects were dedicated to ecodesign, one in the project in El Salvador.. Also, ecodesign concepts and the manual are already part of the last year curriculum, this will be further strengthened the coming year. Since Landivar is the only university in Guatemala with a design engineering career, their involvement in ecodesign is very important. In short, Landivar has taken the role as central actor in the local Guatemala network. In El Salvador, AG Tech as lead counterpart was very active in the project, and several follow-up activities were planned.

Figure 8-7: Delft and Landivar Students in Guatemala (l.), small-group work after lecture at University Don Bosco (r).

The growing feeling of project ownership of the various partners in the region was a very important indicator for the possibilities of continuation of ecodesign activities independent of the project. Regional partners take the lead in all activities and see it as a local initiative, and the role of Delft staff has become more and more advisory, as it should be. Also, partners initiate new ecodesign activities or related activities more and more, thereby consulting DUT but no longer relying on a large input from The Netherlands. Certainly inside CEGESTI, TEC Landivar, the ecodesign approach was internalised and they saw themselves as capable of executing ecodesign activities. Expert support from Delft was still necessary for completely new activities, detailed curriculum building or more advanced project approaches.

In line with the local approach, the awareness building activities in the project were focused on national workshops (project report 31, Annex B). The first national workshop that took place was in Guatemala, June 2001. In this workshop 40 participants attended. The workshop programme was aimed at explaining the ecodesign concept and project, and after that the preliminary results of the projects in the metal sector were presented and discussed. Also, the opportunities for strategic alliances between (metal) companies were presented and discussed. Further, the participants discussed in small groups on the possible follow-up activities that could be organised. Next major activities in the field of awareness building planned were the national workshops in Costa Rica (sustainable tourism) and El Salvador (chain approach). Also in these workshops, over 40 participants attended.

Supportive activities for capacity building

A number of activities were started to support the capacity building on a regional level (project reports 22 and 23 – Annex B).

A Survey into the use of regional eco-indicators for ecodesign was performed (project report 32 Annex B). This survey defines the possible and relevant use of eco-indicators in the regional context, such as the comparison of (concept) products, eco-labels for products and the usefulness as a tool for designers, but also for governments in policy development. In light of the experiences of developing this kind of indicator systems in Europe and the US, the advice was to start with building support and input of experience and knowledge by the initiation of a Regional Eco-indicator Platform Group, in which the key actors (both users and developers of such systems) should be represented.

The organisation of a regional Ecodesign award for industry was started (project report 33, Annex B), to which all regional industries can submit. The obtained results will be discussed and the most successful ecodesign products will be awarded with a special price. More pro-active firms can receive an ecodesign certificate. The aim of this contest is to enlarge regional awareness for ecodesign and to involve regional industry in the discussion of the development of ecodesign in the region, and reward the pro-active companies in the region for their efforts. The award was combined with similar initiatives of CCAD (Comision Centroamericana de Ambiente y Desarrollo). CCAD has developed a system of environmental awards themselves, and have agreed to take in the Ecodesign award as one of the categories. Other categories are an energy efficiency award, a technological industrial innovation award and an environmental management award. The awards were handed for the first time in 2002. Integration of the Ecodesign award into the CCAD scheme has improved the image of ecodesign, and also will guarantee the longer-term initiatives on ecodesign, since CCAD is planning to organise the awards in the future.

A regional ecodesign web page and related electronic communication means (list server etc.) was launched. Until now, the information and dissemination products are paper based (manual, fact sheets, etc.). The experience is, that the use of electronic means in the industry involved is already relatively high, and will grow quickly in the future. New information, tools and exchange of results should therefore preferably be internet-based. The full Ecodesign manual is downloadable for free. Growing internet use and availability of faster connections in the region makes this a feasible option, to be preferred over the option to mail a hardcopy or CD-ROM.

Follow-up projects

A number of direct follow-up activities that arose from this project are to be mentioned (status 2002). This means the positive results of this project have already led, directly and indirectly, to the establishment of several new projects and initiatives strengthening the local networks in the respective countries.

In a number of the demonstration companies, new initiatives in ecodesign or related fields will take place. As mentioned, several of them have gained a structural capacity in this field, and follow-up are being developed.

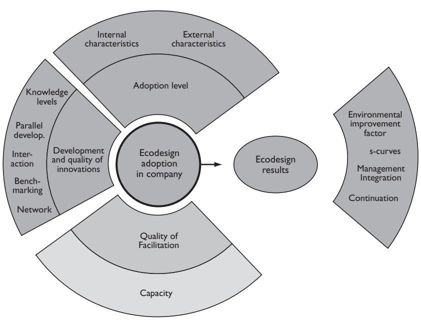
CEGESTI has started an ecodesign project in the food industry (status 2002), working with 6 food companies. Further, CEGESTI has planned several proposals for new ecodesign projects in the future with the support of local funds (personal communication Guillermo Velasquez CEGESTI). DUT has proposed a broad multi-year programme for industrial design engineering and innovation support to small and medium sized companies in Nicaragua to the Dutch embassy in Managua. Ecodesign is one of the topics of the proposed project. The consultancy Tecnosoluciones, which was also involved in the ecodesign course, is one of the counterparts in the proposed project (personal communication CICAT). In El Salvador, the strengthened relation between the country and The Netherlands can be an opportunity: new efforts are being made to improve the technical cooperation between the two countries. Contacts with the Salvadoran Ministry of Foreign Affairs are being made by AG Tech (personal communication Horacio Mendoza). One of the regional alliances CEGESTI and other counterparts in the region are involved in is connected to a GTZ project on SME's and the Environment. Although ecodesign is at the moment not the first priority for the multi-year GTZ project, it is on the agenda for future elaboration. The NCPCs are now integrating ecodesign into their portfolio. Several courses and workshops including ecodesign are given or planned. FEPYME has started an initiative in the field of sustainability and tourism in Guatemala.

An ongoing initiative in Guatemala (status 2002) is a Norwegian Ecodesign project 'Design Without Borders', in cooperation with Landivar University, aimed at small and medium sized industry in the region of Quetzaltenango. Project leader is a former student in our project, and work is being performed in the field of relief housing design and design and organisation of municipal waste systems. Landivar graduation students are involved in the project (personal communication Tor Inge Garvik).

Another follow-up initiative will be the involvement of University of Landivar in a Delft University cooperation project on long distance learning course development on Ecodesign. This will be executed together with Los Andes University of Colombia. Other partners such as CEGESTI and TEC will also be involved in the project (personal communication J.C. Diehl). Also other universities (ITCR, UCA, UDB) are continuing curriculum building activities and practical graduation projects in the field of Ecodesign (personal communications Oscar Arce, Francisco Chavez, Nelly Castillo).

Part IV: Analysis

Chapter 9: Analysis of adoption of ecodesign in the companies



In this chapter the findings of ecodesign adoption in the companies are analysed by means of the research model and by further qualitative analysis of the case study material. Thus, an effort is made to answer the research questions related to the case studies (Q1-Q4) stated in section 2.2 , based partly on a confrontation and analysis of theory and practice, and partly on a further qualitative analysis of the case study data.

This analysis is performed in the following steps. First, all case studies are analysed on an individual basis according to the set of factors that are applicable to them (formulated in questions F1 – F12). This is described in section 9.1. Next, the cases studies of the first and second phase of the project are analysed as a group in 9.2, taking into account both the research factors and other, qualitative data. Because after the first project phase, changes in the set-up of the projects have been made, integrating learning experiences of the first phase, in 9.3 differences between phase 1 and 2 are analysed. In 9.4, the research model is revisited and the influence of the various factors to the actual adoption is analysed from that perspective.

9.1 Analysis of ecodesign adoption

12 research factors were developed as independent variables to analyse the results of the ecodesign adoption in the industry case studies (see chapter 6, table 6-1). the research questions (Q) and detailed question stated (F's) stated were the following:

Q1) How does the adoption of ecodesign – seen as a product innovation process – take place in participating companies in Central America?

- F1. How well did the company use the different levels of knowledge necessary for product innovation?

F2. Did the company include both the technical and the market development in the project?
F3. Was the company actively searching information from its surroundings?
F4. What is the phase of adoption of ecodesign in the company?
F5. Is the company part of an active innovation-diffusion network?
F6. Did the company use benchmarking/copy strategies to enter the market?

Q2) Are the ecodesign projects in the companies successful, is the approach continued and does the approach diffuse to other companies?
F7. What improvement factor has been reached by the company?
F8. What scope did the company take into account in the ecodesign project?
F9. Did the company integrate the ecodesign concept into their management system?
F10. Did the company continue/expand with ecodesign projects?

Q3) What are the key company-internal factors that influence (positively or negatively) this adoption of ecodesign?
F11. Does the company have the following 4 internal characteristics: cost reduction, image, env. benefit, positive attitude?

Q4) What are the key contextual variables (stimuli and barriers) that influence the ecodesign adoption?
F12. Is the company stimulated externally by these stimuli:
Regulations, demand market, demand to supplier

In table 9-1 (a, b and c), the findings of the case studies companies are described in direct relation to the research factors 1-12. These tables briefly describe the situation in each of the companies in relation to the research factor. For all 14 case study companies, these questions were answered and a score given for the actual performance or behaviour of the company on this factor - rated from A (full compliance) to D (no compliance) according to the operationalisation system described in Chapter 6 (table 6-2). An overview of the scores for all companies is presented below in table 9-2.

In addition to these case-by-case findings, some generic findings can be described on all cases.

From an environmental point of view, the redesigned products typically use fewer materials, are (therefore) cheaper to produce, and in some cases easier/more efficient to produce. Also, some products have lower impact during use, and in two cases better distribution systems are implemented. The environmental benefits can be estimated as being between 10 and 70 % environmental impact reduction compared to the reference product on specific impact level. These impact reduction rates achieved in the products of the demonstration companies are comparable to the achievements with the first eco-redesigned products in The Netherlands (PROMISE project), performed in 1990-1991 (te Riele and Zweers 1994).

The products in the Central American products were eco-redesigned in a relatively short period of time. Most of the prototypes were produced four to five months after the start of the project. Most Dutch projects took over a year. Reasons for this short period could be the relatively large possibilities to improve the products, the more informal and directive management (The director/owner of the company decides), and also the strict timeframe for the students to work on the projects, which forced several companies to finish the prototype or loose momentum.

Looking at the type of innovations accomplished, most of the changed products can be categorised as redesigns of existing products, with relative small changes compared to the reference product. One product however, the coffee depulper of REA, is a completely new product compared to its predecessor. Also the desk of Panel-ex and the bottle of Kontein can be considered to be prototypes of new products. Systems approaches can be found at Aventuras and El Jobo, and also the depulper of REA could be the first part of a new system for coffee production.

Table 9-1a: Findings of first four case studies in relation to research factors 1-12

Factor	Detailed research question (F)	Company, Country Industrias Waiman, Costa Rica	Heliconia del Caribe, Cost Rica	Panel-ex, Costa Rica	Mafam, Costa Rica
DEVELOPMENT OF ECODESIGN INNOVATIONS					
1. Chain-linked knowledge system	1. How well did the company use the different levels of knowledge necessary for product innovation?	Mostly (dispersed) in-company knowledge, information from products on the market, parts are disassembled and copied	Company is very well informed about the developments in the product field, environmental issues etc.	Information on the product development mostly, knowledge of materials available	Knowledge on product development available
2. Technology/market development	2. Did the company include both the technical and the market development in the project?	Market survey was done, some contacts were made with potential customers, separate from technical development	Concurrent development of product and market – note: packaging is a relatively simple product	Until now, no market development, mostly technical development. Changes expected.	Mainly technical development
3. Interaction with surroundings	3. Was the company actively searching information from its surroundings?	Contacts with some customers, information gathering (mainly brochures) from competitors. Sales organisation filters information	Active info search within (restricted) possibilities of the small company – manager is in charge of everything	Contacts with customers (through sales dep. and installation)	Some contacts with suppliers of packaging materials
ADOPTION AND DIFFUSION OF INNOVATIONS					
4. Adoption phase	4. What is the phase of adoption in the company?	Decided to go for this first project.	Decision to change the product (packaging), replace old packaging introduce it on the market	Decided to go through the process until prototype	Persuasion – only first tests of packaging were made
5. Innovation-diffusion network	5. Is the company part of an active innovation-diffusion network?	Connected to sales organisation, which is closer to market.	Not connected to extensive network	Direct contact with customers, no further part in a network	Not part of innovation network
6. Benchmarking-/copying	6. Did the company use benchmarking/copy strategies to enter the market?	Benchmarking is used, strategic focus mainly on lower price, 'affordable products'	Benchmarking approach, improved and high quality approach	Existing products from f.i. USA and Germany are copied – competitive on price but price probably has to come down further	Benchmarking with improved product aspects and product quality.
ECODESIGN CONCEPT					
7. Improvement factor	7. What improvement factor has been reached by the company?	Energy use of refrigerator on necessary cooling level is down, but not quantified. Conservative estim. is 10 - 20% reduction	Packaging: 14% material reduction	Prototype had up to 20% materials reduction, 57% reduction of formaldehyde use, 27% reduction of melamine	20 % secondary packaging reduction, 3% primary packaging reduction
8. Scope	8. What scope did the company take into account in the ecodesign project?	Redesign of existing refrigerator.	Redesign of existing packaging	New design of office furniture	Product (packaging and transport system) redesign
9. Integration in management	9. Did the company integrate the ecodesign concept into their management system?	No	Operational integration – conscious of environmental issues in operations	No	No
10. Short-term continuation	10. Did the company continue /expand with Ecodesign projects?	None	No other products/packaging were redesigned	None	None
STIMULI FOR ECODESIGN					
11. Company factors and characteristics	11. Does the company have the following 4 internal characteristics: cost reduction, image, env. benefit, positive attitude?	Image improvement (better product) is existing.	Positive attitude, cost reduction and environmental benefit is clearly existing within the company	Although initially the attitude was positive, the product was never produced.	Cost reduction, and initial positive attitude of management
12. External factors	12. Is the company stimulated externally by: regulations, demand market, demand to supplier?	CFC elimination and energy saving are internationally regulatory stimuli, future market demands expected	International packaging regulations are increasingly strict. Markets demand better environmental specs as well	There are no external drives at the time of project, some market demand expected in the future	Although several regulative issues are upcoming, none were effective at project time

Table 9-1b: Findings of next five case studies in relation to research factors 1-12

Factor	Detailed research question (F)	Company, Country Venus, Guatemala	Talleres REA, Guatemala	Mobelart, El Salvador	Kontein SA, El Salvador	Bendig, Costa Rica
DEVELOPMENT OF ECODESIGN INNOVATIONS						
1. Chain-linked knowledge system	**1. How well did the company use the different levels of knowledge necessary for product innovation?**	Good knowledge of product development, and knowledge on developments elsewhere, materials knowledge	In-company knowledge of product development, info on materials, new development in the coffee industry	High-level product design process, good knowledge of international development, materials knowledge	Good knowledge of product development process and of existing knowledge on materials, products, and environment	In-company knowledge of product development, existing knowledge on innovations in the coffee sector, and environmental issues related to it.
2. Technology-/market development	**2. Did the company include both the technical and the market development in the project?**	Market development and technical development were both executed, but not in combination and short-term only	New product development and market development both executed, but not combined	New product and new market for the product were developed in an integrated way.	Market development usually done by the client (who is buying the bottles), connected but separate from technical development	Only technical development (coffee machinery markets were very bad during and after the project)
3. Interaction with surroundings	**3. Was the company actively searching information from its surroundings?**	Contacts with international competitors and markets	Contacts with sector organisation, and innovative companies	Close interaction with clients, customers, researchers, active info seeking on new developm.	Part of a larger consortium of companies, information coming from various sides	Yes, international contacts with companies, suppliers
ADOPTION AND DIFFUSION OF INNOVATIONS						
4. Adoption phase	**4. What is the phase of adoption in the company?**	Decided on execution of this project – packaging redesign	Decision on ecodesign – for depulper and after that more products	Decision on execution and marketing of the product	Decision on ecodesign project and integration of ecodesign into management system. However, specific product was not introduced on the market	Decision to implement ecodesign in the project and in the design approach for other products as well
5. Innovation-diffusion network	**5. Is the company part of an active innovation-diffusion network?**	Connected to other exporters, connected to international consumers	Not connected to many other companies/ organisations	Connected to international materials suppliers, sales org., high-end markets, designers	Part of a larger consortium that is connected to research and materials suppliers	No, supplier for various sectors, key knowledge is metal working that can be applied cross-sectoral
6. Benchmarking-/copying	**6. Did the company use benchmarking/copy strategies to enter the market?**	'good products with a low price'	Benchmarking approach on competitors' products – additional improvement made	Copying approach from US-/European designs, improved and adapted for local market	Benchmarking and low-price strategy	Copying and low price strategy
ECODESIGN CONCEPT						
7. Improvement factor	**7. What improvement factor has been reached by the company?**	33-40 % reduction of packaging materials	70% weight and 50% materials reduction, use of water in process eliminated	15% materials reduction, new modular design	Elimination of PVC, more then 30% materials reduction	20% materials reduction
8. Scope	**8. What scope did the company take into account in the ecodesign project?**	Redesign of packaging	New product design	Redesign	New product design	Product redesign
9. Integration in management	**9. Did the company integrate the ecodesign concept into their management system?**	Integrated in operational way: in designing of new packaging	Ecodesign is operationally integrated – as shown by development of new products	Operational level integration	Strategic level integration – but not too much activities in practice.	Operational level, directly applied in product development. No strategic orientation
10. Short-term continuation	**10. Did the company continue /expand with Ecodesign projects?**	No	Yes, another product (Criba) has been redesigned with the ecodesign approach	No	No	No, stopped producing coffee equipment because of bad market conditions. No explicit new ecodesign projects in other type of products
STIMULI FOR ECODESIGN						
11. Company factors and characteristics	**11. Does the company have the following 4 internal characteristics: cost reduction, image, env. benefit, positive attitude**	Cost reduction for packaging materials, image, initial positive attitude	All four factors apply: cost reduction, positive attitude, benefits of environmental improvement, positive image	Cost reduction, image improvement	Cost reduction, image improvement (visible waste reduction, elimination PVC)	Cost reduction, image
12. External factors	**12. Is the company stimulated externally by: regulations, demand market, demand to supplier**	International regulations on packaging	Regulations on water use in coffee sector	Some starting demand from market	International packaging regulations mainly. No demand (yet) from markets or suppliers	Regulation on water in coffee sector

Table 9-1c: Findings of second phase case studies in relation to research factors 1-12

Factor	Detailed research question (F)	Company, Country Aventuras Naturalis, Costa Rica	Turbomac, Guatemala	Inmepro, Guatemala	Executiv, Guatemala	El Jobo, El Salvador
DEVELOPMENT OF ECODESIGN INNOVATIONS						
1. Chain-linked knowledge system	**1. How well did the company use the different levels of knowledge necessary for product innovation?**	Knowledge for (eco)service development very good, also aware of development in sustain-able tourism and env. issues	In-company knowledge of prod-uct development, knowledge of technical developments in specified areas (e.g. burner techn.)	Knowledge on product development, technical knowledge available	Information on product development and technical and market information on the furniture and office sector	In-company knowledge of product development. Technical knowledge on agricultural technologies
2. Technology-/market development	**2. Did the company include both the technical and the market development in the project?**	Market development and service development were connected and executed simultaneous	Technical development mainly, market development not tackled at the time of the project	Only technical development, market development with sales organisation and postponed	Both product and market development were executed	Mainly technical product development, no concurrent market development
3. Interaction with surroundings	**3. Was the company actively searching information from its surroundings?**	Active information seeking, connections with several organisations and research	In-house information and additional information where directly needed	Mainly through sales organisation and direct technical contacts	Active information-seeking behaviour, aklso outside the direct technical fields of interest	Strong information seeking behaviour of company advisor, well-informed on developments
ADOPTION AND DIFFUSION OF INNOVATIONS						
4. Adoption phase	**4. What is the phase of adoption in the company?**	Adopted ecodesign and made it part of its already existing and ongoing (eco)service developm.	Adopted ecodesign as complementary to own environmental approach	Adopted execution of the product development up to prototyping	Adopted for first efforts with approach only. No prototype – design only	Adopted the approach for first project
5. Innovation-diffusion network	**5. Is the company part of an active innovation-diffusion network?**	Connected to several other actors, mainly information seeking	Some connections but mainly in specialised areas	Mainly production facility – part of larger network with sales organisation	Connected to several other companies – both technical and service-oriented	Not connected to any larger network
6. Benchmarking-/copying	**6. Did the company use benchmarking/copy strategies to enter the market?**	Benchmarking to competitors, improved product strategy (high price)	Copy and improvement for burners, low price strategy for overall product	Benchmarking existing products, low price strategy compared to Us manufacturers	Low-price benchmarking with US products	Low-price benchmarking strategy
ECODESIGN CONCEPT						
7. Improvement factor	**7. What improvement factor has been reached by the company?**	A range of improvement from short-term recycling to hydro-power energy. No quantification, estim.: 30-40% reduction overall	In addition to high efficiency burner, materials savings up to 10% and modular design	Not quantified, improvement estimated at 10%	Not quantified for prototype. Spin-off project with burners: 30% energy reduction.	At least 20% reduction of raw materials use due to new product formulation. 30% water use reduction in production
8. Scope	**8. What scope did the company take into account in the ecodesign project?**	Systems approach, taking into account all aspect of full product/service system	Product redesign	Product redesign	New product design	Systems scope: production, product and future focus on waste and energy
9. Integration in management	**9. Did the company integrate the ecodesign concept into their management system?**	Ecodesign in operational activities	Existing strategic position of environmental aspects was strengthened	No	No	No
10. Short-term continuation	**10. Did the company continue /expand with Ecodesign projects?**	Continued with improvement programme	No new product was taken for follow-up	None	None – but spin-off project with eco-efficient burners of Turbomac	Continued with other aspects of whole system
STIMULI FOR ECODESIGN						
11. Company characteristics	**11. Does the company have the following 4 internal character-istics: cost reduction, image, env. benefit, positive attitude?**	Cost reduction (materials and energy costs), positive image to customers, positive attitude management and env. benefit	Materials cost reduction, positive image to customers, positive attitude management	Cost reduction	Positive attitude towards environments	Cost reduction, positive attitude
12. External characteristics	**12. Is the company stimulated externally by: regulations, dem-and market, demand to supplier?**	Demand from market and tourism sector in general	No external stimuli	No external stimuli	No external stimuli. Future market demand expected	Some market demand on organic and low-fat products

9.2 Cross-case analysis of ecodesign adoption

On the basis of the analytical results for the individual companies (tables 9-1 and 9-2), in this section a cross-case analysis is made of ecodesign adoption in the companies. This is done by order of the research questions (Q's) as formulated in Chapter 2, connected tot the criteria questions (F's) developed in Chapter 6 and stated earlier in this chapter. This analysis is not trying to find answers that would be applicable for all of industry in the region, since this research is not based on a sampling logic, but does try to find more clarity under which conditions certain results, processes or events are likely to be found in the underlying case studies (literal replication) or why they are not found (theoretical replications). After analysing the factors, for each of the research questions (Q's) more qualitative results are analysed to give additional perspectives or confirm earlier analytical findings.

Table 9-2: Scores on research factors, Individual case study results

Factor / Company Country	Wai CR	Hel CR	Pan CR	Maf CR	Ven GUA	REA GUA	Mob ES	Kon ES	Ben CR		AvN CR	Tur GUA	Inm GUA	Exc GUA	El J ES
DEVELOPMENT OF ECODESIGN INNOVATIONS															
1. Chain-linked knowledge system	C	B	B	C	B	B	B	B	B		B	B	B	B	C
2. Technology/market developm.	B	A	C	C	B	B	A	B	C		A	C	C	B	C
3. Interaction with surroundings	C	B	C	C	B	B	A	B	B		A	C	C	B	B
ADOPTION AND DIFFUSION OF INNOVATIONS															
4. Adoption phase	C	B	C	D	C	B	B	B	B		B	B	C	C	C
5. Innovation-diffusion network	D	D	D	D	C	D	B	B	C		B	C	C	B	D
6. Benchmarking/copying	C	B	C	B	C	B	B	C	C		B	B	C	C	C
ECODESIGN CONCEPT															
7. Improvement factor	C	C	C	C	B	A	C	B	C		B	C	D	D	B
8. Scope	D	D	C	D	D	C	D	C	D		A	D	D	C	A
9. Integration in management	D	C	D	D	C	C	C	B	C		C	B	D	D	D
10. Short-term continuation	D	D	D	D	D	C	D	D	D		C	D	D	D	D
STIMULI FOR ECODESIGN															
11. Company characteristics	C	A	D	B	B	A	B	B	B		A	A	C	C	B
12. External characteristics	C	B	D	D	C	C	C	C	C		B	D	D	D	C

Scoring on factor: A = Score A (full compliance); B = Score B (2/3 compliance); C = Score C (1/3 compliance); D = Score D (no compliance)

Q1) How does the ecodesign process – seen as a product innovation process – develop in the demonstration companies in Central America

F1. How well did the company use the different levels of knowledge necessary for product innovation?
F2. Did the company include both the technical and the market development in the project?
F3. Was the company actively searching information from its surroundings?
F4. What is the phase of adoption of ecodesign in the company?
F5. Is the company part of an active innovation-diffusion network?
F6. Did the company use benchmarking/copy strategies to enter the market?

Analysis of the findings and scores on the research factors

F1 – knowledge use
The companies all used the basic product development knowledge available in the company and necessary for product innovation. Of course, this was to a large extent required for the methodology used.

Many companies also used additional existing (environmental) knowledge, gathered from outside the direct information base available in the company, to further improve the product. There was virtually no generation of new knowledge (R&D) involved during the projects. In light of the short duration of the projects, and the normal low level of R&D encountered in small and medium sized companies in this region, this could be expected.

F2 - integrated development
The innovation process was brought to the companies in a flexible form of the "Delft" method (Roozenburg and Eekels 1995), i.e. integrating the market development and – if necessary- the production development parallel to the product development path. Integration and concurrent development of the technical product and development of its (future) market was done by three of the companies. Many of the companies did work on both developments, but separated in time and process from each other. In many cases, the renewed product was first designed, then it was investigated how the market responded, and whether new adaptations to the product or other markets had to be found. In six of the cases, only technical development on the product took place and no market development.

F3 – interaction with surroundings
Active information searching behaviour was found in two-thirds of the companies, mainly the same ones that used the external knowledge base (F1). Most contacts made were with suppliers, colleagues/competitors, and through generic sources on the internet.

F4 – adoption phase
The adoption phase with regard to the adoption of ecodesign was variable between the companies: all companies were interested in applying the method - this was, as

described, part of the company selection procedure - and all invested time and effort into it, though varying in intensity. About half of the companies did not move beyond the phase of knowledge and persuasion on ecodesign, and performed one project only, the demonstration project. The choice afterwards, to adopt the ecodesign approach and make it part of their every day business, was taken by the other half. Two of those companies, REA and Aventuras, have really confirmed their commitment to ecodesign by performing renewed and continuous projects. The others can be said to have decided to adopt ecodesign as a valuable approach, but have never confirmed this choice. This relatively low level of adoption is also reflected in the low level of continuation and follow-up of the projects.

F5 – innovation-diffusion network
Continuous involvement in an innovation-diffusion network is not common, and occurs on a passive level in four companies: Kontein as part of a larger consortium, Executiv as a middle large innovative firm, Mobelart as a small innovative company with state-of-the-art technology and new markets, and Aventuras as an innovative tourism organisation. For the other companies, involvement in such networks was either incidental (f.i. through the project activities) or did not exist.

F6 – benchmarking-copying
Copying or benchmarking is the main approach to develop or redesign of products for the companies in Central America. None of the companies has own R&D, in general products from (foreign) competitors are analysed, adapted and copied. Looking at the status of the company with regard to local market entrance, both pioneers/early entrants (Mafam, Möbelart, Aventuras, Turbomac) and later entrants (most other companies) can be found. This type of pioneer market entry depends on absence of international competitors entering the market, a situation that is rapidly changing also in Central America.

For furniture, this is still possible. Pioneers such as Möbelart typically cash in on this 'early mover' advantage, since their furniture is trendy and modern for the region –thus can be sold for a higher price. In this case the benchmarking is done with products outside the local market.

Some of the later entrants however, also use the "imitate and improve" strategy. A good example is the REA depulper, which is a combination of clever benchmarking from competitors products and an own design and improvement process. The final redesigned depulper therefore is now better then the comparable product in the local market. About half of the companies focused their benchmarking approach on a lower price strategy mainly.

Further analysis

For many of the demo companies, especially the smaller ones, the ecodesign project was *the first time* that they have gone through a structured design approach. This can be seen as an important learning experience, which will help the companies to acquire the knowledge and capabilities necessary to deliver higher product quality and improved product diversification.

The *experiences* with the product development approach vary:
In the (smaller) companies without design experience, the approach was the first experience and in general terms successful. Obviously, necessary information for the design process was often lacking and difficult to obtain. By leaving most of this to the external project team/student, some projects were finished, but the company did not learn how to do this without help. In most companies that already had a design process, the approach was picked up quickly (Mobelart, Kontein, Bendig) and in general added value to their knowledge and approach. This was not the case in Panelex, where a design approach existed, but the contacts of product development department with the marketing/sales department were difficult, so integration with marketing aspects did not happen. In some of the small companies, (REA, Waiman) market information was not systematically available yet, however gathering this information opened new opportunities and sped up the process.

The integration of various aspects into one (re)design project, as it is made possible in the Delft product development approach, was also a learning experience for many of the companies. Examples are the innovative approach for packaging design in several of the companies (a cascade-wise design process, ref. Ten Klooster 2002), or the combination of materials selection/form-follows-function/ergonomic design in REA.

Information needs at different levels (existing knowledge, research) for the innovation process, as depicted most clearly in the chain-linked model (Kline and Rosenberg 1986) is a top issue in Central America. Information is often not available. Although all companies had internet access, most of the information needed is not (yet) available on-line. The region is not well connected to knowledge centres in academia and industry. Also, region-specific information is scarce or not existing – especially information on environmental attributes of products and materials.

Q2) Are the ecodesign projects in companies successful and do companies continue with ecodesign?

F7. What improvement factor has been reached by the company?
F8. What scope did the company take into account in the ecodesign project?
F9. Did the company integrate the ecodesign concept into their management system?
F10. Did the company continue/expand with ecodesign projects?

Analysis of the findings and scores on the research factors

F7 – improvement factor
One company has reached a factor 2 (50%) reduction that is considered a very good result for eco(re)design projects: REA. Four companies have scores of over 30%, which is considered a good result. In the case of Venus, a factor 2 reduction is valid for the

packaging of the individual candies, overall reduction of packaging is 40%. The new Kontein bottle has a potential reduction percentage between 30 – 70%, but was not yet produced. Reduction at Aventuras could not be quantified but is conservatively estimated around 30 %. The reduction at El Jobo is around 30% as well. The other products scored a reduction percentage between 10 and 20%, usually on materials reduction. This can be considered as an average result for eco-redesign projects.

F8 – scope
Most projects had the scope of redesigning the existing product for the same or the same and new markets. In four cases, Panelex, REA, Kontein and Executiv, a product was designed that differed so much from the old, that it can be categorised as a new product design. However, of these four only the product of REA was put on the market. Two projects had a wider systems' scope – as a logical result of the project requirements: the service project at Aventuras and the chain project at El Jobo.

F9 – integration in management system
Eight out of fourteen companies claim they have integrated ecodesign into their management system on an operational level. One of them, Kontein, has adopted ISO 14000 and claims to have integrated ecodesign into that system. For Turbomac, environmental issues were and are a key strategic element of their management system. There is no sign of integration of environmental issues into management systems in the six other companies.

F10 – continuation
The level of continuation with eco(re)design of other products within the companies is very low. REA has taken up two more projects in the 1-2 years after the initial project. Aventuras is continuing with new projects. In all of the other companies, in the years after the initial project no other concrete ecodesign projects were executed, although some companies claim to have this planned for the future.

Further analysis

The question whether the demonstration cases have been *successful*, can be answered from different perspectives:

From a *Demonstration* point of view, the cases were certainly a success. The general 'blueprint' for the demonstration aspect of the project is to get quick success stories to prove the approach is valid on the local level, and to support further capacity building and institutional/policy change. The fact that within two years, nine industrial ecodesign cases could be presented that show local products, redesigned with improved environmental attributes, is certainly successful and promising (and is used that way).
This success, however, should be consolidated:

- The presented results should be able to withstand closer scrutiny. In light of the very detailed and scientifically reviewed (graduation) reports backing up each of the studies, this is the case in our project.

- There is a danger that the cases appear to be isolated one-time successes, without any follow-up in- or outside the company. This is a danger also in our project, in line with the findings of the 'high external assistance' level provided to execute the cases. This requires the continuous capacity building and learning approach outlined in other parts of this study.

From an *Environmental improvement* point of view, the cases also are a success. In all cases, environmental improvement was reached in the redesigned product in comparison to its predecessor. Some critical reflections have to be made on this:
How easy was it to improve the old product in the first place?
Although the company and product selection criteria excluded bad products, still some of the original products were not well designed, so improvements were relatively 'easy'. However, because of the selection criteria used, we can assume that our selection of products equals or even exceeds the average product quality in the region, so from this point of view the environmental improvement can be considered a success for the region.
How much of the improvement was just simple resource efficiency improvement, which would have been reached in any structured design process?
This question pops up, seeing that most of the environmental improvement is materials reduction. Resource efficiency improvement would certainly have been reached in any rational structured design process, 'eco' or not. However, depending on the type of product, the extra focus on environmental issues throughout the design process did certainly maximise this. In products where the materials costs are a large part of total product costs, or when an 'old' product is redesigned (f.i. the depulper of REA), resource efficiency would have been high anyway. However, in products where material costs are much lower and other cost factors much higher, a number of the development directions now chosen, and resulting in material reduction, would not have been taken. In the case of the medical bottle from Kontein, elements such as advertisement space could have been treated with much more priority then resource efficiency in a 'normal' design process. Now, clever solutions were found that integrated all elements. Resource efficiency improvement is an inherent and important part of the ecodesign approach, as it is any design process. In the Dutch Ecodesign project it was also found that 'reducing weight' is an important ecodesign principle in several types of products, including packaging and machinery (van Hemel 1998).

There is certainly room for more environmental improvement. In every ecodesign project, environmental aspects are just one of the many requirements to be met, within a limited time frame for the design process, and depending on external factors that are difficult to influence. In the Central American projects, an additional factor is the fact that it was the first structured design experience for many of the companies. Further in the 'learning curve' more improvements can expected to be made.

The final proof for success is of course whether or not a product sells on the *market*. In total, 9 products out of 14 were actually introduced on the market and 1 (Inmepro stove) is still planned. 1 product (of Kontein) was not actually introduced on the market, but ecodesign activities as such were continued. In 3 companies out of 14 there was never any concrete result from the project on the market (Mafam, Panel-ex and Executiv).

From the 9 products (or its improved successor) on the market, the results are as follows (status 2002): Mobelart's kitchen (different models) Heliconia's packaging and Turbomac's stove are market successes. The improved tourism service package from Aventuras is also a success. Introduction of EL Jobo's cream is too recent to know whether it will be a success. Waiman's refrigerator (different models) was sold only in small quantities until now. Venus' new packaging was introduced in a selection of their international markets. The machines of Bendig and REA sell by the piece and irregularly, and the coffee (machinery) market is in a deep recession, so sales are very low. Bendig has actually temporarily stopped production.

From an ecodesign point-of-view, market penetration should preferably be at the expense of a competing (environmental worse) product and/or the total market should not grow more then the overall impact reduction factor achieved, else total environmental impact will still go up (rebound effect). However, there are no data available on the actual (change in) market shares and the total market volume of the ecodesigned products and their competing products, so we have no way of knowing what the overall effect of the project is.

The structured innovation approach requires a structured and consistent type of management of the company. The role of the management and management systems in most companies was twofold in our project, especially in the smaller companies. One the one hand, lack of structural planning of the activities, limited allocation of resources and manpower, poor management of information flows and overall project management was a barrier for the continuity within the project. On the other hand (over) structuring can also be a barrier for innovative actions. The informal and top-down type of management of the smaller companies had advantages also. Communication lines between the managers and the external team (especially the in-company student) were usually extremely short, creative sessions and direct feedback on ideas easily arranged, flexibility of the process very large. Within the strong external facilitation of these projects, this lack of formalised structured management of the project can be a threat for follow-up activities. Larger companies such as Kontein and Venus do have a structured management process. Top management of the companies was directly involved in the project, which guaranteed high priority and avoided delays or bureaucratic procedures. However, it did not guarantee follow-up projects in the companies.

The moderate results on continuity of ecodesign projects in the companies clearly show the need for more structural focus on ecodesign in institutional and legislative frameworks. Lack of current market demand for 'cleaner' products in the region clearly leads to diminished attention of the companies after the initial project. Environmental aspects of products cannot be maintained by short-term projects alone, and need to be supported by longer-term initiatives, institutional frameworks and governmental policy. However, the same low score on continuity also took place in the Dutch Ecodesign 1 and 2 projects, where only few follow-up projects were taken up by the companies after the first demo project.

The demonstration projects can be the starting point of success from the viewpoint of *sustainability*. Eco-redesign as executed in the projects is in the middle range of the sustainability spectrum. To reach some elements of sustainability, much higher levels of reduction, and changes on a higher system's level then the product must be reached. The depulper of REA comes in the direction of the next level, when combined with other newly developed parts of the total coffee processing system. Aventuras made a start with continuous improvement of their total service system. This next level was of course not the target of this first project. However, activities have to be deployed in follow-up projects that actually go beyond eco-product-redesign.

Q3) What are the key company-internal characteristics that influence (positive and negative) this ecodesign process?

F11. Does the company has the following 4 internal characteristics: cost reduction, image, env. benefit, positive attitude?

Analysis of the findings and scores on the research factor

F11 – internal characteristics
Most companies have at least two of the key internal company characteristics that have been identified as stimulating innovation and/or ecodesign – four companies have three of four. Cost reduction, positive attitude and image improvement are the most frequent. This indicates that internal preconditions for successful ecodesign projects are generally met.

Further analysis

As a first remark, it must be stated that the selection procedure that led to the demo companies of course selected more innovative firms within the targeted groups, since a number of positive company-internal characteristics were explicit criteria:
- interested and willing to go into ecodesign project
- own product development function
- opportunities for environmental improvement of the product
- ability to execute the project
- organized and structured production process.

Thus, a comparison with companies lacking these characteristics is not possible, since those companies were filtered out.

Cost reduction was the most frequent encountered internal characteristic that stimulated ecodesign. This is a characteristic that will be found in many processes of change, and is certainly not unique for or directly connected to ecodesign. Environmental harmful changes –legal or illegal - that lead to cost reduction would have a similar stimulus.

Therefore, a key company-related characteristic for continued ecodesign success is the positive attitude of management towards environment in general and ecodesign in particular. The most important management factor that influences the success of the ecodesign approach in almost all cases is the person of the manager. In all successful cases, the belief and enthusiasm from the manager is clear. In the small companies, such as REA, Mobelart, Waiman and Heliconia, the manager was primarily, directly and strongly involved in the project. But also in the bigger companies the influence of a project 'champion' in higher management was the key factor. This finding is in line with the elements mentioned in van Hemel (1998) for positive manager characteristics – positive attitude, enthusiasm and high innovation ambition. The regional culture of family-owned businesses where the position of the owner/manager is very strong, amplifies this effect compared to experiences in Europe.

Environmental 'benefit' or improvement of the product per se was never the main driving force alone. However, environmental awareness and concern were mentioned by most of the managers as an important consideration to participate in the project. The differences with the 'top three' drives in the Dutch situation are possible related to the absence of the external drives: Dutch managers claimed that environmental benefit was the main drive, and image improvement scored number three. Presumably this is the effect of the external pressure on the company, internalised into a company characteristic.

Other company-related characteristics that have a strong positive influence (or negative when missing):

- Companies with a innovation attitude, and with product development as a core activity: Mobelart is such a company, with tailor-made design projects, very sensitive to the innovative element. Also Bendig has a strong identification with being innovative.
- Companies in the right sector: The coffee sector is under some legislative pressure; both REA and Bendig provide products for that sector.
- Having a clear and communicable innovation product strategy (Cooper 1983), or, in terms of Buys (1987), having an innovation-search issue: this was the case with both Mobelart (the need for a larger series product to expand on the existing tailor-made products), and REA (the need for a new 'core' product to survive on the market).

Product related characteristics that influence the success of the project:

- Products under environmental pressure: most clearly that was the case for the water/energy use in the coffee sector. Also, the exporting companies (Heliconia, Venus) were focused on environmental pressure on packaging in the EU and US.
- Increased commercial opportunities by ecodesign: again, REA and Bendig, both companies explicitly marketing their products with 'ecodesign'.
- Industrial rather then end consumer markets: 6 out of 9 are products for industrial/professional markets.

Overall, similar characteristics seem to apply in the Central American situation as found in European literature. The strong emphasis on the managers' role however seems to be connected to the cultural setting of the region.

Q4) What are the key contextual variables (stimuli and barriers) that influence the ecodesign process?

F12. Is the company stimulated externally by these stimuli: regulations, demand market, demand to supplier?

Analysis of the findings and scores on the research factor

F12 – external stimuli
The number of external characteristics that apply averages only one factor over all companies. This means external stimulation for ecodesign is far less then the internal drives. Most encountered are international regulations, for example on packaging, and upcoming national regulation, for example in the coffee sector.

Further analysis

External drives for ecodesign are not so strong in the region. Regulation is not stimulating ecodesign, except a beginning of it for the coffee industry, and US and EU pressure for exporting companies, for most companies there is no customers or suppliers demand. In the absence of external drives for ecodesign, internal drives become even more important for the introduction of ecodesign in companies in Central America.

Cultural differences do not seem to contribute to a large difference with internal or external stimuli compared with European companies. One important characteristic related to culture – family ownership and the prominent position of the owner/manager – is dealt with in previous parts of this chapter.

9.3 Similarities and differences between the first and second phase cases

Because of the intentional different set-up of the second phase of the project, it is interesting to compare the two groups of cases.

The second phase companies in general had comparable scores on the criteria as the first case companies – as can be seen in table 9-2. This means that the average scores on the different criteria are the same for the results of the cases. There is one exception: For one criterion there is clearly a higher score in the second phase, more or less dictated by the project set-up: F8 (scope) shows a wider scope for the project, two companies score on the systems level. This is a logical result of the project set up: service orientation at Aventuras and chain orientation at El Jobo.

The overall highest scoring company is among the second phase group: Aventuras Naturalis. In addition to the systems approach in the project, this seems mainly a result of the attitude and knowledge in the company from the start:the company already knew most improvement directions, and the systematic approach, taking into account the whole service system has triggered the fast and successful action. Also, the company has internalised the learning process and tries to be consistent in all their activities, f.i. by starting to look at their office energy use, and by eliminating the helicopter service for tourists that was offered before. Not surprisingly, of all companies it has the highest total amount combined of positive internal characteristics and external stimuli. Not yet finalised in the tourism project is the issue of how to manage complex issues such as joint transport improvement, where concerted efforts with competitors are needed. The company considers a network initiative with independent actors in charge.

The ecodesign innovation and adoption in these second phase companies seems to take place along similar lines as in the companies of the first phase. The results of the projects appear to be comparable to the first phase results as well, although some 'synergy' effects can be found in the application of the widened concepts: As described above, Aventuras gets into solutions that go beyond the product level.

The other second phase projects also show some innovative aspects.
The positive results in the Guatemala project are clearly amplified by the sector approach. The companies are closer connected in the various workshops, discussion and exchange take place. Know-how information about materials, techniques and approaches is exchanged. This could be seen as a light form of an innovation-diffusion peers network. The strategic alliances that are formed in the sector project is Guatemala adds a new dimension to company learning. Tacit knowledge is applied in new situations, leading to mutual benefit of the partners and in these cases also further environmental improvement of the systems. This environmental improvement is not an automatic result – alliances can lead to other forms of business, sustainable or not. The chain project in El Jobo, El Salvador is leading to a better insight in the connections of the different 'links' of the chain, and integration of the various steps that is needed for the improvement directions (such as energy and water management throughout the chain). Also, 'Know-why' in El Jobo is brought to a higher level. The decision to start with the development of a new product/market combination, at the same time taking action from ecological and economical imperatives, is not without risk, and was not easily possible in the company's culture for several years.

9.4 Influence of the factors on ecodesign adoption

With the analysis made of the individual factors that influence (F1-6,11-12) and imply (F7-10) ecodesign adoption, what patterns can be identified? In the research model for adoption, two sets of factors were clustered that would influence and form the ecodesign adoption and the results emerging from that adoption. The internal and external stimuli, related to the adoption phase of the company (F11,12 and 4), and

what was called the overall quality of innovation, including information seeking behaviour, innovation development and benchmarking strategy (F1-3,5,6). Clearly, a one-on-one pattern will not be found, because the factors are a selection of the full spectrum, and interrelations between various factors also do exist.
The effect of ecodesign adoption is then operationalised in environmental improvement results, scope of the project, continuation and management integration.

As a general pattern, the theoretical expectation that having enough internal and external stimuli leads to a higher adoption phase and subsequently continuation with ecodesign seems to exist. The companies that have more stimuli, mainly cost reduction, positive attitude of the management and regulation as external factor, take the decision to implement ecodesign, and most of them also integrate ecodesign into their management system, either only operational and sometimes also strategically.

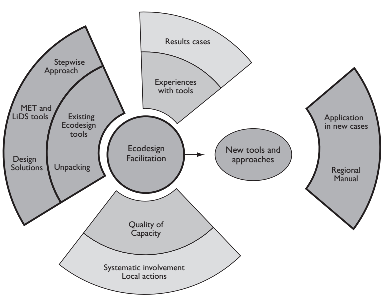
Do these companies also have better ecodesign results with their product? This pattern is not so obvious, although it does seem that the highest improvement factors for the eco(re)designed products are reached by companies that do have several internal and external stimuli. The reverse pattern does not directly exist – companies that have few stimuli do not have a very low improvement factor for their products. This also has to do with the fact that, because of the pre-selection of willing and relatively good companies, and because of the intensive facilitation, a certain minimum result could be reached by all of the companies.

If we look at the information and innovation management quality of the companies (F1-3,5,6) the pattern of influence on adoption and ecodesign results seems to be more complex: Interactive companies that actively gather information in interaction with their surrounding do have a higher adoption rate and good and continued ecodesign results. There seems to be a less clear pattern between the fact that a company is part of an innovation-diffusion network and the level of adoption and results. As was analysed before, apparently the quality of these networks in the region is not yet of a level to have a decisive influence.

Do the ecodesign results vary with the type of benchmarking – on price or on quality improvement? There does not seem to be a different pattern between those two types, both price fighters and quality makers can have high or average improvement factors. There is a weak tendency that quality makers do integrate ecodesign more into their management systems than price fighters.

A general pattern combining both sets of factors (innovation quality and stimuli) is emerging that both groups are related in the companies – so companies with a higher quality of innovation also have more stimuli – and that these companies do have better overall results of ecodesign adoption. This implies that the factors selected are indeed influencing the adoption level to a certain extent; it also implies that the factors are connected among themselves.

Chapter 10: Analysis of Facilitation



In this chapter the results of the facilitation efforts during the project are analysed. This is done by analysis of the research factors of Chapter 6 and by further qualitative analysis of the material. In this way, an effort is made to answer the research questions related to facilitation (Q5 – Q7) stated in section 2.2 based both on an analysis of theory confronted with practice, and on further qualitative analysis of the data. In section 10.1 first the facilitation applied in the individual case studies is analysed in relation to the factors F13 – c 16. Next, the facilitation of both project phases is further evaluated taking into account both criteria and further qualitative data analysis. The transition to local leadership in the facilitation is analysed in 10.2. In 10.3, the pattern of influence of the various factors on the facilitation is analysed.

10.1 Facilitation and manual development

Six research factors were developed as independent variables to analyse the results of ecodesign facilitation in the industry and country case studies (Chapter 6, table 6.1). The questions (F's) stated were the following:

Q5) How was the initially provided ecodesign methodology handled?

F13. Did the company use / accept the structured process (complete or in simplified form) for an ecodesign project?
F14. Did the company apply the environmental tools MET, LiDS and did they get the environmental information for that?
F15. Did the company find and include solutions on the various design strategies for the environment (8 LiDS options)?

Q6) What elements of the ecodesign approach can be optimised for use in Central America?

F16. Did the company supplemented their own tools/additions to the methodology supplied?

Q7) How does the transition to local facilitation of ecodesign develop? Is it optimised?

F17. Was the programme performed in a co-operative way, local actors progressively taking the lead in the company projects?

F18. Were the programme steps 'design, initiation, implementation, monitoring, evaluation used?

The findings in the individual companies on the issues of ecodesign approach and tool use, in relation to the research factors F13-16 (see Chapter 6) are given below in table 10-1. The next two questions on Technology Transfer factors F17 and F18 relate to a higher system level and are dealt with per country programme. These findings are described in detail in paragraph 10.2.

For all 14 case studies, on the basis of the findings described in table 10-1, a score given for the actual performance or behaviour of the company on this factor – rated from A (full compliance) to D (no compliance) according to the operationalisation scheme described in Chapter 6 (table 6-1). An overview of those scores is given in table 10-2.

Table 10-1: Findings on ecodesign approach and tool use in case study companies, in relation to the research factors 13-16.

Factor	F13. Structured process	F14. Environmental tools use	F15. Design strategies	F16. Unpacking
Detailed Research Question (F) **Company, country**	**Did the company use the structured process (complete or simplified) for ecodesign?**	**Did the company apply the MET and/or LiDS tools, and did they get the environmental info to do that?**	**Did the company include solutions on the 8 design strategies of LiDS?**	**Did the company supplement their tools/additions to the methodology supplied?**
Waiman, CR	Used and completed the process, the new prototype refrigerator was introduced on the market	Analysis on the environmental aspects was performed, and LiDS tool was used for strategy development	strategies 5 and 6	no
Heliconia, CR	Full process was completed, new packaging introduced to the market	Environmental analysis performed (MET) and ecodesign strategies	1, 2 and 6	Some elements on market analysis
Panel-ex, CR	Did not complete full process, 2 concepts were detailed that were not taken into production or introduced to the market	MET matrix was used, Environmental strategies were developed in a somewhat different way than LiDS	1 and 2	no
Mafam, CR	Full process was not finished, solutions were elaborated in changes of transport system, no production of new product or market introduction	MET matrix was used, data for waste phase could not be found. LiDS was used	2 and 4	no
Venus, GUA	Full process was completed, including market introduction of new product.	MET and LiDS were used	2 and 4	no
REA, GUA	Complete process was performed	PIT tool was used, partly MET, but difficult to get detailed info. LiDS was used	1, 2, 3, 4, and 5	Quick LCA, PIT, Cost analysis
Mobelart, ES	Complete process was performed	MET and LiDS were used	2 and 6	Market analysis Cost analysis
Kontein, ES	Complete process was performed	MET and LiDS were used	1 and 2.	Own design tools
Bendig, CR	A short and quick version of the full process was used – but in principle all key steps were taken	A short environmental analysis was done, LiDS was used.	2 and 4	PIT tool
Aventuras, CR	An extended format of the regional manual for ecodesign was developed to accommodate the service element in the company's operations	A full and extended Met and materials analysis, and LiDS were performed	1, 2, 4, 6	Regional manual
Turbomac, GUA	Process as in the regional manual was used	MET and LiDS were used	2 and 6	Regional manual
Inmepro, GUA	Process Regional manual was used	MET and LiDS were used	2 and 6	Regional manual
Executiv, GUA	Full process was not executed.	MET and LiDS Tools were partly used	1	Regional manual
El Jobo, ES	Regional manual was used	MET was used as far as feasible (not for all parts of chain)	2, 3	Regional manual

Table 10-2 Scores on research factors, facilitation

Factor / Company Country	Wai CR	Hel CR	Pan CR	Maf CR	Ven GUA	REA GUA	Mob ES	Kon ES	Ben CR		AvN CR	Tur GUA	Inm GUA	Exc GUA	El J ES
FACILITATION: ECODESIGN METHOD															
13. Structured process	B	B	C	C	B	B	B	B	C		B	B	B	C	C
14. Environmental tools use	A	A	A	A	A	A	A	A	C		A	A	A	C	B
15. Design strategies	C	C	C	C	C	A	C	C	C		B	A	C	D	C
TECHNOLOGY TRANSFER															
16. Unpacking	D	C	D	D	D	C	C	C	C		B	B	B	B	B
17. Local lead (country pr.)	A	A	A	A	C	C	C	C	B		A	A	A	A	B
18. Programme steps (country pr.)	A	A	A	A	C	C	C	C	B		A	A	A	A	B

Scoring on factor:	A = Score A (full compliance):	B = Score B (2/3 compliance):	C = Score C (1/3 compliance):	D = Score D (no compliance):

Q5) How was the provided ecodesign methodology used in the companies?

F13. Did the company use / accept the structured process (complete or in simplified form) for an ecodesign project?

F14. Did the company apply the environmental tools MET, LiDS and did they get the environmental information for that?

F15. Did the company find and include solutions on the various design strategies for the environment (8 LiDS options)?

Analysis of the scores on research factors

F13 – structured process
Most of the companies followed the structured process as it was pointed out in the UNEP manual (and second phase: Regional manual) fairly well. Some companies only used some key elements of the method, usually the MET and LiDS tools. The stepwise approach is considered logical and usually fits in the procedures of the company.

F14 – MET and LiDS were used by a large majority of the companies, with generally good results. However, for LiDS, additional tools had to be used to make the options more recognizable and less abstract, tools such as instant checklists of possible options. As stated before, there was enough environmental information available to perform a general MET analysis, but in most cases no detailed information for in-depth analysis of environmental effects was available. Also, the description of the LiDS strategies was considered to be rather abstract and conceptual, and support was often needed form the external faciltitors. Therefore, it was often complemented with checklists and simplified tools such as PIT.

F15 – Ecodesign strategy/LiDS options
Almost all companies found and included options from at least 2 LiDS strategies, some up to five strategies. By far most options implemented fit in the strategy 'materials reduction', followed by optimisation of initial lifetime', 'efficient distribution' and 'improved production'.

The findings of the methodology use in the second phase companies are comparable to the first phase, with the key difference that the regional manual was used in those companies, and that overall time investment per company had shifted considerably from the external Dutch (plus CEGESTI) facilitation to the local group of facilitators.

Further analysis on the methodology use by the companies is given below in the section on manual adaptation.

Q6) What elements of the ecodesign approach can be optimised for use in Central America ?

F16. Did the company supplemented their own tools/additions to the methodology supplied?

Analysis of research factor

F16 – additional tools
Half of the companies in the first phase did not add any tool or other additions to the methodological approach. The other half did only make some small amendments to fit the project to other schemes and approaches used in the company. No fundamental changes in the approach have been reported or proposed by any of the companies. In the second phase, all companies used the adapted regional manual, which differed on a number of points from the UNEP manual. In the case of Aventuras, because of the service approach, a number of (European-based) analysis tools were used in addition to the regional manual.

Further analysis

In both project phases 'unpackaging' took place. The advantages of unpackaging as stated in literature (Djeflat 1988) seem to apply to our situation: the local counterparts are able to build up their own expertise, introduce more of the local specifics and are thus more involved in the total decision making process.
The disadvantages of unpackaging also apply: the composition of the manual was a hard and arduous task, eating into the project budget much more than planned, on both sides on the ocean. Although the publishing of the new manual is felt as a great achievement, it still has to be rigorously tested in regional circumstances and industry. Some elements now tentatively included have to be optimised on the basis of further experiences. This testing was regretfully not a part of the current project.

By far the most important 'unpackaging' of the Europe-based methodology took place not on the company level, but on the project level when developing the regional manual for Ecodesign. The key elements on which the European ecodesign approach and manual were adapted after the first project phase are the following:

Drives for ecodesign

In the European context, external drives for ecodesign are important. Government policy, market demand, activities of competitors, demands from suppliers, pressure from the social environment (public opinion) all can push companies to start ecodesign. In most Central American projects, external drives for ecodesign were absent. Legislation is basically effect-oriented and certainly not focused towards environmental aspects of products. Existing environmental policy towards industry in general is not well established and not very strict implemented.
Internal drives are much more important for the companies – cost reduction, image, environmental benefit, competitiveness by better product quality and new markets.

Adaptation

It was concluded, that emphasis had to be put on internal drives. The ecodesign approach was adapted in this respect. In the practical steps in the case studies, internal drives were the key factor to be analysed. In the manual, the element of internal drives was emphasized more clearly and analysis in cost reduction opportunities was given more priority. In the presentation of results in various dissemination activities, those internal drives for the company were also clearly stated as key reasons to start with ecodesign.

Systematic product development

The ecodesign approach is based on the principles and existing knowledge on integral product development. Ecodesign does not change the basic structure of the design process, but adds new aspects in almost each step of product development. In the European context, most companies starting with ecodesign have a structured product development system in place. Many medium sized and large companies employ professional industrial design engineers. Most companies in Central America that embark on the ecodesign path at the same time have their first learning experience with a more formalized, structured design process.

Adaptation

In the project, these differences are accommodated both ways. On the one hand, the ecodesign approach was applied flexibly, so that the existing experience, knowledge and practice of the companies would not disappear in an over-structured 'European' system. Local experience with materials, products and markets was used as optimally as possible in the projects. The common benchmarking focus was expanded and improved (see below). Typical regional attitudes towards longevity of products and reuse/second use of materials and products (often for economic reasons) were integrated as much as possible. On the other hand, a certain rationalisation and structuring of the design process would improve product quality in almost all cases, so the ecodesign project was also used to introduce structured product development. In the manual more attention is given to the design process via description and tools for design steps that are more or less 'taken for granted' in the European version.

Benchmarking

From the case studies, it was clear that copying by comparison with other products (benchmarking) is the prevalent road to developing new products, ranging from simple 'knockoffs' to creative adaptations of existing products. The ecodesign approach mainly facilitates the use of the improvement strategy to be combined with the low price strategy. Since in the European context copying is culturally more or less 'not done' , or at least not explicitly mentioned (most companies do it to some extent), it is also not elaborated in the ecodesign approach, which focuses on innovation as key mechanism.

Adaptation

The benchmarking approach was followed in many of the cases in Central America and therefore integrated systematically into the manual. A step-by-step approach was formulated to benchmark the competitors' or foreign products and process the information in such a way, that constructive improvement options can be derived from it.

Redesign focus

Redesign of existing products is often denoted as the 'lowest' form of ecodesign, and preference is given to new product development with a radically improved environmental profile, or to new systems and services that allow for a large impact reduction. However, it must be remembered that product and systems innovations are usually part of a longer term 'learning curve' in the company, which frequently started with redesign of products in the first place. Also, product and system innovation is more likely in a company with an innovative attitude and structure, and usually with extensive former experience in more modest product changes. This is why the European manual already suggests starting with a redesign approach by choosing a reference product first. Still, much of the attention is given to new product development. In the case of Central American industry, most (SME) companies are at the beginning of that learning curve, and will start with redesign of their current products. This is also more in line with the preferred benchmarking approach described above.

Adaptation

The ecodesign approach for Central America is more strongly focused at redesign options and improvement directions, both in the practical projects and in the examples and tools presented in the manual.

Simplified tools

It was clear from the beginning of the project, that the tools presented in the European approach were conceptually complex and required a lot of insight into both environmental problems and product development. This insight will be lacking in the beginning of the process. Conceptual tools that present the broad array of improvements for products over their complete life cycle (Like the LiDS –Life Cycle Design Strategies – tool) will not be useful in this phase.

Adaptation
The experiences with these checklist-type tools such as PIT (CEGESTI 1999, Diehl et al 2001) are good to use as a starting point in the projects. The tools build a basic understanding in the company for ecodesign principles that can be followed by more conceptual thinking that is necessary for continuation of the process.

Use of LCA
Another (complex) tool that is important in ecodesign is the LCA (Life Cycle Assessment) for quantification of the environmental impact of a product. Currently, easy-to-use software is available that calculates the environmental impact in f.i. ecopoints or eco-indicators. The problem in the case of Central America is twofold. First, the use of LCA requires a systematic and extensive availability of all data concerning materials, production, distribution, use and disposal of the product. Those data are not usually available in a Central American company. Second, the calculations made in LCA's are based on a large number of assumptions that vary per region. Basic assumptions on effects of energy use f.i. depend on the energy source, which differs per region (for instance the use of hydropower vs. oil for electricity supply). Thus, the results must be 'translated' to specific regional circumstances. Currently, those data are only partially available for Central America.

Adaptation
The focus in the projects is therefore on semi-quantitative and qualitative tools for the estimation of environmental impact.

Use of regional examples
The original European manual is illustrated with many examples of ecodesign worldwide – mainly of industrialised countries. For a regional Central American manual to be effective, it has to be illustrated with regional examples

Adaptation
On the basis of the experiences with the company case studies, the Ecodesign manual for Central America includes mainly regional examples. This makes it easier for the companies that use the manual to relate to the topic, and also can convince them that ecodesign is actually working for their specific circumstances.

10.2 Transition to local leadership

Q7) How does the transition to local facilitation of ecodesign develops? Is it optimized?

F17. Was the programme performed in a co-operative way, local actors progressively taking the lead in the company projects?
F18. Were the programme steps design, initiation, implementation, monitoring, evaluation used?

Analysis of factors: These factors are scored per 'network', group of case studies within one country, since within each country the same project team performed the projects.

F17 – local lead
The first phase projects score relatively low, with the exception of the Costa Rican network. This is because in Guatemala and El Salvador the projects were still more controlled by DUT and CEGESTI, and the necessary local capacity was not yet in place. In Costa Rica CEGESTI gradually took the lead already in those first projects. The second phase projects in Guatemala score considerably higher, mainly because the local lead was taken strongly by Landivar University. The situation in El Salvador improved gradually.

F18 – programme steps
The programmes in Costa Rica were performed including all phases mentioned, these steps being standard in the quality system of CEGESTI. The first phase programmes in Guatemala and El Salvador missed a monitoring and evaluation phase by the local network partners, although some evaluation took place on behalf of CEGESTI and DUT. This improved very much in the second phase programmes. In Guatemala, all phases were performed, in El Salvador all phases except evaluation.

Further analysis

First phase
From a Facilitation perspective, the "U-lead" position of the local partners is implemented step by step. The influence of DUT in the overall project activities was very large in the beginning, organizing the start-up workshop in Delft for the counterparts, directing the sector and company selection by continuous communications and several missions in the beginning of the project. Also, the first 4 company demonstration projects were closely monitored by Delft personnel from a project management point of view, the start-up workshop for the companies in Costa Rica was 'Delft dominated'.

In the second year of the project, 1999, the lead was gradually taken over by CEGESTI as key counterpart. The daily management was transferred to the project leaders at CEGESTI, DUT researchers taking a more advisory role. This transition was done in close dialogue, in which for each new phase of the project it was discussed which tasks could be transferred to CEGESTI. The next demonstration projects in Guatemala and El Salvador were monitored by CEGESTI, and executed by the local counterparts. CEGESTI completely took the lead in organising the manual development (with considerable Delft expert input) and in organising the regional conference, de factor changing the position of Delft from coordinator to content supplier, expert and research partner. Contractually, DUT continued to be coordinator and financial responsible organisation, as well as supervisor of the project.

In all 9 first-phase company projects, the situation with regard to the lead of the project is completely different, since the process was strongly assisted externally. Each of the companies had a 6 months involvement of an almost graduated European product design engineering student, each tutored by a team of professors and experts. Although the companies had to invest their own time and expertise in the project as well, and had to pay the costs of the students, this intense help to the project is still virtually for free. But students leave again, and this expertise is discontinued. Despite the negative aspect that the company can become dependent on the strong assistance in this kind of project, at the same time this approach teaches young professionals the basics of Ecodesign. The preference however, is to involve local students in stead of European ones, which will keep the expertise in the region and allow for further involvement of local universities in the capacity building process. This transition was started in the second phase of the project

The "U-lead" principle was not yet implemented in the first phase of the project within the other countries in the region. Guatemala counterpart UTEPYMI/CIG was involved in two demonstration projects and was actively involved in the follow-up of one of the companies. However, CEGESTI took the lead throughout those projects. Personnel changes (for reasons not related to the project) occurred shortly after the finalisation of the projects, the experts that were trained in ecodesign left the organisation, and UTEPYME/CIG was no longer active in Ecodesign. For the second phase, the national skills within Guatemala had to be strengthened, both within CIG and outside. The El Salvador counterpart University Don Bosco was involved in two demonstration projects (again, CEGESTI In the lead), and in addition to this is integrating the topic within some parts of their curriculum and research projects in the field of environment. UDB was very active in organising conferences on the topic. However, UDB did not take the lead in developing new ecodesign initiatives, so also in El Salvador strengthening of the know-how was necessary. The Hondurese counterpart FIDE did not further develop skills in the field of ecodesign after the initial course, due to the delay of project activities that occurred after Hurricane Mitch in 1998.

The fact that CEGESTI took the lead in the beginning also in Guatemala and El Salvador is according to plan, but delayed building of local capacity in the countries. To facilitate further built-up of own capacity in the countries, an extended and follow-up course was envisioned in the next phase, project ownership had to be made more local, and a 'knowledge transfer' system to the local counterparts had to be built into the next projects.

Second phase
With the regional manual and case studies available in the second phase, the trained professionals in the region have learned to facilitate the ecodesign projects themselves. Flexible use of these materials and addition of new elements were included in the facilitation, and this way the ecodesign approach was made more local. The different type of organisations have integrated this knowledge in different ways: Consultancies add it to their portfolio of services, Universities and Technical Institutes added it to their curricula and student projects, industry organisations and institutions added it to their activities, such as organising workshops.

The extended focus on sectors, services and chain also delivered new insights for the facilitators: how to organise sector workshops, looking for possible alliances between companies, looking for networks that can take certain actions that are impossible for individual company, looking for concerted activities in several parts of the production chain.

The notion to teach more professionals in the region on ecodesign, gradually took shape. The first example was set in the project itself, by training almost 40 professionals, of whom about half are were involved in the industry projects. NCPCs followed with integrating ecodesign in their courses.

The facilitation of second phase projects by local teams worked out better than the first phase. In Costa Rica CEGESTI was in charge which made it a strong and experienced team, in Guatemala Landivar took the lead in the projects which also performed well. The team in El Salvador had their first ecodesign project, and in that case CEGESTI had to take charge at several points in the project. Overall, the role of CEGESTI was still crucial, but in the case of Guatemala as strong actor such as Landivar can and is performing independently. The role of TU Delft became clearly more and more that of an expert advisor and a 'coach' to CEGESTI.

The transition towards the use of local graduation students instead of Dutch students worked out quite well. In Costa Rica, in addition to TEC students also for the first time UCR students were involved in the Aventuras Naturalis project, and in Guatemala and El Salvador a prominent role was played by Landivar graduation students.

Integration of ecodesign with related fields such as cleaner production, innovation and environmental management is very slow. First efforts are the trainings of NCPCs. Also, a TU Delft project proposal for Nicaragua integrates innovation (for SMEs) and ecodesign, but this will again be a Dutch development co-operation driven project proposal. The joint development of the CCAD awards for the categories ecodesign, environmental management energy efficiency and innovation can be seen as a first step towards integration between the different fields.

10.3 Influence of the research factors on facilitation

The analysis of the influence of the research factors on facilitation is of a descriptive, exploratory nature. In the research model for facilitation (see Chapter 6), one set of factors that influence the facilitation is the existing ecodesign methodology with its tools that were introduced in the project. It seems that the approach as presented in the UNEP manual led to a high-quality facilitation process in the first phase case studies. The structured process was welcomed, the tools used to a very large extent, relatively few additional tools and methods were used in addition to this. This can also be seen in one of the key results of the facilitation process, the regional manual: although relevant adaptations further improved the applicability, still the core approach and key tools from UNEP were preserved.

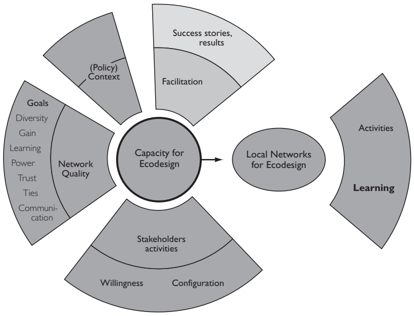
This positive influence of the approach applied was further strengthened in the second project phase: having the regional manual available, an even better match with the needs of the companies could be made. This has indeed been the case: in all projects of the second phase, the methodology was received very well, and the key tools were applied without problems. Also, local facilitators feel more comfortable with a local applicable methodology available. Overall, it can be stated that the having an appropriate and regionally adapted methodology has a positive influence on facilitation quality.

A next influencing factor is the availability of successful cases and experiences with the methods and tools. This last element has been dealt with above, since this is translated into the regional manual and the experienced local facilitators. The first element, availability of local success stories is often mentioned as a key element to gain interest and enthusiasm for a new concept. This experience is confirmed in this project: when local examples became available, they were used in lectures and presentations, and every time the reactions were positive and interest was raised.

A third factor that is expected to improve facilitation quality was the systematic involvement of local facilitators. This is directly connected to capacity quality, which will be analysed in the next chapter. Here, the process of this transition towards local lead can be analysed. This was a process with several drawbacks, as explained before, because of change in personnel at experienced counterparts and shifts to other counterparts. However, once cooperation was established with a good and stable counterpart, the transition process could be fast and complete, and the resulting local facilitation was of a high quality.

This transition to local leadership is a key success of this project. The local feeling of ownership on the topic of ecodesign that results from it can be a key stimulating factor for future ecodesign initiatives.

Chapter 11: Analysis of Capacity building



The analysis of capacity building starts with a descriptive and explorative stakeholder analysis in 11.1. This analysis was used in the first project phase to prepare the best configurations for the second phase. The results of these efforts and ongoing activities are analysed as well. In 11.2, the quality of the local networks for ecodesign that are emerging in the second phase is assessed. This is done on the basis of the networking and configurations criteria F19-F27. In paragraph 11.3, the learning aspects (F28-F30) are analysed. Last, in 11.4, the patterns of influence of the research factors on capacity building are analysed.

11.1 Key actor involvement

This section has a different structure than the analysis chapters on adoption and facilition, because of the highly explorative nature of the research on this topic. While for adoption and facilitation the project could start immediately with case studies, building of capacity for ecodesign in the region had to start with the analysis on the possible actor organisations and institutions that can be involved in the further dissemination of ecodesign. The analysis starts in the first project phase with an assessment of the institutions that can be involved, followed by a more detailed stakeholder analysis. Based on the findings of this, activities are analysed that were planned for different actor groups in the second project phase. Then, an assessment of the current situation of follow-up activities (status 2002) is given.

Therefore, in this section 11.1 a descriptive analysis is given of the activities, and the analysis is not directly related to the research factors developed in Chapter 6 (For the networks emerging after phase 2, such an analysis will be presented in 11.2).

First phase

As a first step of charting the actors involved in the region, an institutional assessment was made of these relevant organisations in the region with respect to ecodesign, thus giving insight in the 'social system' that exists. Intermediate institutions are expected to play a central role in the transformation to a more sustainable society. Tackling the social dilemmas that invariably accompany the environmental issue will put a heavy demand on agreements between all stakeholders, and on support for collective decision-making (Röling and Jiggins 1998), with intermediate institutions in the centre of interaction. The assessment used was developed by the IDRC as part of their experience in research in international development (Lusthaus et al. 1995). This assessment aims at gathering the following data from each of the organisations:

- The institution's external environment
- Institutional motivation
- Institutional capacity
- Institutional performance

The assessment delivered valuable information to be processed further. To identify all important groups of people or individuals that can have an influence on the introduction of ecodesign in the region, a stakeholder analysis was performed. In the analysis, all parties are identified that are directly or indirectly involved. It sets out the issues, concerns and information needs of the stakeholders, and describes the relative positions, influence and power tools that each of them has. Part of the information can be derived from the institutional assessment as described above. The stakeholders analysis goes beyond that and focuses on the actual relation between the stakeholder and the issue of ecodesign introduction in Central America, as experienced during the missions and information of the counterparts. Stakeholder analysis was developed mainly as an approach for individual companies (Ackoff 1981), as part of a company's organisational analysis. It is therefore closely related to other analytical techniques such as SWOT (Strengths, Weaknesses, Opportunities and Threats) and CFS (Critical Success Factors). Stakeholder Analysis focuses more on the context as a whole, and is therefore relevant in this stage of the study. With some simple adaptations, the analysis is made practicable for our situation, where we do not look at individual companies, but at the whole system of ecodesign activities.

Step 1: Acknowledgement of Stakeholders:
The first step was the identification of the key stakeholders. This was done on the basis of the institutional assessment of all possible organisations in the region that could play a role in ecodesign activities. The boundaries were set at organisations that were involved in or related to industrial activities: industry itself, intermediate industry organisations, customers, government, financial institutions, labour organisations, research organisations, environmental organisations.

Step 2: Creating a Characteristics overview:
In this phase, answers were sought to the following questions:

- What is the importance of the stakeholders for ecodesign ?
- What does the stakeholder demand/want with ecodesign ?
- What does the stakeholder deliver for ecodesign?
- What are the expected goals of the stakeholders?
- What are the strengths and weaknesses of the stakeholders?

The results are described in table 11-1.

Step 3: Identification the Opportunities and Threats of the stakeholders for the development of ecodesign (SWOT).

The Stakeholder Analysis is a technique that does distinguish several component types and relationships. The component types are: communication demand, wish, service, strategic goal, strength of stakeholder, weakness of stakeholder. The relationships that the stakeholders has towards ecodesign, f.i.: stakeholder makes a demand / wish, stakeholder delivers a service, stakeholder has a positive/negative influence on, etc. These components and relationships are summarised in the table 11-1 for the stakeholders identified.

The next step is to analyse, on the basis of the insight gained in the stakeholder analysis, what the key actors are or should be in the further development of ecodesign in the region. This is analysed in paragraph 11.2.

Table 11-1: Stakeholder analysis for the supporting organisations for ecodesign in Central America (grouped per country).

Component: Stakeholder	Communications	Importance	Demand, Wishes	Services	Goals	Strength	Weakness
1. Demo companies	Explaining advantages	++++	Accessible method, info,, Assistance	Case studies, Ecoproducts	Profits, Cost reduction, Market opportunities	Region specific examples, Entrepreneurs	Continuity
2. Cegesti	Explaining the concept, advantages	++++	Examples, info,, Knowledge transfer	Research, Consultancy, Training	Project funding, Profit	Experience in industry and with consultancy	Capacity
3. Itcr/tec	Concepts, Research results	++	Student proj., research proj.	Research, Education	Curriculum development, Knowledge results	Student involvement, Continuity	Practical industry experience, Capacity
4. Asometal	Involving companies, explaining ecod	+++	Loans for companies, methods	Assistance to members,, Information training	Improvements/profits for members	Close to companies	Experience, Protection members
5. Bcie bank	Provides information to companies	++++	Solid investments	Funding for companies, Information	Return on investment, profit	Direct influence on projects	Short term pay-back demands
6.Utepymi	Explaining the concept, advantages	++++	Examples, info,, Knowledge transfer	Research, Consultancy, Training	Project funding, Profit	Close to industry	Experience in industry capacity
7. Camera industry GUA	Provides info to companies	+++	Projects	Assistance to members,, Information, Training	Improvements/profits for members, Profit utepymi	Close to industry	Consultancy experience, Protection members
8. Conama-/Marena	Explaining concepts,need to change	++	Criteria/input for policy development	Policy measures, National coordination	Reduction env. Impact, successful policy	Policy measures possible	Implementation and enforcement weak, Bureaucratic
9. Universidad, Don bosco	Concepts, Research results	++++	Student projects, research proj.	Research, Education	Curriculum development, Knowledge results, Project funding	Student involvement, Industry contacts, Continuity	Practical industry experience, Capacity
10. Fide	Explaining the concept, advantages	+++	National proj., research proj.	Consultancy, Information, Training	Project funding, Improvement national	Connection with industry	Capacity, Consultancy experience
11. Conacyt Concyt	New technologies,	+	New technologies,	Policy,, Research	Accessible technology,	Technology push	Implementation slow, bureaucratic
12. Anacafe	New concepts, new technologies	++	Improvements coffee production	Assistance to members,, Information	Profits for members reduction env. Impact	Knowledge of sector	Weak members protection
13. Public Univ. Guatemala	Concepts, research results	+	Student projects, research proj.	Research, Education, Training	Curriculum development, Knowledge results	Student involvement	Practical experience, Low capacity, Bureaucratic
14. Landivar Univ. Guatemala	Concepts, research results	++++	Student projects, research proj.	Research, Design education, Training	Curriculum development, Knowledge results	Student involvement, Fast	Practical experience
15. Ccad	Opportunities, need to change	++++	Regional activities, Input for policy dev.	Policy measures, Regional coordination	Reduction env. Impact, successful. Policy	Policy measures, regional push, High level	Far from industry
16. , Ncpcs,	Concepts,, Advantages	++	Methods, Examples/info	Demo projects, Training, info	Reduction env. Impact, Companies involved	Dedicated to the concept, international links	Capacity
17., Fepyme,	Involving companies,, Explaining ecod.	++++	Loans for companies, methods	Assistance to members,, Info, Training	Improvements/profits for members	Close to companies,, Expertise	Protection members, Lack of funding
18., Asi	Involving companies, explaining ecod.	+++	Loans for companies, Methods	Assistance to members,, Info, Training	Improvements/profits for members	Close to companies	Experience, Protection members
19., Gtz	Explaining concepts, advantages	+++	Key projects, results	Projects, training, funding	Project results,, Technical development	Expertise, funding	Fit in own programme

Q9) What are the key actors in the process of capacity building and what is their role and involvement?

In the first project phase, many organisations showed Interest and willingness to be actively involved in the second phase activities. To come to a strategic selection, a number of essential clusters of type of organisations, each with a specific societal function to deliver, were formulated which makes it easier to set priorities. The definition of the clusters is based on the model of Basic configurations developed for innovation centres in The Netherlands (Coehoorn 1995 after Mintzberg 1983). The current project can be described as a mix of a R&D driven configuration and a sponsor-driven configuration. Central 'target group' of both configurations is industry, in the case of this project small and medium sized firms in the region. Simplified, the main relations between types of organisations regarding ecodesign in the region can be visualised as depicted in figure 11-1: In the centre are the companies, connected with consultancy/engineering organisations, research organisations, industry organisations, governmental organisations and financial organisations.

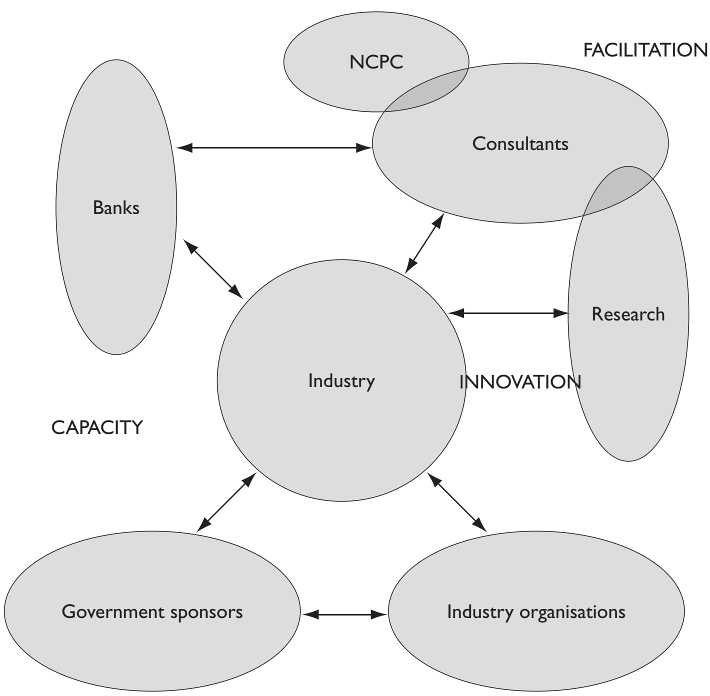


Figure 11-1: Key stakeholders for ecodesign in Central America

Thus, five key clusters were discerned that each have their functional relation with industrial companies, and can be addressed on their specific function:

- Advisors/consultancies: facilitation, technical. management advice, project deployment

- Research organisations: facilitation, innovation research projects, information support
- Industry organisations: capacity, project deployment, information support
- Governmental organisations: regulation, supportive measures capacity
- Financial organisations: financing, supportive project deployment.

There are several other types of organisations that can play a supportive role in these type of configurations, such as labour organisations, consumer organisations and environmental organisations. However, the five clusters described above are key clusters, and for practical reasons were targeted first. In practice, these other organisations were not actively contacted and did not ask for involvement themselves during the project.

In table 11-1, the individual services to be delivered for ecodesign by the organisations were analysed. In this section, these data are summarised per cluster:

Cluster: Advisors/consultancies (and 'second line' organisations such as NCPC).
Capacity building is needed to enlarge expertise and experience with ecodesign. Tools needed by this cluster to functioning the ecodesign network are: manual, fact sheets, toolbox, training programmes, projects and case studies. Actors are e.g. CEGESTI, UTEPYMI, and NCPCs.

Cluster: Research institutes.
A variety of research projects and student projects can be the function of this cluster. Tools needed are: manual, research results, software (like environmental analytical tools) and inter-university co-operation projects , curriculum programming.
Actors are e.g. ITCR/TEC, Landivar University, University Don Bosco (El Salvador).

Cluster: Industrial organisations.
These organisations can support their members with technical/managerial support, information and financial support (through branch projects). Tools needed include the manual, project (ideas) and case studies, in addition to technical information. Key actors are Fepyme, Asometal and ASI.

Cluster: Government
Supportive measures (subsidy funds, information, tax abatement), economic measures (taxes) and regulation are among the possible initiatives of governments. The need is integral policy advice and Technology Assessment on ecodesign. Also, examples and experiences, as well as environmental and technical information is necessary. For our project, key actors in the region are CCAD and the Dutch Embassy as governmental sponsor.

Cluster: Financial organisations.
Banks and other financing organisations will be able to subsidise project funding, as well as loans and investment funding for industry. They need information on the economics of ecodesign, and case studies on achievements. Key actors are banks, for example the BCIE bank.

Q8) How does the process of capacity building and awareness raising on ecodesign develop in Central America ?

In general terms, the following activities were undertaken with the societal actors in the first phase of the project (Table11-2). The activities are described in detail in various parts of Chapter 8.

Table 11-2: First phase capacity building activities

Action	Target	Involved Actor Clusters
Demonstration project follow-up	Demo companies	C(onsultancy), I(ndustry org.) F(inancial org.)
Industrial follow-up projects: (Sectors)	Industry	C, I, F, G(overnment)
Manual and fact sheets	Companies, Intermediates	C, R(esearch)
Training activities, conferences	Sector organisations, Chambers of Industry	C, R, I, G
Intensive training on ecodesign facilitation	Direct counterpart organisations	C,R
Curriculum development	Universities, Companies	R, I
Regional conference	All	C, R, I, G, F
University co-operation	Universities	R
General awareness raising (articles)	All	C, I, R

Q10) Is capacity and awareness building on ecodesign successful ? Can/should it be optimised?

Second phase

Although this was a regional project, it took place in a setting where national beliefs and feelings are very strong. An experience with the first phase of the project was, that there was a need for a more national focus on the different countries, especially in Guatemala. Although the content of the activities would not differ very much, there can be more involvement of local actors, and national specifics can be better dealt with. Therefore, some of the follow-up activities were organised on a national level. In light of the thinly spread budget of the project, it was envisioned that the activities are organised around a number of 'focal activities' for each of the clusters. In the second phase, a number of typical capacity activities were planned (reports 21-23, Annex B), these were:

- New ecodesign projects (service, sector and chain-oriented)
- High level course for professionals
- Survey on eco-indicators
- Specialized national workshops
- Regional ecodesign award for industry

On the basis of the type of services the clusters can deliver, as explained earlier, the relations and possible involvement of the clusters to the activities were analysed (table 11-3).

Table 11-3: capacity building activities related to clusters

Cluster: / Activity:	Consultancy	Research	Industry organisations	Financial organisations	Government
New Projects	++	+	+	0	0
(High-level) Courses	+	+	0	0	0
Eco-indicators	+	++	0	0	+
National workshops	+	+	+	+	+
Ecodesign award	0	0	++	+	++
Webpage	+	+	+	0	+

(++ strong relation, + relation, 0= no relation)

Although all five clusters have been targeted in the different actions, the government and financial institutions in general were not as strongly involved in the second phase, nor did they show strong interest themselves. Also, most of the initiatives taken do not require a strong commitment or any other strong obligation from the stakeholder. Key exception to this is the attitude and involvement of the SICA/CCAD (Regional commission on sustainable development) that showed a keen interest in the topic and co-financed the regional conference. The cluster that was targeted in many of the activities and reacted positively was research: contacts with several universities increased in the second phase.

Universities

A very strong development in the second phase is involvement of universities and technical institutions, both in practical involvement in ecodesign via student project, as in curriculum building. The strong involvement of Landivar staff and students has led to a focus on ecodesign in the curriculum development and graduation projects. It was one of the topics of Landivars' 2001 'design week' activity. Landivar will participate in the international project on the further development of long-distance learning tools and curriculum elements, together with TU Delft and Los Andes University Colombia. In El Salvador, ITCA has gained practical experience in project work of their students in El Jobo. The fit with the curricula of ITCA is not good, since design engineering careers are not offered at ITCA. Integration into CP projects seems a better way forward. After not being selected for the second phase project in El Salvador, UCA has continued more or less independently with an ecodesign project, and has added additional methods and tools from its own experience. Also here, the fit with the careers is not good. URC has entered the project in the specific and highly important field of sustainable energy sources. This is still a weak connection, since they were not highly involved in the whole process. Future efforts should be aimed at further integration.

However, some universities have missed learning opportunities: Both University Don Bosco in El Salvador and to a lesser extent TEC in Costa Rica have reduced their activities in the ecodesign field, after high involvement in the first phase. Also in this case, future opportunities for joint work in the local networks should be aimed for.

Follow-up activities

The follow-up activities that were started (status 2002) are described in Chapter 8 (report 23, Annex B) Also, some of the activities undertaken in the project are continued, other are not. This and the involvement of cluster types is presented in Table 11-4.

Activity	Continued from 2002 onward?	Involved clusters	Countries
Demo companies follow-up	Yes, in a few of the companies only	Consultancy, Industry	Costa Rica, Guatemala
Industrial follow-up (outside demo)	Yes, food industry Costa Rica, 'Design without borders' project GUA	C, I, Research	CR, GUA
New projects (research)	No		
Manual development	No		
Training activities	Yes, connected to new projects and by NCPCs	C. I	CR, GUA, El Salvador
Curriculum development	Yes, in several universities	R	CR, GUA, ES
University cooperation	Planned, no activity yet		CR, GUA
Eco-indicators	No		
National Workshops or conferences	No		
Ecodesign Award	Yes, integrated in CCAD award scheme	C, I, Gov., Financial	Regional
Webpage	Yes	C, G	CR

Table 11-4: follow-up activities per 2002

As can be seen from table 11-4, the follow-up activities are still located at the same type of organisations that were involved in the project. There is still little involvement from government and financial institutions. Also, new research projects on the concept or related issues did not emerge. Concluding it can be said that current follow-up is directly related to the key activities of the project, and broadening of the scope or involvement of new actors does not yet occur.

11.2 Emerging Local Networks

An important element of the transition from first to second phase activities was the focus on local (= national) network building. In Costa Rica, Guatemala and El Salvador, the first contours of local networks are showing at the end of the project. Clearly, these are emerging networks, in the first phases of building up, still very informal and subject to change. All networks were concentrated around the project activities inside the ecodesign project, and have to find a new nucleus of attention after the project.

Using the analytical framework of the research factors, a first analysis is made of the strong and weak points of each network, thus giving insight in possible improvement directions. The research factors developed in Chapter 6 are repeated below. All related research questions (Q) are quoted since there is not a one-on-one relation with the research factors.

Q8) How did the process of capacity building and awareness raising on ecodesign develop in Central America?
Q9) Who are the key actors in this process and what is their role and involvement?
Q10) Is building capacity and awareness on ecodesign successful? Can/should it be optimised?

F19. Is there a joint perception of the goals. Are the goals accepted by all partners?
F20. Are all relevant actors involved in the network?
F21. Is there a visible additive gain for all actors involved?
F22. Is a joint learning process between actors going on, or at least possible?
F23. Is power distributed fairly between the actors?
F24. Is there basic trust and interdependence between the actors?
F25. Do both strong and weak ties exist in the network?
F26. Is there an adequate communication pattern in the network?
F27. Is there conformity between the configuration and the goals/activities of the network?
F28. Is double loop learning taking place in the organisations of the network?
F29. Is organisational learning taking place in the network organisations?
F30. Is learning taking place through all levels of the system?

Since these networks are only beginning to develop, the scores on network quality checks are still low and can be indicative only, since the optimum for these scores are valid for developed networks. For the networks, the detailed description of these research factors is given below (tables 11-5, 6 and 7). The analysis was mainly based on observations of the researcher and project team in working with the organisations in the network. Also, data from the interviews with stakeholders were used to construct the analysis. According to the scoring system of Chapter 6, the factors were analysed and a score was given as presented in table 11-8.

F19 – 26 overall analysis network quality

The Costa Rican network is the same as in the first and second phase, therefore has the same score. However, the Costa Rican Bendig network is scored separately because it was part of a separate (Asometal) programme. The Guatemalan and El Salvadorian networks have changed considerably from the first to the second phase – for the better, the new networks score higher. The Costa Rican ecodesign network consists of CEGESTI, the involved companies, TEC, UCR, CCAD, and outside actors: TU Delft and the Dutch Embassy. The analysis of the network is given in table 11-5.

Table 11-5 Costa Rica Network

	"Network Quality" factors	Costa Rica network
F19	Goals	Goals are not jointly shared, but in the same direction
F20	Participants	Core actor is clearly CEGESTI, missing are institutional and governmental actors. CEGESTI has to take the lead in all activities.
F21	Gain for Actors	Yes, sometimes restricted by organisations goals (TEC) Limited resources, competition
F22	Learning Process	Learning process is fragmented but exists, mainly between sets of actors (f.i. CEGESTI and CCAD)
F23	Power	Non-hierarchical but not (yet) transparent enough.
F24	Trust	Basic trust but certainly no shared resources
F25	Ties	'Strong ties' can be improved. 'Weak ties' are available, can be improved also
F26	Communication	Basic Communication, but too incidental

The strong starting position of CEGESTI as lead consultant has led to an uncomplete knowledge sharing with the University actors such as TEC. Critical improvements would be the better (financial) involvement of university actors, involvement of local government and financial actors and some kind of joint project in which several of the actors are involved and work together to improve the common focus.

The Guatemalan network (Table 11-6) of the first phase ceased to exist after the projects and is not analysed in detail. The second phase Guatemalan network consists of Landivar, Fepyme, the Ministry of Economic affairs, the companies (old and new) and the CIG as host of the Guatemalan NCPC. Outside partners are CEGESTI and Opsvik (the Norwegian ecodesign initiative involved with the same network partners).

Table 11-6: Guatemala network

	"Network Quality" factors	Guatemala network
F19	Goals	On a general level, no specified
F20	Participants	Yes, core actor is Landivar, government involvement just recently and weak. Financial partners missing.
F21	Gain for Actors	Yes, but unclear resources for the future
F22	Learning Process	Strong between several partners such as Landivar, companies and Fepyme, not shared with all other network partners.
F23	Power	Non-hierarchical and quite transparent at the moment, Fair distribution of power
F24	Trust	Trust between current project partners, not (yet) between old and new project partners
F25	Ties	'Strong ties' are there, can be improved, 'Weak ties' limited
F26	Communication	Basic communications only

This Guatemala network seems a potentially good emerging network, although financial opportunities for the future are missing, except for the Norwegian project, which will be mainly 'manpower' and expertise involvement. Improvement of the ties between the current actors could probably lead to new opportunities for projects and financing.

The first phase network in El Salvador was altered and enlarged in the second phase: The second phase network currently consists of AG Tech, CONACYT, CONAPYME, ITCA, El Jobo, the old project companies, UCA and Don Bosco university. Outside actors are CEGESTI/TU Delft (table 11-7).

Table 11-7: El Salvador network

	"Network Quality" factors	El Salvador network
F19	Goals	On a general level, not specified
F20	Participants	Core actor is AG Tech. Low involvement of government, financial institutions missing
F21	Gain for Actors	Yes, but low financing in the future
F22	Learning Process	Yes, but low University involvement in this
F23	Power	Non-hierarchical at the moment,, Power not distributed fairly at the moment
F24	Trust	Basic trust growing
F25	Ties	Lack of ties. 'Strong ties' should be expanded, 'Weak ties' don't exist
F26	Communication	Fairly good communications, not between all actors

Missing in this network is still a strong university/knowledge centre involvement and stronger local government involvement. Although some financing opportunities exist for the future, these are still limited.

Table 11-8: scores on research factors for capacity building, on network level

Factor / Country network	Costa Rica (Wai, Hel, Pan, Maf)	Guatemala (Ven, REA)	El Salvador (Mob, Kon)	CR (Ben)		CR (AvN)	Guatemala (Tur, Inm, Exc)	ES (ELJ)
NETWORKING								
19. Joint perception goals	B	D	C	D		B	B	C
20. Key actors	C	C	C	C		C	B	C
21. Gain for all actors	B	C	D	C		B	B	B
22. Joint learning	C	C	C	C		C	B	C
23. Fair power distribution	C	D	C	B		C	B	B
24. Basic trust & interdependence	B	C	C	B		B	C	C
25. Strong and weak ties	B	C	B	C		B	B	D
26. Adequate communication	C	C	D	C		C	C	C
CONFIGURATION								
27. Conformity config. and goals	B	D	C	B		B	B	C
LEARNING								
28. Double loop learning	B	C	C	C		B	B	D
29. Organisational learning	B	D	D	C		B	B	D
30. Full learning cycle	B	D	D	C		B	C	D

Scoring on factor:	= Score A (full compliance):	= Score B (2/3 compliance):	= Score C (1/3 compliance):	= Score D (no compliance):

F27 – Conformity of configuration with goals

The conformity of the actual configuration of the network with the project goals, which requires a R&D/Sponsor type of configuration, is the highest in the situation of Costa Rica. The network consists of an innovative consultant, CEGESTI, together with two universities (TEC and UCR), with assistance of CCAD, a government organisation which has to develop a new policy field for the region – sustainability. This means most actors are interested in new knowledge, innovation and information – a good fit with the R&D focus of the project. Also, the other aspect, the sponsor-orientation of the project (Sponsor being the Dutch Embassy) has the strongest fit with the situation in Costa Rica because of the location of the embassy.

A similar R&D orientation is valid for the network in Guatemala during the second phase of the project, when Landivar took the lead, supported by Fepyme.

The networks in El Salvador show a somewhat lower conformity, although in the first phase a university was involved, but in that phase not much emphasis was given to the research and knowledge element.

No conformity existed with the first Guatemala network, with the Industrial chamber of Guatemala as key counterpart. Clearly, the goals of this organisation were quite different from the projects' objectives.

11.3 Learning aspects

F28. Is double loop learning taking place in the organisations of the network?
F29. Is organisational learning taking place in the network organisations?
F30. Is learning taking place through all levels of the system?

Analysis of the criteria scores

F28 – double loop learning
F29 – organisational learning

In principle double-loop learning took place in all key counterpart organisations involved in the project, most often in the sense that in addition to the practical single-loop learning by applying the ecodesign methodology, also the conceptual framework that many of those organisations had changed. Counterparts that were more remote in the network did not always show this type of learning. This f.i. explains the lower score of the Bendig network compared to the other Costa Rican networks, since the metal sector association Asometal did not show this type of learning.

The related issue of organisational learning did not happen that much – this would mean organisations would adapt their strategies and goals to the topics learned in the project. This only happened to high extent in CEGESTI and Landivar, and virtually not in the other organisations involved.

F30 – learning on all levels (see section 5.3.2 and figure 5-6)

The levels where learning took place in an interconnected way in Costa Rica certainly included the first three – industrial practice, knowledge gathering by industry and facilitation by the consultants and researchers involved. Also, the systems approach in the second phase resulted in improved learning of the company Aventuras: the company started to look outside the obvious improvement options in their products and also initiated activities f.i. in their own office, and in the transport system.
Less clear was learning at the levels of policy and of the institutional support framework (with the exception of CCAD).

The network organisations in Guatemala during the second project phase also show learning on the first three levels. Improved learning between the companies took place (the synergy in the strategic alliances between them). On the policy level, there is some interest from the Ministry of Economic affairs and the NCPC. However, learning to facilitate was on a lower level than in Costa Rica and mainly restricted to Landivar University.

Learning in the other networks was generally restricted to individual companies or organisations, and little or no interconnected learning took place.

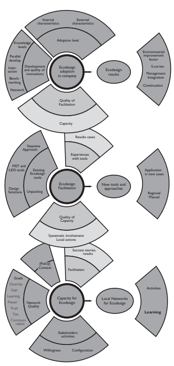
11.4 Influence of the research factors on capacity building

The analysis of the influence of research factors on the capacity building is of a descriptive and exploratory nature. In the research model for capacity (see Chapter 6) one set of factors that was determining overall capacity results was the network quality. Looking at the findings of network quality, a trend can be seen that the quality of the network does indeed influence the level of activity that is taking place on ecodesign.

The networks which scored higher on network quality, also had a better conformity between the type of configuration and the goals that were formulated in the project and afterwards. Since capacity itself is a factor influencing adoption and facilitation, we have also looked for patterns of the higher scoring networks in relation to these variables. However, there does not seem to be distinctive patterns of improved facilitation or adoption in this respect. The most plausible reason for this is that the networks are just recently formed, and not yet influencing the results of adoption and facilitation. The other way round, there are no clear signs that adoption and facilitation results influence quality of the network development – this seems to be a process that is not directly depending on these type of results and has a more autonomous development.

There is a close relation between the level of local lead as it was analysed at the facilitation level, and the network quality: better networks score higher in this respect. Also it is evident that more and higher level learning takes place in those networks.

Chapter 12: Conclusions and recommendations



In this chapter, conclusions are drawn from the results of the project presented in the Chapters 7 and 8 and the analysis presented in the Chapters 9 to 11. The research questions and related questions from the research factors are answered. In section 12.1, the conclusions on adoption are presented. In 12.2 conclusions are drawn on the facilitation and in 12.3 on capacity building activities. In section 12.4 recommendations are given for future activities and research in the field of ecodesign. Section 12.5 deals with the reflection on the research approach and on the theory.

12.1 Conclusions on adoption of ecodesign in the companies

Q1 – How does the ecodesign process – seen as a product innovation process – develop in the demonstration companies in Central America

The ecodesign process in most of the companies can primarily be seen as a benchmarking or copying type of innovation process. In most cases of redesigns of the existing product, the improvement directions are taken from examples of competitors or comparable products from Europe or the United States. Common strategies that were followed for this were either a lower price strategy, usually competing with products that were imported, or an improved product quality strategy competing with other regional producers. In the latter case the producers are early movers in this quality segment of the market, in absence of international competitors because of the type of product (like furniture) (Romijn 1996, Schnaars 1994). Benchmarking and copying approaches are the dominant types of design approach in Central America. This has some important implications for the type of design process that can be observed. The knowledge use is focused on the information necessary for the 'horizontal' product development process in the company itself, with additional information from the competitors' products. R&D knowledge is not generated, existing knowledge not commonly tapped. For specific ecodesign-type knowledge (f.i. specialised environmental information) this means that there is no culture in the company to disclose this type of information. It can be concluded that this type of information therefore must be brought in by external advisors, and in a low-complexity form – see further in section 12.2 on 'facilitation'.

With regard to integral joint development of product and market (Roozenburg and Eekels 1995) it can be concluded that a sequential development (technical development first) is the common approach in the companies. Market information is gathered up front, and is used in the terms of reference for the product, but integral development, f.i. in close cooperation with customers, is rare. This is in line with the approach of continuous innovation, which is used at the level of ecoredesign of products. Some of the companies were actively searching for information and potential cooperation with their surroundings in the field of innovation. This was strongest in the companies Mobelart and Aventuras Naturalis, both of which offer an innovative and high quality product or service for a relatively wealthy segment of consumers. However, for the majority of the companies it can be concluded that the information-searching behaviour was restricted to the necessary information on the benchmarking strategy.

What does this type of innovation attitude mean for the adoption level for ecodesign by the companies? In the typology of Rogers' innovation and diffusion model (Rogers 1995), it can be concluded that all companies came to the phase of knowledge about ecodesign and persuasion to at least try this type of innovative approach. However, the obscuring factor in this is that the opportunity to try this innovation is offered to them for a very low 'price', and without any large risk. Combined with the fact that this was a pre-selected group of companies, this positive intention is the minimum to be expected. The phase in which the actual decision was taken to go ahead with ecodesign and put an eco-redesigned product on the market is taken by nine of the companies. The decision to go ahead with other products or other activities related to ecodesign was then taken by six of those. There is a relation between the general level 'innovativeness' of the company and the level to which ecodesign is adopted – in other words, the more innovative firms tend to go further and faster in the adoption of ecodesign as well. This confirms the proposition that ecodesign can be seen as a special or of normal product innovation, and that the same pro-active companies that show innovative behaviour will also be among the first to engage in ecodesign as soon as external drives are in place.

The fact that benchmarking is the common product innovation route for the companies, can be related to the finding that extensive involvement in innovation-diffusion networks, seen as an imperative for European innovative companies, can not be found in most case study companies. Apparently, the information needed for the product innovation is so much more clear and available in existing knowledge of competing products, that time investment in this type of advanced networks is not yet necessary. On the other hand, participation in this project in itself is a first step to move into these types of networks. Although intensive networking is not necessary, Information and innovation management quality of the companies does influence the adoption level for ecodesign: more interactive companies gathering information have a higher adoption rate and good and continued ecodesign results.

The projects were organised in a stepwise schedule which allowed for the whole sequence of phases from the ecodesign methodology to be executed. The average project time of less than one year can be considered to be short. However, because in most cases a redesign of an existing product was the focus of the project, this period was long enough. The high investment in outside expertise (project team staff, in-house period of a Dutch or local graduate student) is of course a-typical compared to a normal company project without this support. Follow-up projects without support, or similar projects of other companies without support, can therefore only be organized if a company gives high priority to innovation and environmental objectives for their products, and probably such a project will need a longer time planning. For the initial purpose of this project – to get local examples of eco(re)designed products and use them in further activities – the project organisation chosen was the right one. The examples were available quickly, and thus could be used in the next phases of the project. For continuation of ecodesign in the same companies, or multiplication of the number of ecodesign projects in more companies, another approach is needed, because time and money investment per case study is too high for widespread multiplication. The first action towards multiplication, the metal sector project in Guatemala, was positive in this respect: less external involvement per company was needed; still the structured ecodesign approach could be executed. It should be noted here that a part of the external facilitation in the cases consisted of graduate student participation. This type of support is of course replicable for many companies since in-company graduation projects for local industrial design engineering students will continue to be organized.

The ecodesign project was the first experience with a fully structured and integral product development process for many of the companies, and as such an important learning experience. For most of the smaller companies without design experience this was a completely new approach. Local consultancy and university education in this field is just developing and is still scarce. The question remains whether, after the external help has left, the companies can replicate the structured process. In companies that already had some design experience, the structured approach was more quickly integrated into existing systems, and there is a higher chance that this improved design process can be replicated independently from external advisors.

Q2 – Are the ecodesign projects in the companies successful, is the approach continued and do other companies continue with ecodesign?

The conclusion after analysing the results of the project is that from the point of view of demonstration, the projects are a success. Nine projects, resulting in nine examples of ecoredesign, available for dissemination within two years. Five more examples available after two more years - this is a good result and comparable to other ecodesign projects (te Riele and Zweers 1994, Brezet and van Hemel 1997, van Hemel 1998, Gertsakis et al. 1997). The claims that are made for the product improvements are backed up with detailed, reviewed reports describing all aspects of the design process and the resulting product (Annex B, refs. 1-14). Market introduction is relatively positive (9 out of 14) and although direct continuation by the companies with repeated ecodesign projects is low, two companies only, four more companies have engaged in other sustainability related activities. Overall, the projects results have served their purpose as examples for dissemination and for further capacity building activities.

But were they also a success from an environmental point of view? The analysis has made clear, that in all cases some level of environmental improvement was reached. Most products scored an environmental impact reduction percentage between 10 and 20 %, usually on materials reduction, two products had a reduction of 50%. As analysed, these are common to high levels of product improvement, similar to findings in European projects, so from this perspective it can be concluded that the projects were a success. A possible argument against this conclusion is that the old products were bad in the first place, and that any structured design process would deliver this type of improvements because of simple resource efficiency principles, regardless of any environmental focus. This argument can be countered: first, it can be assumed that the quality of the products selected will not differ from that of the average products in the region, or will even be better, since the selection procedure has moved us towards good, responsible companies with a structured and well maintained production process. Second, resource efficiency is certainly considered an inherent part of ecodesign; however in non-ecodesign projects other requirements, for instance the need to have ample advertisement space on a packaging, can work against resource efficiency. Ecodesign functions to balance those elements and to find smart and innovative solutions for such potentially contrary requirements.

Was this the best possible result –or in other words, was there no further room for improvement for these products? Possibly there is room for further improvement, but in light of the high complexity and additional marginal costs and efforts needed to go beyond 'factor 2' improvements and with the restrictions of the current project, not much better results could have been expected. It can be concluded that within the scope of most of the case projects – eco-redesign of an existing product - the results are satisfactory. Higher improvement factors will ask for a different set-up and scope of the projects, a different time-frame and a different network of participating companies and organisations. Some first efforts have been made to go beyond the single product level: one company, REA, has made a start with a higher-level system approach by detailing the redesigned product as a first element of a newly designed system of coffee production machinery. In two projects of the second phase, the scope was deliberately put on a service respectively production chain level. However, the reduction levels achieved are not (yet) higher than in the cases of individual products. This is also in line with the experiences in Europe, which show that the conceptually predicted higher reduction levels are not easy to obtain because of the higher complexity of the project and because of possible rebound effects.

How are the results in light of the company selection process? Due to the stepwise selection process of the companies – from preferred sectors to shortlisted companies to selected companies – only those companies were selected for the case study projects in which the chance for a successful project was high. Key selection criteria such as willingness, opportunities for improvement, an organized production process means that companies with a high risk of failure were excluded up front, and companies with a more pro-active attitude were selected. Still, the chance that a project is terminated because of organisational or management reasons always exists, and also the production of a successfully redesigned product at the end of the project is not guaranteed. The final results from the case study projects (9 products out of 14 on the market) therefore could be expected but still considered good in comparison with similar projects in Europe. Still, it is possible such a good score is reached when larger groups of companies would be targeted for this type of project, for instance in the framework of new industrial or environmental policy. There will be many more pro-active and innovative companies in the region, as can be seen from the participation in the regional award scheme. The type of companies selected show a good spread over the preferred sectors. With the results of these companies a large multiplier could be reached in those sectors. Some of the selected products are not produced by many companies (like the two coffee machinery products), but in those cases the improvement options implemented – such as material reduction and improvement of initial lifetime - have a much wider applicability and can be multiplied also in many other companies.

The second phase projects had scores on the product results level that are comparable to the first phase: The wider scope of these projects does not automatically lead to better results, as was argued already before. However, this wider scope does mean that other things are learned in the projects: solutions that go beyond the product level in the project at Aventuras and El Jobo, synergies between companies in the Guatemalan metal companies. Initiatives for which cooperation with other companies, outside the normal production chain and including competitors, are necessary. This is the case in the transport issue at Aventuras. Set-up of innovation-diffusion networks with several partner organisations will be needed for this.

It can be concluded that autonomous continuation with new ecodesign projects and integration of ecodesign at the strategic level of the company's management system is still relatively low. This can be explained by the once-off character of the demonstration projects and the intensive external facilitation. With external support gone and external stimuli missing, the chance that an autonomous development will take place is very small. Lack of current market demand for green products, absence of institutional and legislative frameworks leads to diminished attention of the companies after the initial project. This phenomenon can also be found in many European efforts in the field of cleaner production and ecodesign. Dieleman (1999) investigated the lack of continuation with cleaner production in the first Dutch case studies. Key aspects he found are lack of informal and formal organisation and management in the companies, lack of external incentives and a pollution control paradigm blocking further preventative approaches. A positive exception is found in packaging companies in Europe. Because of the strong incentive of regulatory pressure, ongoing improvement of packaging product is reported (Ten Klooster 2002). Which positive framework conditions and what societal set-up is needed to change this situation for ecodesign in Central America, will be dealt with in later parts of this chapter. Until now (status

2002), diffusion of the approach to other companies than the case study companies is also generally low, for the same reasons. However, one should take into account that ecodesign is still in an early stage in the region and that these developments take time. Follow-up ecodesign projects are started, and a number of other companies in the region perform ecodesign projects or related projects in the field of sustainability (as can be seen in the participation in the regional awards - Annex B ref. 33), although it is certainly not yet common practice.

Q3-Q4 - What are the company-internal and –external characteristics that influence the ecodesign adoption process?

Does this low uptake of ecodesign means the necessary internal and external stimuli are missing in the region? It can be concluded that the external drives that are usual key factors in Europe – legislative or regulatory pressure and demand from the market - are missing to a large extent, with the exception of companies that produce for export markets, and companies in the (eco)tourism sector, that do have those drives. Also pending legislation (mainly on waste water) in the coffee sector makes this an issue for the metal companies REA and Bendig. On the other hand internal drives and characteristics do exist: Cost reduction, image, positive attitude, and to a lesser extent, environmental benefit. On average, at least two of those factors were considered appropriate in each of the companies. This leads to the conclusion that the requirements for internal stimuli are generally met. (Expected) environmental benefit alone was never a determining factor, and was always found in combination with one of the other factors. It can be concluded that the key internal drives found here are similar to the ones found in European demo companies with the exception of the factor '(perceived) environmental benefit'. Probably the fact that this drive is found much more in Dutch companies is related to external stimuli such as strict environmental legislation that is in place in the Netherlands for many years. This has led to internalisation of environment as an important feature for the companies' production and products. When these external factors are missing, this connected internal drive is also not developed.From the internal positive characteristics, the managers or owners' positive attitude seems to be the most important one. This finding is strongly related to the fact, that the smaller companies in the region are family-owned and -managed companies. This family-ownership also made the decision lines short and fast, which contributed to the fast result in the case study projects. However, the same factor works against ecodesign once the initial interest of the manager was lost: in that case continuation of the activities is terminated just as fast as the first results were achieved.

Emerging patterns of influence of the research factors on adoption were found in the analysis. Companies that have more stimuli for ecodesign, take the decision to implement ecodesign and integrate it into their management system, mostly operational. A better ecodesign result in those companies is not so obvious, although the best products are from companies with several internal and external stimuli. However, the reverse is not true – companies with few stimuli do not score low on ecodesign improvement factor. With regard to innovation quality a pattern can be seen that interactive and communicative companies have a high adoption rate and good ecodesign results. No such link exists with participation in innovation-diffusion networks of the companies. Both groups of factors (stimuli and innovation quality) are connected among themselves as well.

We can now reflect on the first central research question of this study (as formulated in paragraph 2.3):

How successful is the *adoption* and implementation of ecodesign by companies in central America that participated in the project, and what are the key factors that influence this?

The overall conclusion is that the participating companies have adopted the ecodesign concept at least to the extent that they have successfully executed a first project, and that some of the companies got engaged in further activities as well. The projects are a success, 14 re-designed and environmentally improved products are developed, of which 9 were introduced to the market. Continuation with other ecodesign projects in the companies is relatively low. The key factors influencing the adoption are internal drives such as cost reduction, image and positive attitude. External drives have an influence mainly for exporting companies. Active information seeking behaviour of the company also has a positive relation with ecodesign adoption.

12.2 Conclusions on facilitation

Q5 – How was the provided ecodesign methodology handled in the companies?

The basis stepwise approach was followed by most of the companies, and it can be concluded that the overall scheme functioned well. The original UNEP manual (Brezet and van Hemel 1997) focuses on design and redesign, but not on benchmarking. The regional focus on redesign and benchmarking type of innovation was accommodated in the regional manual by adding a module on how to benchmark a product, and a good connection with the steps in the manual was given. With this adaptation, the main elements of the UNEP manual are applicable and seem to be 'scenario-free', so applicable both for benchmarking and for new (re)design approaches. The tools provided in the method were almost all new to the companies. It can be concluded that the central tools on environmental analysis (MET) and improvement strategies (LiDS) were used by most companies and were found feasible, although they were applied with the facilitators' support and detailed environmental information on the product was often not available. A combination with simplified checklist-type of tools is recommended for self-use in the companies. The key tool – the ecodesign improvement strategy or LiDS wheel – was applied successfully – but assistance to get used to the terminology and logic of the tool remains necessary. All companies defined at least two improvement strategies for the redesign of their products, most of them in the categories 'materials reduction', 'optimisation of initial lifetime' and 'efficient distribution'. Compared to European experiences, less attention is given to recyclability and material substitution – which apparently are topics in the next phase of ecodesign development and in Europe are closely connected to relevant policy developments on use of (toxic) materials and reuse and recycling.

The high level of facilitation by local and international experts and students, especially in the first phase of the project did have positive and negative effects. Of course this 'flying start' did produce quick results – most first phase companies produced a prototype within eight months from the start. Information and experiences became available quickly and could be applied in the design process. A flexible but structured approach was provided and followed. Most companies became motivated and were positive. On the other side, all this support made it perhaps too easy for the companies. Companies had to pay a moderate fee for the project, still substantial for a small family-owned company in the region. They also had to invest a lot of time in the project. Still, compared to commercial consultancy, the project was virtually for free, with external facilitators doing a large part of the work. The question is whether those same companies would have started, if this support would not have been available. This chicken-or-egg situation is found more often: do you start with demo projects to show something is locally possible, thus attracting more companies to adopt this strategy later, but with the risk that the approach does not spread because capacity is still lacking. Or do you build institutional and policy capacity first, then giving the companies the opportunity to start the new approach in conformity with normal market forces, but with the high risk that things become bureaucratic, move very slowly or never take off? From evolutionary reasoning, the egg has to come first. Similarly the position taken up front for this project is clear: Ecodesign had to show up before it could spread. That implies demo projects had to come first. The weak point of this approach was known as well and occurred again in the first phase – transfer of skills to the company is lower because of the high level of external help. Therefore, it can be concluded that making the transition towards local leadership and capacity as fast as possible in the projects' second phase is the optimal choice. Conclusions on this transition phase are given later in this section.

Q6 – What elements of the ecodesign approach can be optimized for use in Central America

As stated above in answer on research question 5, the main line of approach of the UNEP manual is applicable in the context of Central America. Within this framework, a number of adaptations had to be made to the approach to make it optimal for the regional context. These new or changed elements are:

- focus on internal drives because of the absence of external drives for ecodesign
- flexible structure of the approach, more emphasis on structured product development
- benchmarking focus instead of design-from-scratch
- redesign focus instead of new product design
- simplified tools
- use of regional examples

How did this work out in the second phase? The elements of the new regional manual were used in all projects, and the manual use was evaluated positive in all cases. As is probably the case in using manuals all over the world, the companies did not follow all steps in a linear way, but picked the parts that they think are most relevant in their situation. Although the intensity of the international facilitation and support was lower in the second phase, and more emphasis was laid in the local counterpart and the companies' own involvement, still the approach is based on external advice and support. It will be very difficult for small and medium sized companies to do this without external support. This process of 'unpackaging' the basic European methodology has started in the project and will continue. The local counterparts can introduce more local specifics and change the schemes and tools to fit their own needs. One example: CEGESTI is working on better integration of their innovation and ecodesign types of consultancy tools thereby changing the ecodesign approach once again. To be able to unpackage and adapt the ecodesign approach further, there is a need to further test the existing regional manual in more practical projects and improve it further on the basis of findings from those cases. For this, industrial design expertise from universities such as ITCR in Costa Rica and Landivar in Guatemala has to be used, and international cooperation with outstanding universities such as Delft UT, MIT and University of Tokyo (all involved in the advisory committee of this project) should be enhanced.

Q7 – How does the transition to local facilitation of ecodesign develop? Is it optimised?

The transition from external, international lead in the start of the project to local lead at the end of the project was developed in the two project phases. In the first phase it can be described as a transition from a 'Delft-dominated' facilitation towards a mixed leadership of Delft and CEGESTI. For the projects in Costa Rica, and the end of phase one, GECESTI was in charge of most activities and Delft University changed to an advisory role. Because the local counterparts in the other countries were not yet able to take the lead in their projects, CEGESTI was de facto taking the lead also there. Although CEGESTI works on the regional level in many projects, it was envisioned that local organisations in Guatemala and El Salvador should take over for their countries. Therefore, the second phase was aimed at doing exactly that: local organisations in charge of the projects. In addition to this, broadening of the group of people trained in ecodesign facilitation was foreseen, from only people of the direct counterparts to representatives from more organisations. It can be concluded that this second development phase was successful to a large extent. Landivar University took the lead in Guatemala, with support from CEGESTI. In El Salvador, AG Tech was handling the projects, but the role of CEGESTI had to remain more prominent there to ensure high quality of the activities. The second objective, broadening of the group of trained professionals was reached successfully, with over 40 people trained in the second phase. Parallel to these transitions, another one succeeded: a shift from high involvement of Dutch graduate students in the first phase, to mixed involvement of fewer Dutch students and more local students took place. Those local students are the professionals of the future, trained hands-on in ecodesign.

An innovative approach that also contributed to local leadership was the procedure to select the counterparts for the second phase of the project. In the first phase, the counterparts were selected first and then trained. In the second phase, a larger group of potential counterparts were trained, and had to come up with proposals and industry partners for the projects. The best proposals and partnerships were selected. This element of competition has certainly led to a selection of high quality counterparts. At the same time, the course participants that did not get a project almost all stayed involved in another way in the overall project.

On the issue of programming this type of project, the planning and design of the programmes and individual projects were reasonable to good. Most essential programme steps were used. However, a weak point remains the monitoring and evaluation steps by the counterpart organisation. Except for the contractual obligatory mid-term and end evaluations by the direct contract partners DUT and CEGESTI, only CEGESTI has performed an in-house standard evaluation on the project as part of their quality management system.

Emerging patterns of influence of the research factors on facilitation were found in the analysis. The influence of a well-designed methodology on the quality becomes clear, both for the original UNEP methodology as for the regional manual used in the second project phase. This regionalised approach has the advantage of being tailor-made, easier to apply for local facilitators and inspiring because of the local examples. The transition to local leadership was not without initial setbacks, but once good cooperation was established, it proved to be a key success factor for facilitation.

We can now reflect on the second central research question of this study (as formulated in paragraph 2.3):

Is *facilitation* of ecodesign – both in-company and facilitators' expertise building – successful and locally owned?

It can be concluded that the UNEP Ecodesign manual proved applicable for the first phase in-company facilitation. In the second phase, a regional adapted manual was introduced successfully. This manual can be further adapted in future. The high-intensity, externally supported facilitation led to good projects, with the risk of dependency of the companies on this support. Local involvement in this first phase was varying. In the second phase, local organisations took over the facilitation much more, and in Costa Rica and Guatemala facilitation became locally owned.

12.3 Conclusions on capacity building

Q8 – How does the process of capacity building and awareness raising on ecodesign develop in Central America

The strategy chosen with regard to capacity building was to first engage the direct counterparts in the project as much as possible. This was done by intensive training of staff of the counterparts, followed by involvement in the company projects and all other project activities. Awareness raising activities in the first phase were also executed through the direct counterparts. Reasoning behind this strategic choice was, that with the limited project budget, it was best to concentrate the efforts and try to reach synergy between training, project support and awareness activities. However, several of the trained people changed jobs. Also, the danger that the ecodesign concept becomes 'proprietary' to only a few consultancies in the region is strongly connected to this strategy, and therefore it should not be pursued too long. To make a comparison to the Dutch situation: The approach taken and methodology developed by the Innovation Centres (ICs) in the Dutch IC Ecodesign extension project around 1995-97, although funded with public money, remained proprietary to the ICs and was not published. Also no extensive (publicly available) analysis was made of the cases. This was certainly not the intention for our project in Central America, since we see the results and knowledge of development cooperation projects of this type as belonging in the public domain.

The transition moment towards a broader networking-type of capacity building came with the Regional Conference, end of 1999, and the simultaneous publication of the regional manual. First, the overall ecodesign approach was now publicly available to all interested parties at cost price. Second, the results of the case studies were disseminated, showing the feasibility of the approach. During the conference, a start was made with the networking approach by giving the second conference part the character of a working conference, involving many more organisations in active interaction.

During the second project phase, the focus of capacity building was shifted towards local ownership and local network development. The set-up of the project selection meant, that several new local counterparts were engaged compared to the first phase, thus enlarging the initial network. The activities in this second phase were more aimed at open networking, for instance by organizing three national workshops on ecodesign, related to the topic of the company projects. Local network building was also encouraged by the changing role of the initial project leader Delft University: From being in charge of all activities its role changed to that of advisor and supporting expert organisation. The role of CEGESTI remained prominent, also in the other countries. Overall, the process of local network building is a slow one, which is certainly not finalized with the completion of the project. Strong key organisations are placed well in the networks of Costa Rica and Guatemala, but more needs to be done in El Salvador. Networks in the other countries of the region are not yet in place. The continued organisation by CCAD of the Regional award scheme on environmental innovation, first edition 2002 (Annex B ref. 33), which includes an ecodesign category, is seen as a strong support for further capacity building.

Q9 – What are the key actors in this process and what is their role and involvement?

It is clear that the project counterparts were the key actors in the capacity building process. Overall, those are TUD and CEGESTI, Landivar University in Guatemala (and CIG in the first phase) and AG Tech and UDB in El Salvador. From the side of governmental organisations, CCAD can be mentioned as a key counterpart as well, in light of the award scheme and other support they have given to spread the concept of ecodesign.

The organisations mentioned above have the highest 'importance' score in the stakeholder analysis presented in Chapter 11. However, the configuration of clusters of actors is just as important for capacity building in the region as the individual organisation. For the introduction of ecodesign through the current project, it can be concluded that the basic configuration related to the entire project is that of an R&D Driven configuration, with strong elements of a sponsor-driven configuration.

In an R&D driven configuration, the main key actors are knowledge institutions. This includes most of the key actors, taking into account that also CEGESTI has a high expertise and much experience in research and innovative consultancy. In this line of thought, the roles of the other types of organisations become as follows: Industrial organisations are the gateway to industry, because they can inform their members on the concept of ecodesign and support them in starting ecodesign projects. Government can provide optimal preconditions for the further development of the concept – this is what CCAD is doing currently as the only governmental organisation actively involved. Advisors and consultants and organisations such as NCPCs are important for the actual facilitation capacity and development of further tools and experience. Financial organisations can provide the opportunities for industry to invest in this type of activities. In the traditional R&D configuration, the highest interest is innovation and research. That the emphasis in our project is also on dissemination of the concept and getting a multiplier effect is because of the sponsor-driven elements of the configuration: This focus is towards development cooperation and improving the quality of industry and the environment in the region.

Despite the fact that the overall configuration fits best to the R&D and sponsor-driven type, this does not mean that this has to be the case in each individual national network that is being developed in the second phase of the project. Leadership can be with other type of organisations, changing the type of configuration. However, the approach, experience and deliverables that are available, are probably most interesting for organisations that fit the overall existing profile. This will be further detailed below in the conclusions on local networks.

Universities played an important role during the project – ITCR in Costa Rica and University Don Bosco in El Salvador during the first phase, Landivar University in Guatemala, UCA and ITCA in El Salvador during the second phase. Not only did they participate in the case studies by student projects, also the topic of ecodesign has been introduced into several of the university curricula – the best examples being ITCR in Costa Rica and Landivar in Guatemala. Both universities are actively engaged in new ecodesign activities after the finalisation of our project. Since these two universities are the most important universities in the region for design engineering careers, it also means ecodesign will be part of the expertise of the new young professionals that will start working in industry over the next years.

Some key actor organisations were not involved as much they should have been. Despite several efforts, financial institutions such as investment banks were not heavily involved in the project. It can be concluded that the activities organised in the project were not clearly aimed at this target group, or at least should have been executed differently to be of special interest for them. However, it should be noted that in the same period as the project, the financial sector in the region was targeted by a regional project executed by INCAE/CLACDS on the relation of financial institutions and the environment. One of the results of these activities was an 'Eco-efficiency guide for the Latin American Financial Sector' (INCAE 2000) that was disseminated in the financial sector. The recommendations and approach of this guide supports inclusion of environmental criteria in decisions on loans and investments that would favour investments in activities such as ecodesign.

More successful was the involvement of international development cooperation organisations. in addition to the Dutch development cooperation, financing was also received from US Aid and US EPA, and information exchange took place with the German GTZ and the Norwegian project. As outlined before, the project set-up and results are in line with the interests of donor organisations.
Governmental organisations were informed many times on the developments in the project, representatives participated in the conference and the ecodesign award jury, and there was active involvement from CCAD in several of the project activities. However, strong involvement from for instance environmental or industry ministries or agencies did not occur.

Q10 – Is capacity building and awareness building on ecodesign successful/ Can/should it be optimised?

By looking at the project deliverables, a first conclusion must be that many capacity building and awareness raising activities have taken place. This means that from the target group, a large number of companies and professionals in all kinds of organisations have been reached. Some key figures are (Annex B, refs 21-23):

- Over 50 trained professionals in the region, including over 20 skilled ecodesign advisors.
- A regional conference with over 100 participants, three national workshops with over 40 participants each.
- Specialised workshops and local industry conferences targeting at least five hundred participants.
- Lectures at several universities targeting several hundreds of students, and inclusion of the topic of ecodesign in curricula.

- Publicity, scientific and popular articles, participation of 70 companies in the award contest.
- Dissemination of several hundred copies of the regional manual.

It can be concluded that the target group has been reached; the concept of ecodesign is placed in the minds of the people that need to know about it.

However, information does not automatically lead to capacity. For this, we have stated that learning in local networks is necessary. The results for capacity building in several of the individual key actors are already discussed above in the conclusions on Q9.
The local networks that are emerging from the second phase of the project are the nuclei for learning and acting on ecodesign. The quality of the networks is determining their functioning and their actual achievement on implementation of ecodesign. The networks are still in an early stage (status 2002) and almost all network quality factors should still improve over the years to come. It can be concluded that the current networks in Costa Rica and Guatemala are the most promising ones. In both networks a strong key actor is available to take the initiative. Expertise is available and is being shared between network members. In both networks some type of organisations are still missing which could have added value (institutional and financial organisations). Trust and power distribution between the network members is on a reasonable level; these characteristics will have to be further improved when larger projects are to be handled. Also communication, which is a key factor for this type of networks (van Woerkum 2003) needs to be improved. The network in El Salvador is in an earlier stage of development. If the same configuration as in the other networks is aspired, a strong knowledge institute is missing. The overall experience in the field of design engineering is missing. An alternative route would be to develop the consultancy/industry partnership further, since many of the contacts of AG Tech are in that direction.

With regard to the learning attitude in the networks, the conclusion is that as far as 'learning on all levels' (Röling and Jiggins 1998) is concerned, the Costa Rican and Guatemalan networks clearly have extensive learning on the connected levels of industry practice, knowledge development and facilitation by the advisors and researchers involved. Learning is much weaker on the institutional framework and policy development level. As can be expected; learning levels in the El Salvador network are generally lower, and mostly exist on the industrial practice and facilitation levels.

Emerging patterns of influence of the research factors on capacity development were found in the analysis. Quality of the local network is a determining factor for capacity building in a country – the better the network, the more capacity building activities took place. Influence of the overall ecodesign results can not yet be determined, probably due to the fact that the networks are just recently formed and are not yet influencing facilitation and adoption.

We can now reflect on the third and last central research question of this study (as formulated in paragraph 2.3):

Is there sustained *capacity* in Central America to continue and expand ecodesign activities?

The strategy chosen for capacity building in the first phase was to focus on capacity in the direct counterpart organisations. This was not completely successful because many of the trained persons ceased to be involved in ecodesign. In the second phase, a broader base of expertise was created and a start was made with local network building, which shows promising results. However, some important types of organisations (institutional and financial) are not yet involved and overall, the level of networking and follow-up activities is not yet high enough to ensure continued development of ecodesign. Therefore, recommendations for follow-up are made in the next section.

12.4 Recommendations for follow-up

As stated earlier, the total of follow-up activities as they are now started or planned, and the available capacity in the region is not large enough to ensure a continued development of ecodesign practice in industry of the region. The follow-up at university level seems to be the most promising, but this will be aimed mainly at curriculum development, which will take some time before reaching industry. Direct industry-related activities are follow-up activities in some of the case study companies and two ecodesign projects – in the food sector in Costa Rica and the 'Design without borders' project in Guatemala. More activities are needed in this field. Related training activities, now mostly confined to the regular training programmes of the NCPCs, can be enhanced in combination with industry projects. There is a need for the emerging local networks to take the lead in furthering ecodesign activities. Secondly, recommendations for future research projects are given. Lastly, possible synergy of ecodesign with related issues is described.

12.4.1 Local networks in action

To stimulate follow-up activities, there is a need for the local networks to come up with a plan for a strategic choice of future initiatives. As a first priority, the networks themselves have to be strengthened. Then, attention should be given to the kind of strategic developments desirable.

Network development

For emerging local networks for ecodesign, the need to strengthen network management has a high priority. In a European project on local networks for sustainable production (Cunningham et al. 2003) it was found that emerging networks need to set priority on strengthening their network quality, network management and network communication. Similar conclusions were reached in a research of European networks on sustainable tourism (Fadeeva and Halme 2001).

A number of activities are necessary for this, including

- Involving new relevant organisations in the network
- linking the ecodesign activities to the values and interests of important network stakeholders
- creating enabling conditions for learning on ecodesign
- develop mutual trust between the network actors, ensuring open communication
- keeping contact with other networks and external links
- organising a minimum required management structure for the network, including a contact point (at one of the participating organisations or separate) that can serve as 'front office' for the network
- creating a learning environment for the people and organisations participating.

Future initiatives

Parallel to network quality enhancement, the network needs to develop a strategic plan for the future in which the network determines the course of action on ecodesign. Some of the instruments that can be applied here are:

- scenario and strategy development schemes
- vision workshops
- connections and synergy with other initiatives (see below)

On the basis of such a strategic vision, an operational programme of activities can be developed using instruments such as:

- setting target group priorities
- SWOT analysis of demand and supply for ecodesign
- analysis of funding opportunities
- selection of most feasible activities
- action planning: who will do what and when
- basic operational management planning for the selected activities.

Although a local network has its own unique development, and functions in dynamic circumstances, the types of activities that were executed during the project are also a good base for a future action plan. These activities are:

- industry projects in ecodesign, preferable with a multiplier opportunity such as a sector approach
- research on further development of ecodesign into higher systems levels, such as service and product systems approaches, further development of tools and indicators
- training and curriculum development
- involvement of financial institutions, and development/adaptation of supportive financing and funding instruments
- policy study and development of stimulating and regulating instruments on different governmental levels
- participation in the regional ecodesign award scheme.

12.4.2 Follow-up research

A number of research opportunities arise from this study.

- Further research into *expansion and continuation of industry projects* on ecodesign is recommended. The issue of multiplication of the ecodesign – sector wise or in other ways - is of key importance here. Also, the issue of (the lack of) continuation with the approach is ill understood, and needs further clarification. Therefore, continued involvement of the case study companies in future activities and networking is suggested, to follow current initiatives and stimulate further continuation.

- As mentioned several times, the companies in this study were pre-selected. It would be of interest to do similar research also on a control group: companies that do not have the characteristics and positive attitude towards ecodesign, and investigate innovation adoption and opportunities for ecodesign implementation (e.g. enforced by regulation) in these companies. Experiences with for instance Dutch and European legislation on packaging show that such a regulation-driven development can lead to successful innovations by companies (Ten Klooster 2002). We have to admit that in the current situation in Central America, with a sponsor-driven configuration, it will be hard to get funding for this type of research, but it might be of interest for university research.

- Further research on the further development of the *methodology* is also of crucial importance. Currently (status 2003) a revision of the UNEP Ecodesign manual is ongoing, in which the findings of this study will be one of the inputs. There is a clear need to emphasize more the differences in approach between benchmarking and innovation types of product (re)design and next to this, additional methodological elements for service and product-system approaches need to be developed. Also, the element of continuation after the first pilot and integration into the management system of a company need to be addressed in more detail, and with more practical guidelines.

  With regard to the current regional Ecodesign Manual for Central America, further testing and evaluation in industry and continued unpackaging and adaptation (Djeflat 1988) of the methodology is recommended. Also, a detailed study into the methodology use in companies with regard to knowledge and skills acquisition and cultural aspects is necessary.

- The element of concurrent *market development* and product development is already stressed in the methodology, and connected internal and external research was an important feature of the in-company process. However, market development was still lagging behind product development in most companies. Research is recommended into the factors that cause this difference, and possibilities to improve concurrent development of market and product.

- As in Europe, the research focus on ecodesign should also be more on how companies can integrate the product approach into their *environmental management systems* (Rocha and Brezet 2001). Also, the integration of these approaches with international standards such as the ISO 14000 series is of great importance for the exporting companies in the region.

- *Product- service and product-systems* approaches are of course a very important topic to involve in future research. Developments in this direction have only just started, and it would be of great importance to get experience on these matters not only from industrialised countries, but also from industrialising regions such as Central America. It would also be of great interest to take the critical comments on these concepts into account, and focus more on elements such as institutional behaviour and user behaviour (Ehrenfeld and Brezet 2001). Also attention should be given to related and critical concepts such as postulated by McDonough and Braungart (1998). They challenge underlying concepts such as eco-efficiency and sustainability because these focus industry on 'doing less bad' in stead of 'doing good'. Therefore they advocate for concepts such as eco-effectiveness and sustaining systems.

- *Research on networking* should be performed to find out more about the possibilities for networking for ecodesign in Central America. In this study, we had the chance to look at the very start of local networks. The importance and central role of these types of networks in developing regional sustainability and competitiveness is stressed (Cunningham et al. 2002, Fadeeva and Halma 2001, INCAE 1999) but much more needs to be known about the mechanisms at work, and about optimal ways to further develop and support such networks.

- *Research on social learning and interactive approaches* (Röling 2002, King and Jiggings 2002) is a related field of interest for future projects. In this study, we only touched superficially on these topics, but they are at the heart of the complex and systemic change process towards a more sustainable future for the region.

- On the basis of the findings of this study and of projects on cleaner production in the region, there is a need for a concise *policy study* into the possibilities to develop an effective and supportive policy framework in the region for these types of sustainable approaches. Both regulatory and facilitating policy instruments are needed for this (Tukker et al 2000) and should be developed.

- In this project, active involvement of *financial institutions* was a missing link. Although at the same time this sector was target group for an 'Eco-efficiency guide' (INCAE 2000), we did not see enhanced involvement in or funding of industry projects on sustainability or eco-efficiency (status 2002). Further research into the factors that influence the involvement of these institutions therefore seems necessary.

12.4.3 Synergy between ecodesign and related issues

Possible ecodesign projects in industry depend on objectives of international sponsors and national and regional industry programmes. Although ecodesign can fit into several programme lines including sustainability, innovation and competitiveness, individual successes in getting projects funded will not lead to a coherent system of ecodesign initiatives. Also, finding funding for ecodesign has a better chance if it is done in combination and synergy with other aspects of sustainability.

One strong line of possible integration is with other *innovation* approaches. Ecodesign is considered in this study to be a special case of normal product innovation, and there is a close relation with innovation strategies of industrial companies. In introducing ecodesign, perhaps even more important than the potential environmental benefit is the fact that it connects directly to product innovation in general and therefore to the heart of competitiveness of the individual company and more in general of the society the company is embedded in. For companies in Central America that are exposed to the concept of ecodesign it often will be the first time they engage in systematic and conscious product innovation, going through the various phases that can improve their chances on the local, regional and global markets of today's world. Therefore a further integration with other company innovation strategies and approaches lies within reason. CEGESTI has vast experience in this field and can and will pursue further integration in the future. Landivar has the same potential. Also, the project proposal for Nicaragua, aimed at more general product innovation at SMEs, is an example of this type of integration.

A second line of integration, in the field of sustainability issues is further integration with *Cleaner Production* (CP) approaches. In theory, CP concepts do include all: management attitudes, shop floor operations, industrial processes, equipment and product design. In practice, most CP projects and approaches focus mainly on the environmental effects of the production processes of industrial companies. Analysis by UNIDO of the range of CP options implemented in six programmes in developing countries in '97-'98 show that less than 1 % of the options are product modifications. This is a logical primary orientation, given the fact that CP is trying to change the orientation of industry away from end-of-pipe and waste treatment towards more preventive approaches. However, the idea that product modifications are so rare because they are complex, has been proved wrong by the evidence in many projects including this one. Taking the 'product' part of the CP concept also into account can lead to reduction of the environmental effects of the product throughout its life cycle, from raw material production to ultimate disposal. The added value of ecodesign compared to standard CP approaches also lays in the use of other, product-oriented tools and procedures, and the explicit involvement of different people in the company (marketing and sales people, product developers, etc.) who are not commonly involved in process oriented CP projects. Also, many managerial and strategic issues are tackled in the projects, because of the focus on products and markets, being the heart of the companies' profitability. This integration topic has been discussed with the regional NCPCs many times during the project, and now is slowly taken up by them. This development should be further encouraged, and also extended to other organisations that are active in the field of CP. UNIDO could play a decisive role in this with regard to intake in NCPCs.

A third line of integration is connecting ecodesign activities to the Regional Competitiveness Agenda (INCAE 1999). This competitiveness agenda resulted from a decision by the presidents of Central America after signing the declaration on the Alliance for Sustainable Development in Central America (ALIDES) in august 1994. Essentially, the Agenda is a strategy proposing concrete steps to jump-start the economic progress of the region. The strategic programs formulated are aimed at supporting the Central American countries in their efforts to take advantage of their competitive strengths and to quickly achieve higher levels of competitive development. The approach is based on Porters' theory of national competitive advantage (Porter 1990). See Annex E for a detailed description of the Agenda. Studies on Central American economic activities that are most likely to profitably penetrate the international market led to the identification of the following high potential clusters:

- tourism
- textile industry
- high-value-added agribusiness and
- software and electronic components industry.

According to the Agenda, reorientation of the role of the environment in the region's competitive strategy will greatly enhance its competitive position for the future. Key sectors mentioned to obtain competitive success are the tourism sector and the agricultural sector. These are also two of the key sectors selected in the ecodesign project, so there is a close fit between the ecodesign project and the propositions in the Agenda. The focus on national networks also fits within the search for local competitive clusters of companies. Because of the high political status that the Agenda has, much support is given for execution of the programmes. Also, the approach connects well to the Global Value Chains approach supported by UNIDO, which could be an additional reason for stronger involvement of the NCPCs in this kind of activities.

12.5 Reflection on research model, theory and approach

Reflection on the research model applied

The research model that was applied in this study had to be quite broad. It includes a range of topics connected to the variables adoption of ecodesign as innovation process within a single company, facilitation approaches applied by intermediates and capacity building and networking activities of various organisations. This broad field of attention was considered to be necessary, because the introduction of ecodesign is a complex topic that does take place on those different levels at the same time. However, some restrictions were made to avoid that the research field would become unmanageably large. The focus was on introduction of ecodesign in industry, so not in universities or governmental organisations. Descriptions of change processes in that type of organisations were only taken into account as far as they were directly connected to facilitating industry or building capacity for industry. The macro-economic level of course influences the position and possibilities of companies to implement ecodesign. No empirical research was done in this direction during the project. Key elements were taken into account as contextual factors, such as the generic external drives for ecodesign, and the context of regional competitiveness related to industrial sectors, as outlined in other research work. The conclusion is that this limitation to the variables of ecodesign 'adoption-facilitation-capacity', all focused on implementation in industry, made the study manageable and more transparent in its set-up and analysis. Unavoidably, the conclusions drawn are also limited to this domain, and it is not possible on the sole basis of this study to draw conclusions in other domains, e.g. macroeconomics, national competitiveness or policy development. Also, the limitations also mean that it could not be the aim of this study to investigate the full complexity of innovation and networking on a systemic level. However, the results and analysis can have implications for these other domains, which can be taken into account in future activities.

Because of the broad set of topics and the multidisciplinary approach, this study had to stay away from very detailed analysis on a number of topics. It is not a study on technology. Technical innovations, as far as they occurred, are treated as results from the case studies without detailed technical information or analysis, since in our opinion this would not contribute to the level of understanding on ecodesign introduction in Central America. Also, it is not an environmental research study, in the sense that detailed analysis is made of the environmental improvements achieved with the redesigned products. Again, this would not add relevant information to answer the research question. It should be added that in the underlying research reports (Annex B, refs. 1-14) often detailed technical and environmental analysis is reported which is summarised in this study. Last, this is not a detailed sociological study into networking and networks. Networks were seen as instrumental in achieving capacity building for ecodesign, and the analysis was treated in conformity with this.

For each of the three connected variables adoption, facilitation and capacity, a set of influencing factors were described and depicted in the final research model in Chapter 6. Adoption success is depending on the adoption level of the company, which in turn is influenced by internal and external stimuli and characteristics. Another set of factors determining adoption are the quality and actual development of innovations in the company. Emerging from the adoption process are the ecodesign results, which can be measured on different aspects such as environmental improvement factor and level of continuation. Facilitation is determined by the quality and application of existing tools and the level of successful adaptation and addition of tools. Involvement of local actors that gradually take the lead in facilitation is another important aspect. Capacity is determined by the activities of the key stakeholders in a region, depending on aspects such as willingness and suitable configuration of involved parties. The overall quality of the local network of stakeholders further determines the facilitation result. Next tot these types of independent factors, the variables influence each other: facilitation outcomes depend on adoption and also on capacity, and thus can be seen as an independent factor in that sub-model. The research model is of course a simplification of the complexity in real life. The factors selected are themselves connected, and the model does not pretend to describe the complex interactions and influences taking place between all factors – in the current type of research, multiple case study research, it is designed as a type of 'blueprint' for the study, guiding the type of research questions to be asked and the direction of the case study analysis (Yin 1994).

Theory in his study therefore was used as a basis for the research questions to be asked, and for the definition of data collection. Next, the propositions coming from theory were used to define research factors to compare the empirical results of the case studies. A double selection process took place to finally come to the research factors: First, on the basis of the initial research model and the fields that were expected to be of interest, a survey of theory was made (Chapters 4 and 5). Then, a further selection of detailed theoretical propositions was made on the criterion that there must be a high contribution to insight, explanation and evaluation of the cases. Many PhD studies on environment and society seem to suffer from too much and too elaborate theoretical discourse, which is not connected to the research topic itself (Tellegen 2003). We hope to have avoided this trap by applying this two-step theory selection and connection process.

The operationalisation of the 30 research factors or detailed research questions was done in a semi-quantitative way, dividing the full scale of possible behaviour or action taken into four. In doing so, the borders of the scales are arbitrary to a certain extent, although in many of the cases they are quite factual and obvious. Two considerations should be mentioned here: First, whatever division is made in the scaling system, it is stated clearly and carried transparently throughout the analysis. The scores are not (and can not be) totalled or statistically edited in any way, which would obscure the individual values that lay behind. Second the scaling division is chosen in such a way, that some distinction in scoring between the cases could be expected, in the expectation that this would clarify the overall analysis. In general, it should be noted that the patterns found do certainly not represent one-on-one causal relationships. For this, the full complexity of the system is too large.

Reflection on some of the individual research factors

In retrospect the question is, did the research factors do what was expected? Did they clarify part of the total picture of ecodesign adoption, facilitation and capacity and was our understanding therefore improved? It can be concluded, that most of the 30 factors that were finally selected did contribute to a better insight and evaluation of the cases. Specific remarks on some of the factors that did not (completely) fulfil the expectations can be made.

In Chapter 4, critical remarks were already made on the usability of Rogers' much used *individual innovation adoption* model, most of which were countered for use in this study. It appears that in general, the adoption model was useful and gave insight into the adoption position of the individual firms. However, the 'individual-blame' shortcoming mentioned in Chapter 4 was not really overcome. It is unclear to what extent a low adoption level of an individual company has to do with system failure or complicating factors outside the company. The low adoption level of Mafam for instance should not discredit this company in its full innovation behaviour, since it is known to be innovative in its marketing, management and product assortment changes. However, the conclusion on its ecodesign adoption behaviour remains valid.

The factor on the *scope* of the project (from redesign to systems approach) is more dictated by the project set-up than the actual work done by the companies. Because most projects started with a redesign scope, it cannot be expected that many companies will change that into a higher-level scope. From the viewpoint of overall development of the project (from redesign to a broader scope in the second phase) this delivers quite obvious answers that do not shed much light on the product innovation behaviour of the companies.

The *internal and external stimuli* that were selected on the basis of findings in European studies are not always the same in our study as in these reference studies. The internal stimulus '(expected) environmental benefit' for instance did not nearly score as high. The absence of external stimuli such as legislation seems to be a major reason for this – when missing, internalisation does not take place and the related internal stimulus "expected environmental benefit" also does not exist. This would imply that these factors are much more dependent on each other than described in literature, and that this internal stimulus is much more an effect of the external drives than an independent factor inside the company.

Evolutionary and institutional theory led to the formulation of the factor that participating in an *innovation-diffusion network* was a key factor for innovation quality. The situation in the case study companies appeared to be different; only a few of the companies were involved in this type of networks, and there seems to be no relation with the innovation quality. For most companies the involvement in such networks seems to be of much lower priority then found in cases where innovation-type of product development is dominant.

Although the factors on *Learning* showed a large variation in scoring between the local networks, there was little discretion within the three factors for one network. The differences between the factors are clear, and the low variation probably has more to do with the fact that the networks are in a very early stage of development, and differences and details in learning achievements have not yet crystallised.

Research approach

The choice to perform this study as a multiple case study approach has proven to be the right one. Of course, this choice was partly dictated by the project set-up in the first place. But the type of analysis used in this approach – the 'replication logic' (Ying 1994) allowed for an in-depth and rich analysis of many phenomena that were encountered in the cases, without erroneously trying to prove incidence of certain findings, which is principally impossible on the basis of 14 companies. The use of pre-selected companies (so with a high chance of successful completion) because of the requirement of successful cases in the project set-up, of course influences the overall type of analysis possible. In case a more stratified selection would have been made, also including companies that were not eager to start with ecodesign, or where environmental improvement of the product was less probable, we expect that mainly *additional* results would have been reached, Most probably, a larger variety in environmental results, and more insight into the barriers and obstacles for ecodesign would be have been gained. It is not to be expected that on the research issues covered essentially *other* results would have been reached. For the more explorative analysis of capacity building this case study approach did also function, although more descriptive in nature and building up evidence on the way. The overall quality of the study, as it was assessed on the basis of both positivistic and constructivist evaluation criteria (Guba and Lincoln 1994) appeared to be good in all aspects evaluated. This evaluation also showed, that the double role of being both change agent in the project and researcher of the PhD study did not have a negative effect on study quality.

This study was also presented as action-integrated research: problem driven, focusing on the client organisation. The cycle of: project design – research – analysis – findings - leading into the next phase of project design was followed two times in this project. As explained in Chapter 3, everyday practice required short cycles of this kind on a daily or weekly basis, but the main cycles can be distinguished as the first (1998-1999) and second (2000-2002) project phase. Looking back on the transitions made from the first to the second cycle, the facilitation transition (from external facilitation to local leadership) and the capacity transition (from individual counterparts to local networking) both proved very valuable and successful. We can state that the fact that action integrated research of this kind made it possible to define these transitions on relatively short notice and enhanced the overall quality of the project itself. The transition on the industrial case studies (from product focus to chain/sector/service focus) proved partly successful. Positive outcome was that indeed new approaches were executed, and the sector approach proved to be a good mechanism for multiplication and cross-company synergy. On the other hand, the full spectrum of results of those second phase cases is very similar to the first phase cases. The opportunity we missed was to tackle the relatively low continuation and integration of ecodesign in those first case companies. Missing this seems unavoidable, since the time from the finalisation of the first phase companies to the start of the second phase was too short for this aspect to be taken into account for the transition – the first phase projects were barely finished and the first evaluations were only made in 2000. Still, in retrospect, and with similar experiences in Europe in mind, it would have been very important to continue working with the first-phase companies and learn more about the mechanisms to improve implementation and continuation of ecodesign and integration in the company's management. We probably were too eager ourselves to spread ecodesign to more companies on the short term, paying less attention on long term effects. So that's up to the next project on ecodesign in Central America.

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Summary: Ecodesign in Central America

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Introduction

This thesis describes and analyses the change process started by the project 'Ecodesign in Central America' that was performed between 1998 and 2002. The project started using the ecodesign concept and praxis developed in Europe, and showed successful uptake of this concept in nine participating companies and by the counterparts. With these experiences, the concept was translated and adapted into a regional approach for Central America. The focus in the next phase was on local leadership, network building and learning by professionals in industry and universities. The focus in industry shifted from single product to sector, chain and service approaches.

General levels of environmental performance in Central American industry are low. Concern and awareness in the region over this situation is growing, the need to integrate environment in business strategy is acknowledged more and more. Cleaner production activities have started since 1995; this ecodesign project was the first comprehensive project on products and the environment.

Ecodesign – the development of eco-efficient or more sustainable products – is common practice in many companies worldwide. Delft University of Technology was involved in many of these projects and started to support projects in industrialising regions. Together with CEGESTI (Costa Rica) the regional project 'Ecodiseño Centro-America' formulated and financed for the largest part by the Dutch Embassy in Costa Rica. The central purpose of the project was to improve the environmental aspects of products designed by local small and medium sized companies, thus practising and adapting the ecodesign concept in the region. Key objectives for the first two years of the project were execution of demonstration projects, regional capacity and awareness building. Given the opportunity of a two year extension, additional objectives were expansion from single products to chain, sector and services, and targeted awareness raising for each of the participating countries. Key methodological input for the first phase of the project was the UNEP Ecodesign manual, in which a systematic step-by-step approach for ecodesign project in industry is described. Among the various outputs of the project, some important ones are:

- a region-specific, Spanish manual on ecodesign
- 14 company ecodesign cases, reports and fact sheets
- a regional conference on ecodesign
- over 20 skilled ecodesign advisors, over 50 trained professionals
- a bi-annual regional ecodesign award scheme

Problem definition and focus

Through action-integrated case study research, using the Ecodesign project as empirical field research, this study tries to analyse and describe the process of introduction of ecodesign in companies in Central America. Some scientifically new elements can be expected in this research: The absence of external drives such as legislation means that company-internal factors will be much more important than in Europe. Ecodesign will be studied as a special case of product innovation, special because of the environmental focus. For many of the companies, it will be the first experience with a structured product development approach. In facilitating these projects, the current European-based methodology will have to be adapted to local circumstances – it is one of the first projects in which this methodology is tested and evaluated. For capacity building, this is the first project on ecodesign in an industrialising region where this topic is an explicit study target.
The three focal points of the study are adoption of ecodesign inside the case study companies, facilitation of the methodological approach and capacity building by involvement of key stakeholders in the region. The central research questions are:

1) How successful is the *adoption* and implementation of ecodesign by companies in Central America that participated in the project, and what are the key factors that influence this?

2) Is *facilitation* of ecodesign – both in-company support and facilitators' expertise building – successful and locally owned?

3) Is there sustained *capacity* in Central America to continue and expand ecodesign activities?

Initial research question are formulated on the basis of these central questions. These are further elaborated after literature survey (and will be presented somewhat further in this summary). An initial research model is developed in which adoption, facilitation and capacity building are the dependent variables (see figure S -1)

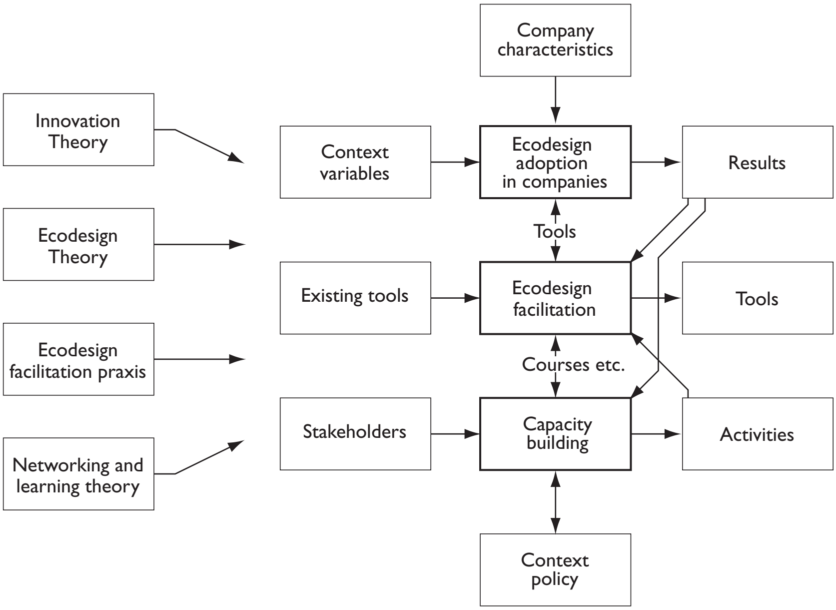

Figure S -1: Initial research model.

The theoretical fields that will be chosen for detailed analysis are presented to the left: Innovation theory, ecodesign theory and facilitation praxis and networking and learning theory. The company adoption process is influenced by several internal and external factors (independent variables) such as company internal characteristics and external drives and barriers, contextual variables such as the economic and policy framework. Facilitation is influenced by factors such as existing methodology, outcomes from the case studies and the existing and developing capacity in the region. Capacity building depends on the availability and willingness of stakeholders, the policy context and the overall input from ecodesign project results.

Research design

From the context of the study, a case study approach emerges, used to analyse the multiple industrial and societal cases and confront these with the theoretical framework, in combination with elements of action-research, used to design and analyse the interventions made during the project, and to recommend future intervention strategies. A multiple case study design is chosen with replication logic: that is, select and analyse a number of cases in such a way that it either predicts similar results or contrasting results but for predictable reasons. In total, 14 industrial case studies will be analysed for ecodesign adoption analysis. For facilitation and capacity building, the cases have been divided into two times three sets of national cases. For case study research, theory development up front is essential. This theory development serves as a blueprint for the study, and provides guidance in what research questions to state and what data to collect. For the topic of ecodesign introduction in Central America, a range of relevant theoretical fields can be found that all shed light on part of this complex topic. These fields are reviewed and a selection of the most illustrative theories is further developed in connection with each other and with the topic of Ecodesign. A number of factors for analysis are formulated and applied to the results of the adoption in industrial cases and to the results of facilitation and capacity building cases. Since in this study direct interventions are made in the cases, it also has elements of action research: problem driven, client oriented, questioning the status-quo and at the same time oriented towards empirical verifiable conclusions.

In a complex topic such as the introduction of ecodesign in a region, also the notion of soft systems thinking can be valuable as a 'mindset'. Soft systems methodology is defined as ' a methodology that aims to bring about improvement in areas of social concern by activating in the people involved in the situation a learning cycle which is ideally never ending' (Bulow 1989).

The quality of the research design is checked against a number of positivistic and constructivist quality checks:
- Construct validity: Are correct operational measures selected for the concepts being studied?
- Internal validity: Are the patterns of relationship we see and conclude in the analysis real and not the result of some other factor we did not consider?
- External validity: Establishing the domain to which this study's findings can be generalized.
- Reliability: Demonstrating that the operations of this study – such as the data collection procedure – can be repeated with the same results.
- Credibility: Can the realities of the stakeholders be matched to those attributed in this study to the stakeholders?
- Fairness: Are the constructions made in the study clarified to and honoured by the stakeholders?
- Authenticity: Are stakeholders empowered to act, and do they learn in the process?

Conclusion of this check is that the study has a high quality design.

Although in reality a number of iterative diverging and converging steps have taken place, for clarity the overall linear logic of a theory-based explanatory case study research is used: *Develop theory - conduct the case studies - analyse the cases – draw conclusions and feedback of the findings into theory and recommendations*. This leads to the four parts of the study: Part I Introduction – Part II Theory - Part III Case study findings and Part IV Analysis and conclusions.

Innovation and Ecodesign theory

Innovation, "the process of bringing a new, problem solving idea into use" is a broad concept used in a variety of circumstances. The body of theory is vast and ranges from economic theory, adoption and diffusion theory to management and marketing theory. We focus on theories from two paradigms: technological and market-oriented.

What theoretical insights from innovation theory can contribute to better understanding of the research questions in this study? Innovation theory as presented in this chapter is mainly connected to the research variable of *adoption of ecodesign* in the case study companies. The application of the model for product innovation from Roozenburg and Eekels (1995) will be central in the cases, since it is already at the center of the approach detailed in the ecodesign manual. Analysis of the use of this approach will shed light on the level of systematic product development possible, and on the level of concurrent product and market development that is important for the life-cycle concept of ecodesign. The chain-linked model for innovation (Kline and Rosenberg 1986) will allows us to analyse the use of the different levels of information and knowledge that are used – or not used – by the companies. This is closely connected to the notion that benchmarking is a dominant type of product development, for which existing information and knowledge of competitors and companies outside the region is essential. The influence of intermediates and other actor groups on the innovation process is stressed by several authors (Buys 1987, van Hemel 1998). Active information seeking outside the direct surroundings of the company is therefore an important factor for innovation. The type of innovations as described by Miller and Morris (1999) that we can expect in our cases will be mostly of a continuous nature. The companies will start with ecodesign cautiously, most of them starting with redesign of existing products, staying within the boundaries of existing systems.

Rogers' model for the adoption of innovations in an individual company (Rogers 1995) is expected to be valid also in our case study companies. The level of adoption reached will indicate the acceptance of the ecodesign concept, and the possibilities for successful results of the ecodesign project. The diffusion model from Rogers is expected to be less applicable, because this depends on a variety of other factors then the sum of the individual adoption processes. For this, we have explored evolutionary innovation models, showing the importance of innovation-diffusion networks (Nelson and Winter 1982, Mulder 1992, Silvester 1996). Connected to this is the notion that the institutional surroundings of a company influence its behaviour on change and innovation (Powell and Dimaggio 1991). Analysis of the networking behaviour of the company therefore is expected to be relevant. Benchmarking as the dominant product development approach can be found in most of the cases in less industrialised countries (Romijn 1996) – so this can also be expected in our case studies. The key strategies that can be observed will be on price competition and on product improvements.

Ecodesign is defined in this study as the "design of products, processes or systems with the entire life-cycle (of the product) in mind, aiming at minimisation of the environmental impact". Eco(re)design of products can be seen as the lower and intermediate part of the spectrum of environmental improvement stages for product-service systems. Typically, environmental impact reduction factor 2 is the maximum to be reached in this type of projects. Higher factors are expected to be reached with product-service and systems approaches, but empirical data available until now show that this is a complex undertaking. In the case studies, we will mainly encounter eco(re)design cases. A start is made in Europe with integration of product aspects in environmental management systems, which ensures the continued attention and efforts in this direction.

For our case studies, the most important stimuli and characteristics (internal and external for a company) found for ecodesign by Van Hemel (1998) seems to be the most relevant to use in the analysis. Several of these factors, such as environmental benefit/improvement, market/customer demand, regulatory pressure and economical factors, are also cited in other studies. Also, the generic characteristics of company leaders are of great influence to the success rate, and can be of interest for the further analysis of the cases. This factor is also encountered in empirical studies on non-environment related innovation.

Facilitation and learning theory

In the practice of the first part of the Central American project, the approach of the UNEP manual "Ecodesign, a promising approach" (Brezet and van Hemel 1997) was used. Baumann et al. (2001) nominate the UNEP manual to be the reference material on ecodesign. In their typology, the UNEP manual is a framework tool, and includes an organising tool, checklists and guidelines tools and analytical tools. Diehl and Brezet (2003) take the UNEP manual as point of departure, since their paper is focused on possible recommendations for an update of this manual. They list 10 manuals that are directly derived from the UNEP manual, and 8 other manuals. Key tools of the UNEP manual are found widespread in other manuals as well.

The manual is designed to stay close to a number of key standard approaches: it follows the common steps of the product development approach: target & strategy development – idea generation – detailed design – realisation. Also, an effort is made to make it as much as possible compatible to many Cleaner Production assessment approaches, to facilitate integration of both process and product oriented environmental approaches. Next to the step-by-step approach, a number of tools are integrated in the manual. Key tools are the Eco-portfolio matrix - a strategic tool for selection of the right product to start the project with, the MET matrix - a simplified analytical tool, the Ecodesign Strategy Wheel - an improvement tool that is used on various levels. Prioritisation tools such as the eco-indicator are included in the additional modules of the manual.

From theory in Capacity Development in Environment and Technology Transfer projects, it becomes clear that the facilitation should be adapted to the local circumstances, and that local actors should gradually take the lead in the execution of projects and implementation of ecodesign in industry. To be able to do so, the technology – in our case methodology – introduced should be as much as possible in an unpackaged form, as to stimulate local partners to use those parts that are most feasible under the local circumstances, and to add local knowledge and approaches. To successfully facilitate ecodesign in industry, there is a need to construct a dedicated configuration for ecodesign on the regional and local level, which can be seen as socially constructed by a set of key actors. Because of the original design of the project, it can be expected that initially this will be a sponsor and research driven configuration.

Learning is defined as the process of acquiring implicit (tacit) or explicit (codified) knowledge. The knowledge can be acquired in manifold ways, such as study, instruction, practice or experience. It includes operational (know-how) and conceptual (know-why) learning, or looking from another angle, single loop, double loop and deutero learning. All different forms of learning take place in the process of introducing ecodesign. The 'manual' knowledge can be seen as explicit, it adds up with the tacit knowledge inside the company or network. Ecodesign clearly involves both operational learning and conceptual learning, for different parts of an organisation in different combinations. Learning processes we can discern include socialisation, externalisation, internalisation and combination, which can be done both individual and in teams or groups. Also, the enabling factors such as resources, opportunities and culture to enable for organisational learning possibilities are to be considered.

A number of central quality elements for local networks are defined, including goals, core actors, power, trust and communication, which can be used as checkpoints for the quality of the emerging local networks for ecodesign in this study. An overall model connecting learning to network elements is developed (see figure S -2), which is action-oriented and can be used to analyse the interconnected levels of a network where learning should take place.

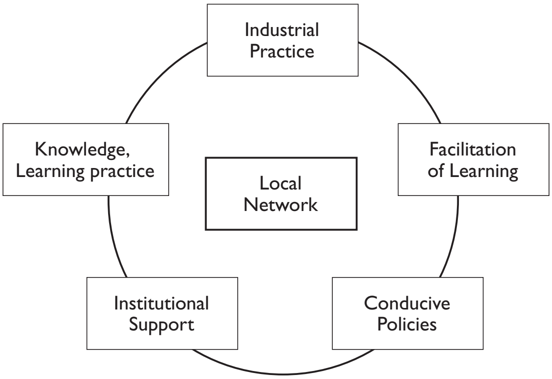

Figure S -2: Model for learning in local networks (after Röling and Jiggins 1998)

Research methodology

The three variables, *adoption, facilitation* and *capacity* are influenced and formed by a large number of other factors. Key propositions from relevant theories and practice were selected and formulated in 30 research factors. To be able to analyse the data of the case studies, the factors are operationalised in a semi-quantitative way. A detailed research question is formulated for each factor – see table 1. Next, for each of the factors a four-scale scoring system was determined. The scaling was designed per factor to be *distinctive*, meaning it is designed in such a way that it is expected there will be differences in scoring of the factor between the different case studies. The factors and

their operationalisation are grouped per dependent variable, so *adoption, facilitation* and *capacity* and are connected to the research questions Q1 – Q10 (table S -1).

Table S -1: Research questions (Qs) and connected detailed research questions from research factors (Fs)

ADOPTION:
Q1) How does the adoption of ecodesign – seen as a product innovation process – take place in participating companies in Central America?
F1. How well did the company use the different levels of knowledge necessary for product innovation? F2. Did the company include both the technical and the market development in the project? F3. Was the company actively searching information from its surroundings? F4. What is the phase of adoption of ecodesign in the company? F5. Is the company part of an active innovation-diffusion network? F6. Did the company use benchmarking/copy strategies to enter the market?
Q2) Are the ecodesign projects in the companies successful, is the approach continued and does the approach diffuse to other companies?
F7. What improvement factor has been reached by the company? F8. What scope did the company take into account in the ecodesign project? F9. Did the company integrate the ecodesign concept into their management system? F10. Did the company continue/expand with ecodesign projects?
Q3) What are the key company-internal factors that influence (positively or negatively) this adoption of ecodesign?
F11. Does the company have the following 4 internal characteristics: cost reduction, image, env. benefit, positive attitude?
Q4) What are the key contextual variables (stimuli and barriers) that influence the ecodesign adoption?
F12. Is the company stimulated externally by these stimuli: regulations, demand market, demand to supplier?
FACILITATION:
Q5) How was the initially provided ecodesign methodology handled?
F13. Did the company use / accept the structured process (complete or in simplified form) for an ecodesign project? F14. Did the company apply the environmental tools MET, LiDS and did they get the environmental information for that? F15. Did the company find and include solutions on the various design strategies for the environment (8 LiDS options)?
Q6) What elements of the ecodesign approach can be optimised for use in Central America?
F16. Did the company supplemented their own tools/additions to the methodology supplied?
Q7) How does the transition to local facilitation of ecodesign develop? Is it optimised?
F17. Was the programme performed in a co-operative way, local actors progressively taking the lead in the company projects? F18. Were the programme steps 'design, initiation, implementation, monitoring, evaluation used?
CAPACITY:
Q8) How did the process of capacity building and awareness raising on ecodesign develop in Central America?
Q9) Who are the key actors in this process and what is their role and involvement?
Q10) Is building capacity and awareness on ecodesign successful? Can/should it be optimised?
F19. Is there a joint perception of the goals. Are the goals accepted by all partners? F20. Are all relevant actors involved in the network? F21. Is there a visible additive gain for all actors involved? F22. Is a joint learning process between actors going on, or at least possible? F23. Is power distributed fairly between the actors? F24. Is there basic trust and interdependence between the actors? F25. Do both strong and weak ties exist in the network? F26. Is there an adequate communication pattern in the network? F27. Is there conformity between the configuration and the goals/activities of the network? F28. Is double loop learning taking place in the organisations of the network? F29. Is organisational learning taking place in the network organisations? F30. Is learning taking place through all levels of the system?

The initial research model can be refined on the basis of the selection of the key independent variables or factors, and the interrelation between those factors. The refinement of the research model is done for each dependent variable, so for adoption, facilitation and capacity. Because of the complex interrelations between the various factors and variables, the initial linear depiction of the model is changed into a depiction of a series of partial, concentric circles surrounding the dependent variable. This does more right to the complexity of the system, and the fact that several of the factors are grouped or have strong interrelations and act their influence on the dependent variables on different levels. These models are of a qualitative and descriptive nature, and should be seen as an aid for the further structuring of the analysis. The refined research model can be found in figure 6-4 in Chapter 6.

Data collection in this study is done in a structured way, using a data collection protocol. The types of sources used in this study include documentation of different types: minutes, reports and administrative documents, archival records, interviews, direct observations, participant observation and the physical products.

The mode of analysis that is followed in this study is one of 'pattern-matching' (Yin 1994). Within the explanatory part of the study, so mainly within the company case study analysis, the empirically based findings or patterns are confronted with the expected ones that are derived from theory and praxis. The level of adoption and the influence on that by the factors can then be cross-analysed through all case studies. 'Explanation-building' is used in capacity building cases: on the basis of findings in the case study, explanations that reflect some significant theoretical proposition are given on certain phenomena that occur in the case study, trying to find relations between them. In addition, qualitative and narrative analysis of additional data and insights emerging from the cases is performed as well.

Ecodesign adoption case study findings

On the basis of sets of criteria, relevant sectors and suitable individual companies were selected in three countries of the region, Costa Rica, Guatemala and El Salvador. nine projects were executed in the first phase (1998-1999). For the second phase of the project (2000-2002), the project team decided to put more emphasis on the functional and system level and on product chain approaches in the new company case studies. These levels are expected to enlarge the possibilities for environmental improvement and economical feasibility of improvement projects. Five projects were selected, a tourism company providing rafting tours (service approach) in Costa Rica, three metal companies (sector approach) in Guatemala and a Hacienda (milk and cream production – chain approach) in El Salvador. Emphasis on tourism and agro-food is in line with the strategies laid down in the Regional Agenda for Competitiveness (INCAE 1999). The companies that have participated and the products selected are listed in Table S-2.

The ecodesign cases proved to be successful. In most companies, new or redesigned products were the result. In all those cases some level of environmental improvement was reached. Most products scored an environmental impact reduction percentage between 10 and 20 %, usually on materials reduction; two products had a reduction of 50%, which can be considered a very good result. Product quality also was improved in most cases. Individual product results can be found in Chapter 7 and Annex A (in Spanish) of this thesis.

In 2001, contact with the first 9 demo companies was renewed to find out what has happened after the demo project. To follow the actual implementation and continuation of ecodesign activities, a number of topics were defined:

- Was the eco(re)designed product actually introduced at the market (all 14 companies)?
- Is the redesigned product (or an improved successor) still on the market?
- Did the company implement organisational capacity for ecodesign?

For the second phase companies, which had finalised the projects just recently, only the question related to market introduction and capacity can be answered. The results are summarised in table S-2.

Table S-2 Companies, products, and market introduction of the products.

Company	Country	Product	Result	Capacity ecodesign
Waiman	Costa Rica	Refrigerator	On market	No
Heliconia	Costa Rica	Export packaging flowers	On market	Yes
Panel-ex	Costa Rica	Office furniture	Prototype only	No
Mafam	Costa Rica	Packaging and distr. cookies	Prototype only	No
Venus	Guatemala	Packaging and distr. candies	On market	Yes
REA	Guatemala	Coffee processing equipment	On market	Yes
Mobelart	El Salvador	Kitchen furniture	On market	Yes
Kontein	El Salvador	Plastic bottles	Prototype only	Yes
Bendig	Costa Rica	Coffee processing equipment	On market	Yes
Av. Naturalis	Costa Rica	Rafting tour	On market	Yes
Turbomac	Guatemala	Household stove	On Market	No
Inmepro	Guatemala	Industrial stove	Planned	Yes
Executiv	Guatemala	Office desk	Design only	No
El Jobo	El Salvador	Cream	On market	No

Facilitation and capacity building case study findings

The ecodesign process in the first phase companies was facilitated intensively, activities including

- Start-up workshop with managers of several companies.
- 1 or 2 day workshop at the company with project team and all involved personnel
- Regular meetings with the project team from CEGESTI, TU Delft and local counterpart

- Project of graduation student (design engineering) from TU Delft – 6 months involvement, of which two months preparation in The Netherlands
- 1 day final workshop
- delivering of final report by the student, 2 months after project involvement.

The key methodological approach, the UNEP manual, was used in the cases. All companies applied a benchmarking/copying product development strategy. For all companies, it was the first time they did take environment into account in the process. The general strategic tools of the manual were applied without problems. The key ecodesign tools, MET matrix and ecodesign strategy wheel were also applied successfully, but getting the detailed information necessary was difficult. Simplified tools were developed and applied based on checklists, rules-of-thumb and questionnaires.

For the second phase facilitation, a transition towards local leadership and continuous learning approaches was made. On the basis of the findings of the first phase, a regional Ecodesign manual was developed based on the UNEP manual, with adaptations for the local situation. In the first phase only a limited number of professionals in the counterpart organisations were trained and the external level of facilitation was still high. In the second phase 38 young professionals were trained, and a selection of potential counterparts was made from this group. They could submit proposals for potential company projects. On the basis of this competition, the second phase projects were selected in combination with the local facilitator group that would perform them. Also a shift from Dutch to local students involved in the projects took place.

Key capacity building activities in the first phase were aimed at the participating counterpart organisations. A central activity in this was a two-week train-the-trainer course in Delft. To start the formation of a wider network in the region, contacts were established with over 20 organisations in the region that could play an important role in the dissemination of ecodesign in the region. As an important event for capacity building, on 28th and 29th of October 1999, a regional conference on ecodesign was organised in San Jose, Costa Rica (CEGESTI 1999). It can be seen as the presentation of the results of the first two project years for all involved parties and interested persons, as well as the start of the discussion and formulation of future plans and activities in the field of Ecodesign. Over 100 participants attended the conference.

In the second project phase, capacity was oriented on building local networks in the three countries involved. The competitive involvement of counterparts described above was one element of this. Another important development was the active engagement of universities in the networks, both in practical involvement or via student projects as in curriculum building. Connected to this approach was the organisation of three National workshops on ecodesign, one in each of the countries. A number of connected supportive activities were organised: a survey into the use of regional co-indicators for ecodesign; the organisation of a regional ecodesign award scheme for industry, later combined with a similar initiative from CCAD; development of a regional ecodesign webpage and electronic communication means.

Several follow-up initiatives and projects related to this project arose already at the end of the research period (status 2002) including ecodesign projects in the food sector (Costa Rica), the project 'Design without Borders' (With Norwegian support) in Guatemala and courses and training at NCPCs.

Analysis and conclusions on ecodesign adoption

The findings of ecodesign adoption in the companies are analysed by means of the research model and by further qualitative analysis of the case study material. This analysis is performed in the following steps. First, all case studies are analysed on an individual basis according to the set of factors that are applicable to them (formulated in questions F1 – F12). Next, the cases studies of the first and second phase of the project are analysed as a group, taking into account both the research factors and other, qualitative data. Because after the first project phase, changes in the set-up of the projects have been made, integrating learning experiences of the first phase, differences between phase 1 and 2 are analysed. The scores of the individual companies can be found in Table 9-2 in Chapter 9.

Some generic findings can be described on all cases.

From an environmental point of view, the redesigned products typically use fewer materials, are (therefore) cheaper to produce, and in some cases easier/more efficient to produce. Also, some products have lower impact during use, and in two cases better distribution systems are implemented. The environmental benefits can be estimated as being between 10 and 50 % environmental impact reduction compared to the reference product on specific impact level. These impact reduction rates achieved in the products of the demonstration companies are comparable to the achievements with the first eco-redesigned products in The Netherlands (PROMISE project, performed in 1990-1991, te Riele and Zweers 1994).

The products in the Central American products were eco-redesigned in a relatively short period of time. Most of the prototypes were produced four to five months after the start of the project. Most Dutch projects took over a year. Reasons for this could be the relatively larger possibilities to improve the products, the more informal and directive management (The director/owner decides), and also the strict timeframe for the students to work on the projects, which forced several companies to finish the prototype or else quickly loose momentum.

Looking at the type of innovations accomplished, most of the changed products can be categorised as redesigns of existing products, with relative small changes compared to the reference product. One product however, the coffee depulper of REA, is a completely new product compared to its predecessor. Also the desk of Panel-ex and the bottle of Kontein can be considered to be prototypes of new products. Systems approaches can be found at Aventuras and El Jobo, and also the depulper of REA could be the first part of a new system for coffee production.

On the basis of the analysis, the following conclusions can be drawn, in answer to the research question Q1-4.

Q1 – How does the ecodesign process –seen as a product innovation process – develop in the demonstration companies in Central America?

The ecodesign process in most of the companies can primarily be seen as a benchmarking or copying type of innovation process. In most cases the redesigns of the existing product, the improvement directions taken from examples of competitors or comparable products from Europe or the United States. The knowledge use in the companies is focused on the information necessary for the 'horizontal' product development process in the company itself, with additional information from competitors' products. With regard to integral joint development of product and market (Roozenburg and Eekels 1995) it can be concluded that a sequential development (technical development first) is the common approach in the companies. In the typology of Rogers' innovation and diffusion model (Rogers 1995), it can be concluded that all companies came to the phase of knowledge about ecodesign and persuasion to at least try this type of innovative approach. Nine companies took the actual decision to put a product on the market. The decision to go ahead with other products or other related activities was taken by six companies. Involvement in innovation-diffusion networks, seen as an imperative for European innovative companies, can not be found in most case study companies. Apparently, the information needed for the benchmarking type of product development is much more clear and available in existing knowledge of competing products.

Q2 – Are the ecodesign projects in the companies successful, is the approach continued and do other companies continue with ecodesign?

From a demonstration point of view, the projects are a success. Nine projects, resulting in nine examples of ecoredesign, were available for dissemination within two years. Five more examples available after two more years - this is a good and similar result in comparison to other ecodesign projects (te Riele and Zweers 1994, Brezet and van Hemel 1997, van Hemel 1998, Gertsakis et al. 1997).

From an environmental point of view the projects performed good as well, most products scored an environmental impact reduction percentage between 10 and 20 %, usually on materials reduction, two products had a reduction of 50%. The second phase projects showed results comparable to the projects of the first phase: The wider scope of these projects does not automatically lead to better results.

Autonomous continuation with new ecodesign projects and integration of ecodesign at the strategic level of the company's management system is still relatively low. This can be explained by the once-off character of the demonstration projects and the intensive external facilitation. With external support gone and external stimuli missing, the chance that an autonomous development will take place is very small.

Q3-Q4 - What are the company-internal and –external characteristics that influence the ecodesign adoption process?

It can be concluded that the external drives that are usual key factors in Europe – legislative or regulatory pressure and demand from the market - are missing to a large extent. On the other hand internal drives and characteristics do exist: cost reduction, image, positive attitude, and to a lesser extent, environmental benefit. This means the requirement for internal stimuli are generally met. (Expected) environmental benefit alone was never a determining factor, and was always found in combination with one of the other factors.

Analysis and conclusions on ecodesign facilitation

The findings on ecodesign facilitation are analysed by means of the research model and by further qualitative analysis of the (company and country) case studies. Similar to the adoption analysis, first the case studies are analysed on an individual basis according to the research factors applicable (F13 - F18). The scores can be found in table 10-2 in Chapter 10.

Q5 – How was the provided ecodesign methodology handled in the companies ?

The regional focus on redesign and benchmarking type of innovation was accommodated in the newly developed regional manual by adding a module on how to benchmark a product, and a good connection with the steps in the manual was given. With this adaptation, the main elements of the UNEP manual are applicable and seem to be 'scenario-free', so applicable both for benchmarking and for new (re)design approaches.

The tools provided in the method were almost all new to the companies. The key tool – the ecodesign improvement strategy or LiDS wheel – was applied successfully – but assistance to get used to the terminology and logic of the tool remains necessary. All companies defined at least two improvement strategies for the redesign of their products, most of them in the categories 'materials reduction', 'optimisation of initial lifetime' and 'efficient distribution'.

Q6 – What elements of the ecodesign approach can be optimized for use in Central America?

A number of adaptations had to be made to the UNEP ecodesign approach to make it optimal for the regional context. These new or changed elements can be summarized as follows:

- focus on internal drives
- more emphasis on structured product development
- benchmarking focus
- redesign focus

- simplified tools
- use of regional examples

The process of further 'unpackaging' the basic European methodology has thus started in the project and probably will continue. The local counterparts can introduce more local specifics and change the schemes and tools to fit their own needs.

Q7 – How does the transition to local facilitation of ecodesign develops? Is it optimised?

The transition from external, international lead in the start of the project to local lead at the end of the project was developed in the two project phases. In the first phase a transition from a 'Delft-dominated' facilitation towards a mixed leadership of Delft and CEGESTI took place. Therefore, the second phase was aimed at letting local organisations get in charge of the projects. In addition to this the group of people trained in ecodesign facilitation was broadened. It can be concluded that this second development phase was successful to a large extent. Landivar University took the lead in Guatemala, with support from CEGESTI. In El Salvador, AG Tech was handling the projects, but there the role of CEGESTI remained more prominent.

The planning and design of facilitation in the programmes and individual projects were reasonable to good. Most essential programme steps were used. However, a weak point remains the monitoring and evaluation steps by the counterpart organisations.

Analysis and conclusions on capacity building.

Q8 – How does the process of capacity building and awareness raising on ecodesign develop in Central America?

The analysis of capacity building was of a more descriptive and explorative nature. A stakeholder analysis was performed in the first project phase to prepare the best configurations for the second phase. Five key clusters were discerned that each have their functional relation with industrial companies, and can be addressed on their specific function:

- Advisors/consultancies: facilitation, technical. management advice, project deployment
- Research organisations: facilitation, innovation research projects, information support
- Industry organisations: capacity, project deployment, information support
- Governmental organisations: regulation, supportive measures capacity.
- Financial organisations: financing, supportive project deployment.

Although all five clusters were engaged in different actions, government and financial institutions in general were not strongly involved.

The transition moment towards a broader networking-type of capacity building came with the Regional Conference, end of 1999, and the simultaneous publication of the regional manual. During the second project phase, the focus of capacity building was shifted towards local ownership and local network development. Several new local counterparts were engaged compared to the first phase, thus enlarging the initial network. Overall, the process of local network building is a slow one, which is certainly not finalized with the completion of the project.

Q9 – What are the key actors in this process and what is their role and involvement?

It is clear that the project counterparts were the key actors in the capacity building process. Overall, those are TUD and CEGESTI, Landivar University in Guatemala (and CIG in the first phase) and AG Tech and UDB in El Salvador. From the side of governmental organisations, CCAD can be mentioned as a key counterpart as well, in light of the award scheme and other support they have given to spread the concept of ecodesign. On the basis of this, it can be concluded that the basic configuration related to the entire project is that of an R&D driven configuration, with strong elements of a sponsor-driven configuration. Universities played an important role during the project – ITCR in Costa Rica and University Don Bosco in El Salvador during the first phase, Landivar University in Guatemala, UCA and ITCA in El Salvador during the second phase.

Some key actor organisations were not involved as much they should have been. Despite several efforts, financial institutions such as investment banks were not heavily involved in the project. More successful was the involvement of international development cooperation organisations. In addition to the Dutch development cooperation, financing for the ecodesign award scheme was also received from US Aid and US EPA, and information exchange took place with the German GTZ and the Norwegian project 'Design Without Borders' in Guatemala.

Q10 – Is capacity building and awareness building on ecodesign successful/ Can/should it be optimised?

A first conclusion must be that many capacity building and awareness raising activities have taken place. This means that from the target group, a large number of companies and professionals in all kinds of organisations have been reached. Some key figures are (Annex B, refs 21-23):

- Over 50 trained professions in the region, including over 20 skilled ecodesign advisors.
- A regional conference with over 100 participants, three national workshops with over 40 participants each.
- Specialised workshops and local industry conferences targeting at least five hundred participants.
- Lectures at several universities targeting several hundreds of students, and inclusion of the topic of ecodesign in curricula.
- Publicity, scientific and popular articles, participation of 70 companies in the award contest.
- Dissemination of several hundred copies of the regional manual.

It can be concluded that the target group has been reached; the concept of ecodesign is placed in the minds of the people that need to know about it. However, information does not automatically lead to capacity. For this, we have stated that learning in local networks is necessary. The results for capacity built-up in several of the individual key actors are already discussed above in the conclusions on Q9.
The Local networks that are emerging from the second phase of the project are the nuclei for learning and acting on ecodesign. The quality of the networks is determining their functioning and their actual achievement on implementation of ecodesign. The scores of the networks on factors F 19 – 26 can be found in Table 11-8 in Chapter 11. The networks are still in an early stage (status 2002) and almost all network quality factors should still improve over the years to come. Networking in Costa Rica and Guatemala is the most advanced. Networking in El Salvador is in an earlier stage of development. If the same configuration as in the other networks is aspired, a strong knowledge institute is missing.

Recommendations for follow-up

The situation with follow up of all activities undertaken in the project is currently (status 2002) as presented in table S-3.

Table S-3: Follow-up activities (status 2002)

Activity	Continued from 2002 onward?	Involved clusters	Countries
Demo companies follow-up	Yes, in a few of the companies only	Consultancy, Industry	Costa Rica, Guatemala
Industrial follow-up (outside demo)	Yes, food industry Costa Rica, 'Design without borders' project GUA	C, I, Research	CR, GUA
New projects (research)	No		
Manual development	No		
Training activities	Yes, connected to new projects and by NCPCs	C. I	CR, GUA, El Salvador
Curriculum development	Yes, in several universities	R	CR, GUA, ES
University cooperation	Planned, no activity yet		CR, GUA
Eco-indicators	No		
National Workshops or conferences	No		
Ecodesign Award	Yes, integrated in CCAD award scheme	C, I, Gov., Financial	Regional
Webpage	Yes	C, G	CR

To stimulate more and advanced follow-up activities, there is a need for the local networks to come up with a plan for a strategic choice of future initiatives. As a first priority, the networks themselves have to be strengthened. Then, attention should be given to the kind of strategic developments desirable.

A number of research opportunities focused on ecodesign in Central America arise from this study:

- Further research into industry projects on ecodesign (issues of multiplication and continuation)
- Similar research with a control group to further investigate adoption issues
- Further research into methodology development, emphasizing more the differences between benchmarking and innovation approaches of product development, and methodologies for service and product-system projects.
- Detailed study into the methodology use in companies with regard to knowledge and skills acquisition and cultural aspects.
- Research is recommended into the factors that cause a lack of concurrent development of products and markets, and possibilities to improve this.
- Research on how companies can integrate the product approach into their environmental management systems
- In-company research on product- service and product-systems approaches
- Research on improvement of networking and social learning in the local networks
- A concise policy study into the possibilities to develop an effective and supportive policy framework for ecodesign in the region.

Possible ecodesign projects in industry depend on objectives of international sponsors and national and regional industry programmes. Although ecodesign can fit into several programme lines including sustainability, innovation and competitiveness, individual successes in getting projects funded will not lead to a coherent system of ecodesign initiatives. Also, finding funding for ecodesign has a better chance if it is done in combination and synergy with other aspects of sustainability. One strong line of possible integration is with other innovation approaches. A second line of integration in the field of sustainability issues can be further integration with Cleaner Production approaches. A third line of integration is connecting ecodesign activities to the Regional Competitiveness Agenda (INCAE 1999).

Abbreviations

ASI	Chamber of Industry, El Salvador
ASOMETAL	Metal sector organisation Costa Rica
CCAD	see SICA/CCAD
CDE	Capacity Development for Environment
CEGESTI	(original meaning: Technology Management Center of Costa Rica– now no longer used as abbreviation)
CIG	Chamber of Industry Guatemala
CONACYT	National Council of Science and Technology, El Salvador
CONCYT	National Council of Science and Technology, Guatemala
CONOMA	National Environmental Commission, Guatemala
CP	Cleaner production
CTA	Constructive Technology Assessment
DfE	Design for the Environment
DfS	Design for Sustainability Programme, Delft University of Technology
DUT	Delft University of Technology
EMS	Environmental Management System
FIDE	Trade and Export Organisation, Honduras
GTZ	German Organisation for Technical Cooperation
GVC	Global Value Chain
INCAE/CLACDS	Latin American Center for Competitiveness and Sustainability
ISO	International Organization for Standardization
ITCR	Institute of Technology Costa Rica
LCA	Life Cycle Assessment
LiDS	Life Cycle Design Strategies
MARENA	Ministry of Environment, Nicaragua
MET	Materials, Energy, Toxics
NCPC	National Cleaner Production Centre
NOTA	(from Dutch) Dutch Institute for Technology Assessment
OECD	Organisation for Economic Cooperation and Development
PIT	Product Improvement Triangle
PROMISE	(from Dutch) Product development with Environment as Innovation Strategy
R&D	Research and Development
SICA/CCAD	Regional Commission on Sustainability and Development
SME	Small and Medium sized Enterprises

SPD	Sustainable Product Development
SSM	Soft Systems methodology
SWOT	Strengths, Weaknesses, Opportunities, Threats
TEC	(=ITCR)
TA	Technology Assessment
TT	Technology Transfer
UDB	University Don Bosco, El Salvador
UNEP	United Nations Environment Programme
UNI	National University of Technology, Nicaragua
UNIDO	United Nations Industry Development organisation
USAID	United States Agency for International Development
US EPA	United States Environmental Protection agency

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In addition, in Annex A many photos of other details of the products are presented.

Resumen: Ecodiseño en Centroamérica

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Introducción

Esta tesis describe y analiza el proceso de cambio empezado por el proyecto "Ecodiseño en Centroamérica" que se ejecutó entre 1998 y el 2002. En una primer fase, el proyecto empezó usando el concepto del Ecodiseño y las prácticas desarrolladas en Europa y mostró la apropiación exitosa de este concepto en nueve compañías participantes y de las contrapartes de cada país. Estas experiencias permitieron traducir y adaptar el concepto al contexto regional de Centroamérica. El enfoque en la segunda fase estaba dirigido a crear una capacidad local, la construcción de una red de servicios conformada por profesionales de la industria y por las universidades. El enfoque utilizado en esta fase fue de trabajo en un sector, en una cadena productiva y en servicios.

En general los niveles de actuación ambiental en la industria centroamericana son bajos. La preocupación y conocimiento en la región sobre esta situación están creciendo, la necesidad de integrar el ambiente en la estrategia comercial se reconoce cada vez más. Las actividades de la producción más limpia han empezado desde 1995; este proyecto de Ecodiseño fue el primer proyecto en Centroamérica que relaciona productos con el ambiente.

Ecodiseño, entendido como el desarrollo de productos eco-eficientes o más sustentables, es una práctica común en muchas compañías mundiales. La Universidad Tecnológica de Delft estaba involucrada en muchos de estos proyectos y empezó a apoyar los proyectos en las regiones en vías de industrialización. En conjunto con la Fundación CEGESTI (Centro de Gestión Tecnológica e Informática Industrial) de Costa Rica, se formuló y se ejecutó el proyecto regional "Ecodiseño en Centroamérica", con el apoyo financiero mayormente de la Embajada de los Países Bajos en Costa Rica y la participación de instituciones contrapartes de los otros países centroamericanos.

El propósito central del proyecto era mejorar los aspectos ambientales de productos diseñados por las compañías pequeñas y medianas de la región, así como la aplicación y la adaptación del concepto del Ecodiseño en la región. Los objetivos durante los primeros dos años del proyecto fueron: la ejecución de proyectos de demostración, la creación de una capacidad regional y la sensibilización sobre el tema. Dada la oportunidad de una extensión de dos años, los objetivos adicionales fueron la expansión del concepto a la cadena de valor, a la aplicación sectorial y la aplicación en servicios, y el incremento de la sensibilización en cada país participante.

El insumo metodológico más importante para la primera fase del proyecto fue el Manual de Ecodiseño del PNUMA, en el cual se brinda una descripción del acercamiento sistemático, etapa por etapa, para la aplicación del Ecodiseño en la industria.

Entre los resultados más importantes del proyecto, podemos mencionar:
- Un manual en español para la aplicación de Ecodiseño en la Región.
- 14 casos de aplicación en empresas, informes y hojas de casos de empresas.
- Una conferencia regional en Ecodiseño y talleres en algunos países de la región.
- Alrededor de 20 consultores en Ecodiseño y aproximadamente 50 profesionales capacitados,
- Un esquema de premiación bianual regional para premiar la aplicación del Ecodiseño.

Definición del problema y del enfoque

A través del estudio de casos y de investigación, usando el proyecto de Ecodiseño como investigación empírica de campo, este estudio intenta analizar y describir el proceso de introducción de Ecodiseño en las empresas en Centroamérica. Algunos nuevos elementos pueden esperarse de esta investigación, tales como: la ausencia de elementos de promoción externos tales como la legislación estricta, hace que los estímulos internos de las empresas sean mucho más importantes que en Europa.

Ecodiseño se estudia como un caso especial de innovación del producto, especialmente debido al enfoque ambiental. Para muchas de las empresas participantes, fue la primera experiencia con un acercamiento estructurado de desarrollo de producto. Para facilitar estos proyectos, la metodología Europea fue adaptada al contexto de la región, siendo uno de los primeros proyectos en que esta metodología se prueba y se evalúa.

Por la construcción de capacidad local y regional, éste es el primer proyecto en Ecodiseño en una región en vías de desarrollo en dónde este tema es objeto de un estudio específico.

Los tres puntos focales del estudio son la aplicación de Ecodiseño en empresas para generar estudios de caso, la facilitación para un acercamiento metodológico y la construcción de una red de actores importantes en la región para la promoción y aplicación de Ecodiseño. Las preguntas centrales de la investigación fueron:

1) ¿Qué tan exitoso fue la adopción y aplicación del Ecodiseño en las empresas de Centroamérica que participaron del proyecto y cuáles son los factores claves que influyen en esto?

2) ¿Es la facilitación de Ecodiseño, al interior de empresas y en la construcción de una capacidad de expertos locales, exitosa y localmente apropiada?

3) ¿Es la capacidad en Centroamérica sostenible para continuar y extender las actividades en ecodiseño?

La pregunta inicial de la investigación se formuló sobre la base de estas preguntas centrales. Éstas se desarrollaron aún más después del estudio de la literatura (y se presentará algo más detallado en este resumen). El modelo de la investigación inicial se desarrolla basado en que la adopción, facilitación y la construcción de capacidad son variables dependientes (vea la figura R -1)

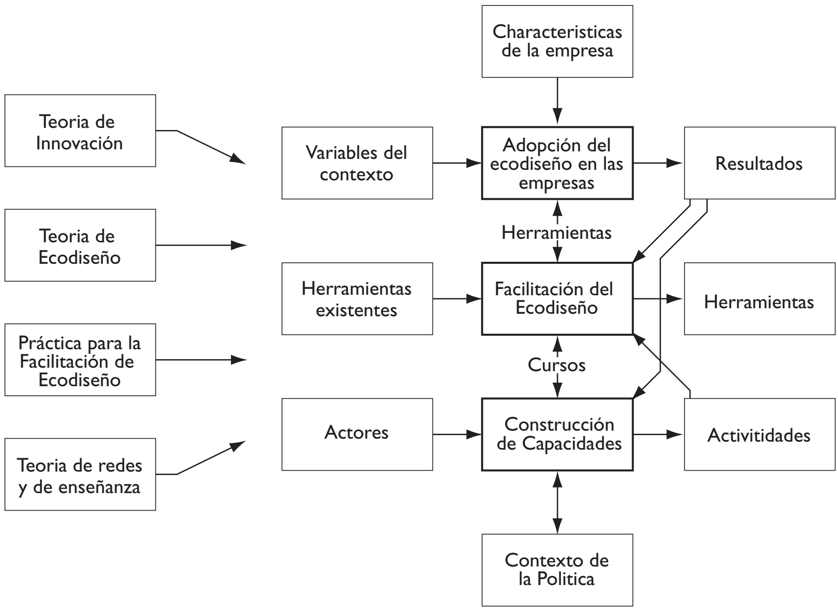

Figura R-1: Modelo inicial de la investigación

A la izquierda, se presentan los campos teóricos que se escogerán para el análisis detallado: la teoría de la innovación, la teoría del ecodiseño y la práctica de facilitación y la red de contactos y la teoría de aprendizaje.

El proceso de adopción en las empresas se influencia por varios factores internos y externos (las variables independientes), tales como las características internas de la empresas, los conductores externos y las barreras, las variables contextuales como el económico y el político. La facilitación se influencia por los factores como la metodología existente, resultados de los casos de estudio y el desarrollo de una capacidad en la región. La construcción de la capacidad depende de la disponibilidad y participación de los actores, el contexto político y los resultados que proyecten los resultados de los proyectos de ecodiseño.

Plan de la investigación

Del contexto del estudio, un acercamiento de estudio de caso surgió, usado para los múltiples casos industriales y sociales y confrontar éstos con el marco teórico, en combinación con los elementos de acción-investigación, usado para diseñar y analizar las intervenciones hechas durante el proyecto, y para recomendar las estrategias de la intervención futuras.

El plan de estudio de casos múltiples fue escogido con la lógica de la repetición, es decir, seleccionar y analizar varios casos similares de manera que predice resultados similares o los resultados contrastantes pero por las razones predecibles. En el total, se analizaron 14 casos industriales de adopción de ecodiseño. Por la facilitación y la construcción de capacidad, los casos han sido divididos en dos secciones de tres conjuntos de casos nacionales.

Para la investigación de estudio de caso, el desarrollo de la teoría es esencial. Este desarrollo de la teoría sirve como un guía para el estudio, y proporciona la orientación sobre qué preguntas de la investigación para hacer y qué datos recolectar. Para el tema de introducción del ecodiseño en Centroamérica, un rango de campos teóricos pertinentes puede encontrarse a partir de que este tema es complejo. Estos campos se repasan y una selección de las teorías más relevantes se desarrolla en relación con cada uno y con el tema de Ecodiseño. Se formularon varios factores para el análisis y se aplicaron a los resultados de la adopción en los casos industriales y a los resultados de los casos de facilitación y de construcción de capacidad.

Desde este estudio, las intervenciones directas son hechas en los casos y también tiene elementos de investigación-acción: el manejo del problema, la orientación al cliente, cuestionamiento al estatus-quo y orientación hacia conclusiones comprobables empíricamente. También en un tema complejo como la introducción del Ecodiseño en una región, la noción de sistemas suaves puede ser valiosa para el cuerpo de pensamiento. La metodología de los sistemas suaves se define como "”una metodología que apunta a provocar la mejora en las áreas de preocupación social, activando en las personas un ciclo de aprendizaje que idealmente nunca termina" (Bulow 1989).

Se verificó la calidad del plan de la investigación contra varios elementos positivistas y constructivistas.

Construyendo la validez: ¿Se seleccionaron las medidas operacionales correctas para el cuerpo de conceptos estudiado?

- La validez interior: ¿Están los modelos de relación vistos y concluidos basados en el análisis real y no el resultado de algún otro factor que nosotros no consideramos?
- La validez externa: Estableciendo el dominio sobre cuales de los resultados de este estudio pueden generalizarse.
- La fiabilidad: Demostrando que las operaciones de este estudio, tales como el procedimiento de colección de datos, puede repetirse con los mismos resultados

- La credibilidad: ¿Las realidades de los actores pueden asociarse con aquellos atribuidos en este estudio a los actores?
- Lo correcto: ¿Son las construcciones que se hacen en el estudio clarificadas y atribuidas a los actores?
- La autenticidad: ¿ Están los actores autorizados para actuar, y ellos aprenden en el proceso?

La conclusión de este chequeo es que el estudio tiene un plan de calidad alto.

Aunque en la realidad, varios pasos de divergencia y convergencia han tenido lugar, para la claridad global de la lógica lineal de una investigación de estudio de caso se uso el modelo siguiente: Desarrollo de la teoría – conducción del caso- análisis de los casos - elaborar las conclusiones y retroalimentación de los resultados en la teoría y en las recomendaciones.

Esto lleva a las cuatro partes del estudio:
Parte I: Introducción
Parte II: Teoría
Parte III: Resultados de los casos
Parte IV: Análisis y conclusiones.

La innovación y la teoría de Ecodiseño

La innovación entendida como "el proceso de traer una nueva idea que resuelve un problema" es un concepto amplio usado en una variedad de circunstancias. La teoría es inmensa y el espectro abarca desde la teoría económica, la adopción y la difusión hasta la dirección y comercialización. Nosotros nos enfocamos en dos puntos de vista: el tecnológico y la orientación de mercado.

¿Qué visiones teóricas de la teoría de la innovación pueden contribuir a entender bien de las preguntas de la investigación en este estudio? La teoría de la innovación como es presentada en este capítulo esta principalmente conectada a la variable de investigación relacionada a la adopción de ecodiseño en las empresas que son estudio de caso.

La aplicación del modelo para la innovación del producto de Roozenburg y Eekels (1995) es central en los casos, desde ya está en el centro del enfoque detallado en el manual del Ecodiseño. El análisis del uso de este enfoque verterá la luz en el posible nivel de desarrollo sistemático del producto, y en el nivel concurrente de producto y desarrollo del mercado que son importante para el concepto del ciclo de vida del Ecodiseño.

El modelo de cadena para la innovación (Kline y Rosenberg 1986) nos permite analizar el uso de los niveles diferentes de información y conocimiento usados - o no usudos- por las empresas. Esto se conecta estrechamente a la noción que el "benchmarking", o medición del nivel de desempeño, es un método dominante de desarrollo del producto, donde es esencial la información existente y conocimiento de competidores y empresas fuera de la región. La influencia de intermediarios y otro grupos de actores en el proceso de la innovación se enfatiza por varios autores (Buys, 1987, van Hemel, 1998). La información activa que se busca fuera de los ambientes directos de la empresa es por consiguiente un factor importante para la innovación.

El tipo de innovaciones como los descritos por Molinero y Morris (1999) que podemos esperar en nuestros casos será principalmente de una naturaleza continua. Las empresas empezarán cautelosamente con el Ecodiseño, la mayoría de ellos empezando con rediseñar los productos existentes, permaneciendo dentro de los límites de sistemas existentes.

El Modelo de Rogers para la adopción de innovaciones en una empresa individual (Rogers 1995) se espera que también sea validado en los casos de estudio. El nivel de adopción alcanzado indicará la aceptación del concepto del ecodiseño, y las posibilidades para los resultados exitosos del proyecto.

Se espera que el modelo de difusión de Rogers sea menos aplicable, porque esto depende de una variedad de otros factores que de la suma de los procesos de adopción individuales. Para esto, se ha explorado los modelos de la innovación evolutiva, mostrando la importancia de redes de innovación-difusión (Nelson y Winter 1982, Mulder 1992, Silvester 1996). Relacionado a esto, esta la noción que los ambientes institucionales de una compañía influencian su comportamiento en el cambio e innovación (Powell y Dimaggio 1991). Se espera por consiguiente que sea pertinente el análisis del comportamiento de la gestión de redes de la compañía.

El benchmarking como un enfoque dominante para el desarrollo de producto puede encontrarse en la mayoría de los casos en los países menos industrializados (Romijn 1996), lo que también puede esperarse en nuestros estudios del caso. Las estrategias importantes que pueden observarse estarán en la competencia por precio y en las mejoras del producto.

Ecodiseño se define en este estudio como "el diseño de productos, procesos o sistemas con el ciclo de vida del producto en la mente, apuntando a la reducción del impacto ambiental."

Eco(re)diseño de productos puede verse como el más bajo y la parte intermedia del espectro de mejora ambiental para los sistemas del producto-servicio. Típicamente, la reducción de impacto ambiental factor 2 es el máximo a ser alcanzado en este tipo de proyectos. Se esperan alcanzar los factores más altos con el producto-servicio y en el enfoque de sistemas, pero los datos empíricos disponibles hasta ahora muestran que ésta es una tarea compleja. En los estudios del caso, principalmente encontraremos los casos del eco(re)diseño.

En Europa la integración de aspectos del producto en sistemas de gestión ambiental, ha sido una salida para asegurar la atención continuada y esfuerzos en esta dirección.

Para nuestros casos de estudio, los estímulos más importantes y características interior y externo para una empresas encuentra para el ecodiseño por van Hemel (1998), parecen ser los más pertinentes a usar en este análisis. Algunos de estos factores, como el mejoramiento/beneficio ambiental, las demandas de mercados/clientes, las regulaciones y los factores económicos, también se citan en otros estudios.

También, las características genéricas de los líderes de las empresas son de gran influencia en el éxito, y puede ser de interés para el análisis detallado de los casos. Este factor también se encuentra en los estudios empíricos en el ambiente no relacionados a la innovación.

La teoría de facilitación y aprendizaje

En la práctica de la primera parte del proyecto centroamericano, se usó el enfoque del manual de PNUMA "Ecodiseño, un enfoque prometedor" (Brezet y van Hemel 1997). Baumann et al. (2001) mencionó el manual de PNUMA para ser el material de la referencia en Ecodiseño. En su tipología, el manual de PNUMA es un marco que incluye una herramienta de la organización, listas de control, herramientas de las pautas y herramientas analíticas. Diehl y Brezet (2003) toma el manual de PNUMA como el punto de partida, desde su artículo se enfoca en las posibles recomendaciones para una actualización de este manual. Ellos listan 10 manuales que se derivan directamente del manual de PNUMA, y otros 8 manuales. Herramientas clave del manual de PNUMA se encuentran también en otros manuales.

El manual se diseña para permanecer cerca de varios enfoques claves estándares, siguiendo los pasos comunes del enfoque de desarrollo de producto: la meta y la estrategia de desarrollo- la generación de idea - el diseño detallado - la realización. También, un esfuerzo para hacerlo compatible, tanto como sea posible, a muchos enfoques de valoración de la Producción más Limpia, para facilitar integración de los dos enfoques, procesos y productos con orientación ambiental.

Al lado del enfoque de etapa por etapa, se integraron varias herramientas en el manual. Las herramientas clave son la matriz de la Eco-Mercado, una herramienta estratégica para la selección del producto correcto para iniciar el proyecto, la matriz MET, una herramienta analítica simplificada, la Rueda de Estrategia del Ecodiseño- una herramienta de mejora que se usa en varios niveles. Herramientas de priorización tales como eco-indicadores son incluidas en los módulos adicionales del manual.

De la teoría del Desarrollo de Capacidad en Ambiente y proyectos de Transferencia de Tecnología, es claro que la facilitación debe adaptarse a las circunstancias locales, y esos actores locales deben tomar el liderazgo gradualmente en la ejecución de proyectos y aplicación de ecodiseño en la industria. Para logra hacer esto, en nuestra metodología la tecnología introducida debe de una forma desempacada, a manera que estimule a las contrapartes locales a usar partes que son muy factibles bajo las circunstancias locales, así como para agregar conocimiento local.

Para facilitar con éxito el ecodiseño en la industria, hay una necesidad de construir una configuración especializada para el ecodiseño a nivel regional y local, para verse socialmente construida por un conjunto de actores importantes. Debido al plan original del proyecto, puede esperarse que inicialmente éste sea el patrocinador y el conductor de la investigación.

Aprendizaje se define como el proceso de adquirir implícita (tácito) o explícitamente (codificado) el conocimiento. El conocimiento puede adquirirse de múltiples maneras, tales como el estudio, la instrucción, la práctica o la experiencia. Incluye el aprendizaje operacional (la habilidad) y el aprendizaje conceptual (saber por qué), y una combinación de ambos tipos de aprendizajes. Todas las diferentes formas de aprendizaje tienen lugar en el proceso de introducción del ecodiseño. El conocimiento del manual puede verse como explícito, adicionado con el conocimiento tácito dentro de las empresas o de la red. Ecodiseño involucra claramente el aprendizaje operacional y el aprendizaje conceptual, para las diferentes partes de una organización en las diferentes combinaciones.

Los procesos de aprendizaje que podemos discernir incluyen el socialización, externalización, internalización y combinación de éstos, lo cuales pueden hacerse de manera individual y en equipo. También, los factores tales como los recursos, las oportunidades y la cultura para habilitar las posibilidades para el aprendizaje organizacional pueden ser considerados.

En este estudio se definen varios elementos centrales de calidad para las redes locales, incluso las metas, actores centrales, poder, confianza y comunicación que pueden usarse como los puntos de control de la calidad de las redes locales para el ecodiseño. El desarrollo de un modelo global conectando el aprendizaje con elementos de una red puede verse en la figura R -2, el cual está orientado a la acción y puede usarse para analizar la interconexión de los distintos niveles de una red, donde el aprendizaje debería tener lugar.

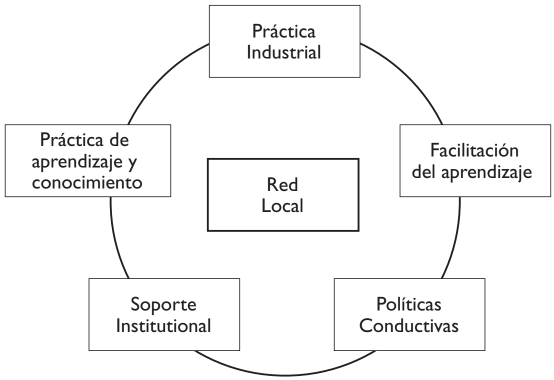

Figura R -2: Modelo para el aprendizaje de redes locales (después Röling and Jiggins 1998)

La metodología de investigación

Las tres variables: adopción, facilitación y capacidad, se influencian y se forman por un número grande de otros factores. Se seleccionaron proposiciones importantes de las teorías pertinentes y de la práctica, que se formularon en 30 factores de la investigación. Para ser capaz de analizar los datos de los casos de estudio, los factores son operacionalizados de una manera semi-cuantitativa. Para cada factor, se formulan preguntas de la investigación, cuyo detalle puede verse en la tabla 1. Luego, para cada uno de los factores se definió un sistema de calificación. La escala se diseñó para cada factor, significando que el sistema espera que habrá diferencias en la calificación del factor entre los diferentes casos. Los factores y sus operacionalización se agrupan por la variable dependiente, tales como la adopción, facilitación y capacidad y se conectan a la investigación por medio de las preguntas Q1 - Q10 (Tabla R -1).

Tabla R -1: Preguntas de la investigación (Qs) y su relación con los factores de la investigación (Fs)

ADOPCIÓN:
Q1) ¿Cómo se hace para que tenga lugar la adopción de ecodiseño en las empresas participantes en Centroamérica, visto como un proceso de innovación de producto?
F1. La empresa utilizó muy bien los diferentes niveles de conocimientos necesarios para la innovación de producto. F2. La empresa incluyó conocimientos técnicos y de mercado en el desarrollo del proyecto. F3. La empresa estuvo buscando activamente información de su entorno. F4. Es la fase de adopción del ecodiseño en la empresa. F5. La empresa es parte de una activa red de innovación-difusión. F6. La empresa usa estrategias de benchmarking/copia para entrar en el mercado
Q2) ¿Son los proyectos de ecodiseño exitosos en la empresa y es el enfoque continuo y es difundido a otras empresas?
F7. ¿Qué mejoras de los factores han sido alcanzados por la empresa? F8. ¿Qué alcance toma en cuenta la compañía en el proyecto del ecodiseño? F9. ¿La empresa integro el concepto de ecodiseño dentro del sistema de gestión? F10. ¿Continua la empresa con proyectos de ecodiseño?
Q3) ¿Cuáles con los factores claves internos en la empresa que influencian (positiva o negativamente) la adopción del ecodiseño?
F11. Tiene la empresa las siguientes cuatro características internas: reducción de costos, imagen, beneficios ambientales, actitud positiva
Q4) ¿Qué variables claves contextuales (estímulos y barreras) influencian la adopción del ecodiseño?
F12. La empresa es estimulada externamente por estos estímulos: regulaciones, demanda del mercado, demanda de los suplidores
FACILITACIÓN:
Q5) ¿Cómo fue inicialmente manejada la metodología de ecodiseño provista?
F13. La empresa aceptó o usó el proceso estructurado (completo o en forma simplificada) para el proyecto de ecodiseño F14. La empresa aplicó las herramientas MET, LIDS y obtuvo de estas información ambiental F15. La empresa encontró e incluyo soluciones de varias estrategias de ecodiseño (las ocho opciones de la LIDS)
Q6) ¿Qué elementos del enfoque de ecodiseño pueden ser optimizados para su uso en Centroamérica?
F16. La empresa complementa la metodología entregada con sus propias herramientas
Q7) ¿Cómo fue la transición a la facilitación local del desarrollo del ecodiseño? ¿Es esta óptima?
F17. ¿El programa fue ejecutado de una manera cooperativa, donde los actores locales progresivamente tomaron el liderazgo en los proyectos de las empresas? F18.Las etapas de diseño, inicio, implantación, monitoreo y evaluación fueron usadas.
CAPACITY:
Q8) ¿Cómo fue desarrollado el proceso de construcción de capacidad y de incremento de la sensibilización en Centroamérica?
Q9) ¿Quiénes son los actores clave en este proceso y cual es su rol e involucramiento?
Q10) ¿La construcción de capacidad y de sensibilización en ecodiseño es exitosa? ¿Debería o puede ser optimizada?
F19 ¿Hay una percepción conjunta de las metas y son estas aceptadas por todos los actores? F20. ¿Están todos los actores relevantes involucrados en la red? F21. ¿Existe una ganancia adicional visible para todos los actores involucrados? F22. ¿El proceso de aprendizaje conjunto entre los actores continúa, o al menos posible? F23. ¿Está el poder distribuido justamente entre los actores? F24. ¿Existe una confianza básica e interdependencia entre los actores? F25. ¿Existen vínculos fuertes y débiles en la red? F26. ¿Hay un modelo de comunicación adecuada en la red? F27. ¿Existe conformidad entre la configuración y la metas/actividades en la red? F28. ¿El aprendizaje combinado de los conceptos y aplicación ha tenido lugar en las organizaciones de la red? F29. ¿Se ha dado lugar al aprendizaje organizacional en la red de organizaciones? F30. ¿Se ha dado lugar al aprendizaje a través de todos los niveles del sistema?

El modelo inicial de la investigación puede ser redefinido con base en la selección de las variables claves independientes o factores, y la interrelación entre aquellos factores. La redefinición del modelo de investigación es hecha para cada variable dependiente, así para la adopción, la facilitación y la capacidad. Porque de la compleja interrelación entre varios factores y variables, el modelo inicial de imagen lineal se transformó en un modelo de imágenes de series de parciales, concentradas en círculos alrededor de la variable dependiente. Esto hace más correcta la complejidad del sistema, y el hecho está en que varios de los factores son agrupados o tienen una fuerte interrelación y ejercen su influencia en las variables dependientes en diferentes niveles. Estos modelos son de naturaleza cualitativa y descriptiva, y deberían ser vistos como una ayuda para una estructura detallada del análisis. La redefinición del modelo de investigación se presenta en la figura S-3.

La recolección de datos en este estudio es hecha de una manera estructura, usando un protocolo de recolección. Los tipos de fuentes usados en este estudio incluyen la documentación de varios tipos: minutas, reportes y documentos administrativos, archivos, entrevistas, observaciones directas, observación de los participantes y productos físicos. El modo de análisis seguido en este estudio es uno de "modelo calzado" (Yin, 1994). Dentro de la parte exploratoria del estudio, principalmente dentro del análisis de los casos de estudio de las empresas, los resultados o modelos empíricamente son confrontados con los resultados esperados y que son derivados de la teoría y en la práctica.

El nivel de adopción e influencia que puede ser ejercida por los factores y pueden ser analizados de manera cruzada a través de todos los casos de estudio. "Construcción-Explicación" es usada en los casos de construcción de capacidad: basados en los resultados obtenidos en el caso de estudio, explicaciones que reflejan alguna proposición teórica significante en ciertos fenómenos que ocurren en el estudio del caso, tratando de encontrar relaciones entre ello. Además, el análisis cualitativo y narrativo de datos adicionales y visiones que surgen de los casos también es realizado.

Resultados del estudio del caso de adopción del Ecodiseño

Sobre la base de grupos de criterios se seleccionaron sectores relevantes y compañías individuales apropiadas en tres países de la región: Costa Rica, Guatemala y El Salvador. Fueron ejecutados 9 proyectos en la primera fase (1998-1999). Para la segunda fase (2000-2002), el equipo encargado del proyecto decidió dar más énfasis al nivel funcional y de sistemas y a los enfoques relacionados con la cadena del producto en los casos de estudio de la nueva empresa. Es de esperar que estos niveles amplíen las posibilidades de mejoramiento ambiental y la factibilidad económica de los proyectos de mejoramiento. Se seleccionaron 5 proyectos, una compañía de turismo en Costa Rica que ofrece "rafting tours" (enfoque sobre servicios), 3 compañías metalúrgicas (enfoque sobre sector) en Guatemala y una empresa láctea (producción de leche y crema – enfoque sobre la cadena del producto) en El Salvador. Los énfasis en turismo y alimentos del sector agrícola se adecuan a las estrategias establecidas en la Agenda Regional para la Competitividad

(INCAE 1999). Las compañías que han participado y los productos seleccionados figuran en un listado en la Tabla S-2.

Los casos de Ecodiseño demostraron ser exitosos. En la mayor parte de las empresas se obtuvieron productos nuevos o rediseñados. En todos esos casos se alcanzó algún nivel de mejoramiento ambiental. La mayoría de los productos obtuvieron un porcentaje de reducción del impacto ambiental que oscila entre el 10 y 20%, generalmente la reducción es en el uso de materias primas; por ejemplo dos productos tuvieron una reducción del 50% en sus materias primas, lo que puede considerarse un resultado muy bueno. La calidad del producto también se ha mejorado en la mayoría de los casos. Los resultados obtenidos en cada producto en particular se pueden encontrar en el anexo A de esta tesis.

En el 2001 se reestableció el contacto con las primeras 9 empresas modelo para averiguar qué había sucedido después del proyecto modelo. Para dar seguimiento a la implementación real y proseguir las actividades de ecodiseño, se definieron varios tópicos:

- ¿El producto rediseñado o ecodiseñado fue introducido realmente en el mercado (en todas las 14 empresas)?
- ¿El producto rediseñado (o su sucesor mejorado) está todavía en el mercado?
- ¿Implementó la empresa en la organización, capacidades para el ecodiseño?

Para las empresas correspondientes a la segunda fase, que habían concluido sus proyectos recientemente, sólo las preguntas relacionadas con introducción en el mercado y capacidad pueden ser contestadas. Los resultados están resumidos en la tabla R-2.

Tabla R-2. Empresas, productos e introducción de los productos en el mercado.

Empresa	País	Producto	Resultado	Capacidad de ecodiseño
Waiman	Costa Rica	Refrigeradoras	En el mercado	No
Heliconia	Costa Rica	Exportación y empaque de flores	En el mercado	Sí
Panel-ex	Costa Rica	Muebles de Oficina	Sólo prototipo	No
Mafam	Costa Rica	Empaque y distribución de galletas	Sólo prototipo	No
Venus	Guatemala	Empaque y distribución de confites	En el mercado	Sí
REA	Guatemala	Equipo para el procesado del café	En el mercado	Sí
Mobelart	El Salvador	Muebles de cocina	En el mercado	Sí
Kontein	El Salvador	Botellas de plástico	Sólo prototipo	Sí
Bendig	Costa Rica	Equipo para el procesado del café	En el mercado	Sí
Av. Naturalis	Costa Rica	"Rafting tour"	En el mercado	Sí
Turbomac	Guatemala	Horno para uso doméstico	En el mercado	No
Inmepro	Guatemala	Horno industrial	En proyecto	Sí
Executiv	Guatemala	Escritorios de oficina	Sólo diseñado	No
El Jobo	El Salvador	Crema	En el mercado	No

Resultados del estudio relativos a la facilitación y a la construcción de la capacidad

El proceso de Ecodiseño en las empresas de la primera fase fue facilitado de manera intensiva. Las actividades incluían:

- Talleres de "arranque" (inicio, partida, comienzo) con gerentes de varias empresas.
- Talleres de 1 ó 2 días en las empresas con los equipos encargados del proyecto y todo el personal involucrado.
- Reuniones regulares con el equipo del proyecto de CEGESTI, de TU Delft y de la contraparte local.
- Proyecto de graduación de estudiante (Ingeniería de diseño) de Tu Delft, que abarca 6 meses de participación, dos de los cuales son de preparación en los Países Bajos.
- Taller final de un día.
- Entrega del reporte final del estudiante dos meses después de haber participado del proyecto.

Se utilizó como guía el enfoque metodológico del manual PNUMA. Todas las empresas aplicaron la estrategia de "benchmarking"(desarrollo de productos por copiado). Para todas ellas era la primera vez que durante el proceso realmente se tomaba en cuenta el ambiente.
Las herramientas estratégicas generales del manual se aplicaron sin problemas. Las herramientas claves de Ecodiseño, la matriz MET y la rueda estratégica de Ecodiseño también fueron aplicadas con éxito, pero fue difícil obtener la información necesaria de forma detallada. Se desarrollaron instrumentos simplificados y se aplicaron basándose en listas de control, reglas de oro y cuestionarios.

Para facilitar la segunda fase se llevó cabo una transición hacia el liderazgo local y se establecieron medios de aprendizaje continuo. Teniendo en cuenta los resultados obtenidos en la primera fase, se desarrolló un manual de Ecodiseño regional, siguiendo el modelo del manual de la PNUMA, adaptándose a las situaciones locales.
En la primera fase sólo un número limitado de profesionales de los organismos de la contraparte se entrenaron y el nivel externo de ayuda todavía era elevado. En la segunda fase, se entrenaron 38 jóvenes profesionales y de este grupo se seleccionó a los líderes potenciales, quienes podían presentar propuestas para posibles proyectos en empresas. Con base en esta competencia, los proyectos de la segunda fase fueron seleccionados en conjunto con el grupo local facilitador que los llevaría a cabo. También se realizó un intercambio con estudiantes holandeses para involucrar en los proyectos.

Se tenía como meta en la primera fase llevar a cabo actividades para desarrollar capacidades claves en las organizaciones participantes como contrapartes. La actividad principal dentro de ellas fue un curso de dos semanas en Delft para entrenamiento del entrenador.

Con el propósito de formar una red más amplia en la región se establecieron contactos con cerca de 20 organizaciones que pudieran desempeñar un papel importante en la difusión del Ecodiseño en el área.

Los días 28 y 29 de octubre de 1999, se organizó en San José, Costa Rica (CEGESTI 1999) una reunión regional sobre Ecodiseño que constituyó un evento importante para el desarrollo de las capacidades. Puede considerarse como la presentación de resultados de los dos primeros años del proyecto para todas las partes involucradas, así como para personas interesadas. También se considera como el comienzo de las discusiones y propuestas de planes futuros y actividades en el área de Ecodiseño. Más de 100 participantes acudieron al evento.

En la segunda fase del proyecto, la capacitación se orientó hacia el desarrollo de redes locales en los tres países involucrados. La participación competente de las contrapartes mencionadas anteriormente fue parte de este desarrollo. Otro elemento importante fue el compromiso activo de las universidades dentro de las redes, tanto en forma de participación efectiva como a través de proyectos desarrollados por estudiantes para el desarrollo curricular. En relación con este objetivo estaba la organización de 3 talleres nacionales sobre Ecodiseño, uno en cada uno de los países. Se organizaron varias actividades de apoyo: un estudio sobre el uso de eco-indicadores regionales para ecodiseño; la organización de un proyecto para un premio de Ecodiseño regional para la industria, que más tarde se combinó con una iniciativa similar de CCAD; el desarrollo de una página regional en internet sobre ecodiseño así como medios de comunicación electrónica. Varias iniciativas de seguimiento y proyectos relacionados con este programa surgieron ya al final del periodo de investigación (status 2002), incluyendo proyectos de Ecodiseño en el sector alimentario (Costa Rica), el proyecto 'Diseño sin Fronteras' (con aporte de Noruega) en Guatemala y cursos y entrenamientos en centros de producción más limpia.

Análisis y conclusiones sobre la adopción del Ecodiseño

Los resultados de la adopción del Ecodiseño en las empresas son analizados por medio del modelo de investigación y por un ulterior análisis cualitativo del material de los casos de estudio. Este análisis se llevó a cabo de acuerdo con los pasos siguientes. Primero, se analizaron individualmente todos los casos de acuerdo con un conjunto de factores aplicables a cada uno (formulados en las preguntas F1 a F12), Luego, los casos de la primera y segunda fase del proyecto se analizan como un grupo, teniendo en cuenta tanto los factores de la investigación como otros datos cualitativos. Dado que después de la primera fase, se han efectuado cambios al establecer los proyectos, integrando las experiencias aprendidas durante la primera fase, son también analizadas las diferencias entre la fase 1 y la 2. Los puntajes obtenidos por cada una de las empresas se encuentran en la Tabla R-3.

Algunos resultados genéricos se pueden describir en todos los casos.

Desde un punto de vista ambiental, los productos rediseñados típicamente utilizan menos materias primas, son por esta razón, más baratos de producir y, en algunos casos más fáciles o eficientes de producir También algunos productos tienen un menor impacto ambiental durante su uso y en dos casos se implementaron mejores sistemas de distribución. Los beneficios ambientales se pueden estimar entre el 10 y el 70% de reducción en el impacto ambiental comparado con el producto de referencia en un nivel de impacto específico.

Estas tasas de reducción del impacto logradas en los productos de las empresas modelo son comparables a los logros obtenidos con los primeros productos eco-rediseñados en los Países Bajos (proyecto PROMISE), llevado a cabo entre 1990-1991. (te Riele y Zweers 1994).

Los productos de los proyectos centroamericanos fueron rediseñados en un periodo relativamente breve. La mayoría de los prototipos se produjeron cuatro o cinco meses después de haber comenzado el proyecto. La mayor parte de los proyectos holandeses tomaron alrededor de un año. Las razones de esto podrían ser las posibilidades relativamente más amplias de mejorar los productos, el manejo y dirección más informal (el director/propietario toma las decisiones) y, además, las limitaciones estrictas de tiempo que tenían los estudiantes para trabajar en los proyectos, lo que obligó a varias empresas a terminar sus prototipos o bien a hacerlo apresurada y descuidadamente. Si consideramos el tipo de innovaciones logradas, la mayoría de los productos modificados se pueden categorizar como rediseños de productos ya existentes, con pequeños cambios relativos si se comparan con el producto de referencia. Un producto, sin embargo, la despulpadora de café REA, es completamente nuevo si se lo compara con su predecesor. De igual forma el escritorio de Panel-ex y la botella de Kontein pueden considerarse prototipos de nuevos productos. Los enfoques de sistemas se pueden encontrar en Aventuras y en el Jobo y también la despulpadora de REA podría ser la primera parte de un nuevo sistema de producción de café.

Basados en el análisis, se puede llegar a las siguientes conclusiones en respuesta a la pregunta de investigación Q1-4.

Q1 – ¿Cómo se desarrolla el proceso de ecodiseño –visto como un proceso de innovación del producto – en las empresas escogidas como muestra en Centroamérica?

El proceso de Ecodiseño en la mayoría de las empresas puede ser visto, en un principio, como un proceso de innovación del tipo de copiado o “benchmarking”. En la mayoría de los casos de rediseños de productos existentes, las orientaciones para las mejoras surgen de ejemplos de los competidores o de productos comparables de Europa o de los Estados Unidos. El uso del conocimiento en las empresas se focaliza en la información necesaria para el proceso de desarrollo ‘horizontal’ del producto en la propia empresa, junto con información adicional de los productos de la competencia. Con respecto al desarrollo integral conjunto del producto y del mercado (Roozenburg y Eekels 1995) se puede concluir que un desarrollo secuencial (primero el desarrollo técnico) es la forma más común de tratarlo en las empresas. En el modelo de innovación y difusión de la tipología de Rogers (Rogers 1995), se puede llegar a la conclusión de que todas las compañías alcanzaron la fase de conocimiento sobre ecodiseño y persuasión para, por lo menos, intentar este tipo de enfoque innovador.

Nueve empresas tomaron la decisión real de poner un producto en el mercado.

Tabla R – 3: Puntajes de los factores de la adopción; resultados individuales de los casos de estudio

Factor / Empresa País	Wai CR	Hel CR	Pan CR	Maf CR	Ven GUA	REA GUA	Mob ES	Kon ES	Ben CR		AvN CR	Tur GUA	Inm GUA	Exc GUA	El J ES
DESARROLLO DE INNOVACIONES EN ECODISEÑO															
1. Sistema de conocimiento de la cadena de valor	C	B	B	C	B	B	B	B	B		B	B	B	B	C
2. Tecnología / Desarrollo de mercado	B	A	C	C	B	B	A	B	C		A	C	C	B	C
3. Interacción con el entorno	C	B	C	C	B	B	A	B	B		A	C	C	B	B
ADOPCIÓN Y DIFUSIÓN DE INNOVACIONES															
4. Fase de adopción	C	B	C	D	C	B	B	B	B		B	B	C	C	C
5. Innovación-red de difusión	D	D	D	D	C	D	B	B	C		B	C	C	B	D
6. "Benchmarking"/copia	C	B	C	B	C	B	B	C	C		B	B	C	C	C
CONCEPTO ECODISEÑO															
7. Factor de mejoramiento	C	C	C	C	B	A	C	B	C		B	C	D	D	B
8. Alcance	D	D	C	D	D	C	D	C	D		A	D	D	C	A
9. Integración en la gestión	D	C	D	D	C	C	C	B	C		C	B	D	D	D
10. Continuación a corto plazo	D	D	D	D	D	C	D	D	D		C	D	D	D	D
ESTÍMULOS PARA ECODISEÑO															
11. Características de la empresa	C	A	D	B	B	A	B	B	B		A	A	C	C	B
12. Características externas	C	B	D	D	C	C	C	C	C		B	D	D	D	C

Puntaje por factor	A = Puntaje A (Total conformidad)	B = Puntaje B (2/3 de conformidad)	C = Puntaje C (1/3 de conformidad)	D = Puntaje D (no conformidad)

Seis empresas decidieron seguir adelante con otros productos u otras actividades relacionadas.
La participación en redes de innovación y difusión, vista como un imperativo por las empresas innovadoras europeas no se encuentra en las mayoría de las empresas estudiadas. Aparentemente la información necesaria para un desarrollo del producto del tipo "benchmarking" es mucho más clara y está disponible en el conocimiento que existe de los productos de los competidores.

Q2 – ¿Tienen éxito los proyectos de ecodiseño en las empresas? ¿se continúa con este enfoque? y ¿siguen otras compañías utilizando el ecodiseño?

Desde un punto de vista demostrativo los proyectos son un éxito. Nueve proyectos se convirtieron en 9 ejemplos de eco-rediseño y estaban disponibles para su difusión en dos años. Cinco ejemplos más estarán disponibles dentro de dos años más. Esto es un resultado bueno y similar si comparamos con otros proyectos de ecodiseño (te Riele y Zweers 1994, Brezet y van Hemel 1997, van Hemel 1998, Gertsakis y otros 1997). Desde un punto de vista ambiental los proyectos también se desarrollaron bien, la mayor parte de los productos obtuvieron un porcentaje de reducción del impacto ambiental que oscila entre el 10 y 20%, generalmente es una reducción de los materiales empleados. Dos productos lograron una reducción del 50%. Los proyectos de la segunda fase mostraron resultados comparables a los de la primera fase: el ámbito más amplio de estos proyectos no conduce automáticamente a mejores resultados. La continuación independiente con nuevos proyectos de ecodiseño y la integración del ecodiseño al nivel estratégico del sistema gerencial de la empresa es aún relativamente bajo. Esto puede explicarse por el carácter "once-off" (¿una vez y fuera?) de los proyectos muestra y la ayuda externa intensiva. Sin la presencia de ayuda externa y con la ausencia de estímulos exteriores, la probabilidad de que ocurra un desarrollo independiente es muy pequeña.

Q3-Q4 – ¿Cuáles son las características internas y externas de las empresas que influyen en el proceso de adopción del Ecodiseño?

Se puede concluir que las motivaciones externas que usualmente son un factor clave en Europa –presiones o regulaciones legislativas y demanda del mercado- están ausentes en gran medida. Por otra parte, sí existen motivaciones internas y características particulares: reducción de costos, imagen, actitud positiva, y en menor medida beneficios ambientales. Esto significa que los requerimientos de estímulos internos se alcanzan generalmente.Los beneficios ambientales (deseados) por sí solos nunca fueron un factor determinante y siempre se hallaron combinados con uno de los otros factores.

Análisis y conclusiones sobre la facilitación del Ecodiseño

Los resultados sobre la facilitación del Ecodiseño se analizan por medio del modelo de investigación y a través del análisis caualitativo posterior de los estudios de los casos (tanto de la empresa como del país). De igual forma que en el análisis de la adopción, primero los estudios de casos se analizan en forma individual, de acuerdo a los factores de investigación aplicables (F13 – F18). Los puntajes obtenidos se pueden encontrar en la tabla R-4.

Q5 – ¿Cómo se manejó en las empresas la facilitación de la metodología de Ecodiseño?

El enfoque regional sobre el rediseño y el tipo de innovación "benchmarking" se adaptó en el manual regional desarrollado y renovado, agregándole un módulo sobre como copiar un producto siguiendo la modalidad "benchmarking" y se integró de forma eficaz a los pasos del manual. Con esta adaptación, los principales elementos del manual PNUMA se pueden aplicar y parecen libres de obstáculos para utilizarse tanto en "benchmarking" como en enfoques para nuevos (re)diseños.

Los intrumentos facilitados en este método fueron casi todos nuevos para las empresas. La herramienta clave – la estrategia de mejoramiento en Ecodiseño o Rueda LiDS- se aplicó con éxito, pero continúa siendo necesaria la asistencia para que se familiaricen con su lógica y terminología. Todas las empresas lograron definir por lo menos dos estrategias de mejoramiento para el rediseño de sus productos, la mayoría de ellas en las categorías 'reducción de materiales', 'optimización de la vida útil' y 'distribución eficiente'.

Tabla R – 4: Puntaje de los factores de facilitación; resultados individuales de los casos de estudio

Factor / Empresa / País	Wai CR	Hel CR	Pan CR	Maf CR	Ven GUA	REA GUA	Mob ES	Kon ES	Ben CR		AvN CR	Tur GUA	Inm GUA	Exc GUA	El J ES
FACILITACIÓN: METODOLOGÍA DE ECODISEÑO															
13. Procesos estructurados	B	B	C	C	B	B	B	B	C		B	B	B	C	C
14. Uso de herramientas ambientales	A	A	A	A	A	A	A	A	C		A	A	A	C	B
15. Diseño de estrategias	C	C	C	C	C	A	C	C	C		B	A	C	D	C
TRANSFERENCIA DE TECNOLOGÍA															
16. Desempaque	D	C	D	D	D	C	C	C	C		B	B	B	B	B
17. Dirección local (programa del país)	A				C		C		B		A	A			B
18. Pasos del programa (programa del país)	A				C		C		B		A	A			B

Puntaje por factor			
= Puntaje A (Total conformidad)	= Puntaje B (2/3 de conformidad)	= Puntaje C (1/3 de conformidad)	= Puntaje D (no conformidad)

Q6 – ¿Qué elementos del enfoque de Ecodiseño se pueden optimizar para su uso en Centroamérica?

El enfoque de ecodiseño PNUMA requirió un número de adaptaciones para que su utilización fuera óptima en el contexto regional. Estos cambios o elementos nuevos se pueden resumir como se detalla a continuación:

Enfoque sobre las motivaciones internas debido a la ausencia de motivaciones externas para ecodiseño.

- Mayor énfasis en el desarrollo del producto estructurado
- Enfoque en el "benchmarking"
- Enfoque en el rediseño
- Instrumentos simplificados
- Utilización de ejemplos regionales

De esta forma se da inicio al proceso de 'desempaque' de la metodología básica europea en el proyecto y probablemente continuará. Las contrapartes locales pueden introducir más especificaciones locales y modificar los esquemas y herramientas para adecuarlos a sus propias necesidades.

Q7 – ¿Cómo se desarrolla la transición hacia la facilitación local del Ecodiseño? ¿Se ha optimizado?

Se desarrolló durante las dos fases una transición de una dirección externa e internacional en el comienzo del proyecto a una dirección local en la finalización del mismo. En la primera fase, tuvo lugar una transición de una facilitación 'dominada por Delft' a un liderazgo mixto asumido conjuntamente por Delft y CEGESTI.

Por lo tanto, se programó que la segunda fase permitiera a las organizaciones locales hacerse cargo de los proyectos. Además de esto , se amplió el grupo de gente entrenada en la facilitación del Ecodiseño.

Se puede concluir que esta segunda fase de desarrollo fue en gran medida exitosa. La Universidad Landívar se hizo cargo de la dirección en Guatemala con el apoyo de CEGESTI. En El Savador, AG Tech estuvo manejando los proyectos, pero en este país el rol de CEGESTI fue más prominente. La planificación y el diseño de la facilitación en los programas y proyectos individuales fueron de razonables a buenos. Fueron utilizados los pasos del programa más esenciales. Sin embargo, queda un punto débil: los pasos de monitoreo y evaluación que llevan a cabo los organismos de la contraparte.

Análisis y conclusiones sobre la construcción de la capacidad.

Q8 – ¿Cómo se desarrolla el proceso de construir la capacidad e incrementar la conciencia sobre Ecodiseño en Centroamérica?

El análisis de la construcción de capacidades fue más de naturaleza descriptiva y explorativa. Se efectuó un análisis de los grupos de interés "stakeholders" en la primera fase del proyecto a fin de preparar las mejores configuraciones para la segunda fase. Se distinguieron 5 grupos claves a cargo de las relaciones funcionales con las compañías industriales a quienes se podría recurrir en relación con sus funciones específicas:

Consejerías/consultorías: facilitación técnica, asesoría gerencial, despliegue del proyecto.
- Organismos de investigación: facilitación, proyectos de investigación en innovación, apoyo con información.
- Organismos industriales: Capacidad, despliegue del proyecto, apoyo con información.
- Organismos gubernamentales: regulaciones, capacidad de brindar medidas de apoyo.
- Organismos financieros: financiamiento, apoyo para el despliegue del proyecto.

Anque los cinco grupos se comprometieron en diferentes actividades, en general ni el gobierno ni las instituciones financieras se involucraron de lleno.

El momento de transición hacia una más amplia construcción de capacidades del tipo de trabajo en forma de red llegó con la Conferencia Regional, a fines de 1999, y la publicación simultánea del manual regional. Durante la segunda fase del proyecto, se traslado el enfoque de la construcción de las capacidades hacia la propiedad local y el desarrollo de una red local. Varias contrapartes locales se comprometieron si comparamos con la primera fase y de esta manera se amplió el entramado inicial. En términos generales, el proceso de construir una red local es lento y ciertamente no ha concluido con la finalización del proyecto.

Q9 – ¿Cuáles son los actores clave en este proceso y cuál es su papel y su compromiso?

Está claro que los actores claves en el proceso de construcción de capacidades fueron las contrapartes del proyecto. Sobre todo son TUD y CEGESTI, la Universidad Landivar de Guatemala (y CIG en la primera fase) y AG Tech y UDB en El Salvador. Con respecto a los organismos gubernamentales, se puede citar también a CCAD como contraparte, considerando el programa de premiación y otras ayudas brindadas para difundir el concepto de Ecodiseño. De acuerdo a esto se puede concluir que la configuración básica relativa al proyecto completo es una configuración conducida por R&D, con fuertes elementos de una configuración conducida por el patrocinador. Las universidades jugaron un papel importante durante el proyecto: en la primera fase, el Instituto Tecnológico en Costa Rica y la Universidad Don Bosco en El Salvador; durante la segunda fase, la Universidad Landivar en Guatemala, la UCA y el ITCA en El Salvador. Algunos actores claves dentro de los organismos no se involucraron todo lo que deberían haberlo hecho. A pesar de varios esfuerzos, las instituciones financieras, como los bancos de inversión no participaron con fuerza en el proyecto. Más exitoso fue el compromiso asumido por los organismos internacionales de cooperación para el desarrollo. Además de la cooperación para el desarrollo brindada por Los Países Bajos, se recibió financiamiento para el programa de premiación en Ecodiseño de la AID y de EPA de los Estados Unidos. Hubo también intercambio de información con la GTZ de Alemania y con el proyecto noruego 'Diseño sin fronteras' en Guatemala.

Q10 – ¿Tiene éxito la construcción de capacidades y la concientización sobre Ecodiseño? ¿Puede o debería ser optimizada?

Una primera conclusión debería ser que muchas actividades para construir capacidades y elevar la concientización se han llevado a cabo. Esto significa que, dentro del grupo objetivo, se ha llegado a un gran número de empresas y profesionales en todo tipo de organismos. Algunos números claves son (anexo B, referencias 21 a 23):

- Más de 50 profesionales entrenados en la región, incluyendo alrededor de 20 consejeros adiestrados en Ecodiseño.
- Una reunión regional con más de 100 participantes, 3 talleres nacionales con cerca de 40 participantes cada uno.
- Talleres especializados y reuniones con la industria local dirigidas por lo menos a 500 participantes.

- Charlas y presentaciones en varias universidades dirigidas a varios cientos de estudiantes y la inclusión del tema de Ecodiseño en curricula.
- Publicidad, artículos populares y científicos, participación de 70 empresas en el concurso de premiación.
- Distribución de varios cientos de copias del manual regional.

Se puede llegar a la conclusión de que se ha alcanzado al grupo objetivo. El concepto de Ecodiseño se ha colocado en las mentes de quienes necesitaban saber de él.
Sin embargo, la información no necesariamente conduce a la capacidad. Por esto hemos establecido que aprender dentro de una red local es lo que se necesita. Los resultados sobre la construcción de capacidades en varios de los actores claves individuales se han discutido ya en la conclusiones de Q9. Las redes locales que están emergiendo de la segunda fase del proyecto son el núcleo para aprender y actuar en Ecodiseño. La calidad de las redes está determinando su funcionamiento y los logros reales en la implementación del Ecodiseño. Ver la tabla R-5 para los puntajes de las redes en los factores F19 a 26. Las redes todavía se encuentran en un nivel primario (status 2002) y casi todos los factores de calidad de las redes deberían todavía mejorarse en los próximos años. El trabajo en la red en Costa Rica y en Guatemala es el más avanzado. En El Salvador en cambio, se encuentra en un nivel inferior de desarrollo. Si se aspira a lograr el mismo nivel de configuración de otras redes, hace falta un instituto que brinde un sólido conocimiento.

Tabla R-5: Puntaje de los factores de construcción de capacidades, a nivel de la red

Factor / Red por país	Costa Rica (Wai, Hel, Pan, Maf)	Guatemala (Ven, REA)	El Salvador (Mob, Kon)	CR (Ben)		CR (AvN)	Guatemala (Tur, Inm, Exc)	ES (ELJ)
ESTABLECIMIENTO DE LA RED								
19. Percepción de las metas comunes	B	D	C	D		B	B	C
20. Actores clave	C	C	C	C		C	B	C
21. Ganancia para todos los actores	B	C	D	C		B	B	B
22. Aprendizaje común	C	C	C	C		C	B	C
23. Distribución equitativa de poder	C	D	C	B		C	B	B
24. Confianza e interdependencia básicas	B	C	C	B		B	C	C
25. Lazos fuertes y débiles	B	C	B	C		B	B	D
26. Comunicación adecuada	C	C	D	C		C	C	C
CONFIGURACIÓN								
27. Conformidad de la configuración y metas	B	D	C	B		B	B	C
APRENDIZAJE								
28. Aprendizaje combinado (teórico/práctico)	B	C	C	C		B	B	D
29. Aprendizaje organizacional	B	D	D	C		B	B	D
30. Ciclo de aprendizaje completo	B	D	D	C		B	C	D

Puntaje por factor				
	= Puntaje A (Total conformidad)	= Puntaje B (2/3 de conformidad)	= Puntaje C (1/3 de conformidad)	= Puntaje D (no conformidad)

Recomendaciones para dar seguimiento

El seguimiento de todas las actividades llevadas a cabo en el proyecto (status 2002) se presenta en la tabla R-6

Tabla R-6: Seguimiento de todas las actividades

Actividad	¿Continuaron del 2002 en adelante?	Grupos involucrados	Países
Seguimiento de Empresas muestra	Sí, en unas pocas empresas solamente.	Consultorías Industrias	Costa Rica, Guatemala
Seguimiento de la industria (fuera de las muestras)	Sí, industria alimenticia en Costa Rica Proyecto'Diseño sin fronteras' Guatemala	C, I, Investigación	CR, GUA
Proyectos nuevos (investigación)	No		
Desarrollo del Manual	No		
Actividades de entrenamiento	Sí, relacionadas con nuevos proyectos y Por NCPC	C.I	CR, GUA, El Salvador
Desarrollo curricular	Sí, en varias universidades	Investigación	CR, GUA, ES
Cooperación universitaria	Planeada, pero no hay actividades aún		CR, GUA
Eco-indicadores	No		
Talleres nacionales o conferencias	No		
Premio de Ecodiseño	Sí, integrado dentro del esquema de premiación de CCAD	C, I, Gobierno, Financieras	Regional
Página WEB	Sí	Consultorías, Gobierno	CR

A fin de estimular más y avanzar con las actividades de seguimiento se necesita que de las redes locales surja un plan para hacer una selección estratégica de las iniciativas futuras. La primera prioridad es que las mismas redes deben ser reforzadas. Luego se debe prestar atención al tipo de desarrollos estratégicos deseables.

Un número de oportunidades de investigación centradas en el Ecodiseño en el área centroamericana surgen de este estudio:
- Ulterior investigación de proyectos en la industria sobre Ecodiseño (resultantes de la multiplicación y de la continuación de anteriores)
- Investigación similar con un grupo de control para investigar posteriormente temas de adopción
- Investigación adicional sobre el desarrollo de metodologías, enfatizando más las diferencias entre los enfoques "benchmarking" y de innovación para el desarrollo del producto, así como metodologías para proyectos de servicio y de sistema del producto.
- Estudio detallado del uso de metodologías en las empresas con relación a la adquisición de conocimiento y habilidades y aspectos culturales.
- Se recomienda la investigación de los factores que causan una falta de desarrollo concurrente de productos y mercados y posibilidades para mejorar este aspecto.

- Investigación sobre cómo pueden las empresas integrar el enfoque al producto dentro de sus sistemas de gerencia ambiental..
- Investigación dentro de la empresa sobre los enfoques producto-servicio y sistemas de productos
- Investigación sobre el mejoramiento del trabajo en red y del aprendizaje social en las redes locales
- Un *estudio de políticas* breve sobre las posibilidades de desarrollar un marco de políticas de apoyo efectivas para el Ecodiseño en la región.

Los proyectos de Ecodiseño posibles en la industria dependen de los objetivos de los patrocinadores internacionales y de los programas para la industria, tanto nacionales como regionales. Aunque el Ecodiseño puede resultar apropiado dentro de varias líneas de programas, incluyendo sostenibilidad, innovación, y competitividad, los éxitos aislados en la obtención de fondos para proyectos no conducirán a un sistema coherente de iniciativas de Ecodiseño. Además, la búsqueda de fondos para Ecodiseño tiene mejores oportunidades si se lleva a cabo en combinación y sinergia con otros aspectos de la sostenibilidad. Una línea importante de posible integración es junto a otros enfoques de innovación. Una segunda línea de integración, en el campo de aspectos de sostenibilidad podría ser una ulterior integración con enfoques de Producción más limpia. Una tercera línea de integración podría ser vincular las actividades de Ecodiseño con la Agenda de Competitividad Regional (INCAE, 1999).

Samenvatting: Ecodesign in Midden-Amerika

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Introductie

Dit proefschrift beschrijft en analyseert het veranderproces dat is gestart door het project 'Ecodesign in Midden-Amerika', uitgevoerd tussen 1998 en 2002. Het project maakte eerst gebruik van het concept end e praxis voor ecodesign zoals dat in Europa is ontwikkeld. Dit concept werd succesvol opgenomen door de negen deelnemende bedrijven en de projectpartners. Met deze ervaring werd het concept vertaald en aangepast tot een regionale aanpak voor Midden-Amerika. Gedurende de tweede fase lag de nadruk op lokaal leiderschap, netwerkontwikkeling en leren door professionals in de industrie en op universiteiten. In de industrie verschoof de nadruk van één product naar sector, keten en service benaderingen.

Het niveau van milieumaatregelen in de industrie in Midden-Amerika is over het algemeen laag. Bezorgdheid over de situatie neemt wel toe, en de noodzaak om milieu op te nemen in de bedrijfsstrategie wordt langzaam onderkend. Schoner Produceren projecten worden sinds 1995 uitgevoerd, dit ecodesign project was het eerste project gericht op product en milieu. Ecodesign – het ontwikkelen van eco-efficiënte of meer duurzame producten – wordt wereldwijd al in veel bedrijven toegepast. De Technische Universiteit Delft was in veel van deze projecten betrokken en ondersteunt projecten in ontwikkelingslanden. Samen met CEGESTI in Costa Rica is het regionale project 'Ecodiseño Centro-America' opgezet, grotendeels gefinancierd door de Nederlandse Ambassade in Costa Rica. Het doel van het project was de milieuaspecten te verbeteren van producten die worden ontworpen door het lokale midden- en kleinbedrijf, om zo het ecodesign concept te testen en aan te passen voor de regio. Belangrijkste doelstellingen van de eerste twee jaar van het project waren uitvoering van demonstratieprojecten, opbouw van regionale capaciteit en bewustzijn. Toen de mogelijkheid zich voordeed van een verlenging van twee jaar, kwamen daar als doelstellingen bij uitbreiding van product naar keten- sector en service benaderingen, en aparte activiteiten gericht op de drie deelnemende landen. De methodologie gebruikt in de eerste fase is de UNEP Ecodesign handleiding, waarin een stappenplan voor een ecodesign project in een bedrijf is beschreven. Belangrijke resultaten en producten van het project zijn:

- een regionale Spaanse handleiding voor ecodesign

- 14 ecodesign case studies in bedrijven, rapporten en fact sheets
- een regionale conferentie over ecodesign
- meer dan 20 ervaren ecodesign adviseurs, meer dan 50 getrainde professionals
- een regionale ecodesign prijs, die om de twee jaar wordt georganiseerd.

Probleemstelling en focus

Middels actie-geïntegreerd case studie onderzoek proberen we in deze studie het proces van introductie van ecodesign in Midden-Amerika te beschrijven en analyseren, waarbij het Ecodesign project als empirisch veldwerk wordt gebruikt. Er zijn enkele vernieuwende elementen in dit onderzoek: Ontbreken van externe drijfveren zoals wetgeving betekent dat bedrijfsinterne factoren veel belangrijker zullen zijn dan in Europa. Ecodesign zal worden bestudeerd als een speciaal geval van normale innovatie, met als extra de milieufocus. Voor veel bedrijven zal het ook de eerste ervaring met een gestructureerde aanpak voor productontwikkeling zijn. De gebruikte Europese methodologie moet worden aangepast aan de lokale situatie – dit is een van de eerste projecten waar de methode systematisch wordt getest en geëvalueerd. Voor het opbouwen van de benodigde capaciteit voor ecodesign is dit het eerste project in een industrialiserende regio waar dit een expliciet onderwerp van studie is. De focus van deze studie ligt op drie thema's: adoptie van ecodesign in de case studie bedrijven, facilitering van de methodische aanpak en capaciteitsopbouw door het betrekken van belangrijke organisaties in de regio. De centrale onderzoeksvragen zijn:

1. Hoe succesvol is de *adoptie* en implementatie van ecodesign door de bedrijven in Midden-Amerika die deelnamen aan het project, en wat zijn de sleutelfactoren die dit beïnvloeden?
2. Is de *facilitering* van ecodesign – zowel ondersteuning in de bedrijven als opleiding van de adviseurs – succesvol en lokaal gedragen?
3. Is er blijvende *capaciteit* opgebouwd in Midden-Amerika om ecodesign activiteiten te continueren en uit te breiden ?

Op basis van deze centrale vragen zijn initiële onderzoeksvragen geformuleerd. Deze zijn verder uitgewerkt na bestudering van de literatuur (en worden verderop in de samenvatting weergegeven). Een initieel onderzoeksmodel is ontwikkeld waarin adoptie, facilitering en capaciteitsontwikkeling de afhankelijke variabelen zijn (zie figuur 2-1 van hoofdstuk 2).

De theorievelden die worden gekozen voor nadere analyse zijn: Innovatietheorie, ecodesign theorie en praktijk, netwerk- en leertheorie. Het proces van adoptie door het bedrijf wordt beïnvloed door verschillend interne en externe factoren (onafhankelijke variabelen) zoals bedrijfsinterne kenmerken, externe drijfveren en barrières, omgevingsvariabelen zoals de economische en beleidscontext. Facilitering wordt beïnvloed door factoren zoals de bestaande methodologie, de resultaten van de case studies en de bestaande en nieuwe capaciteit in de regio. Capaciteitsontwikkeling wordt beïnvloed door de beschikbaarheid en bereidheid van betrokken partijen, de beleidscontext en de invloed van de projectresultaten.

Ontwerp van het onderzoek

Vanuit de context van studie lijkt een case studie (gevalsstudie) benadering het meest geschikt om de industriële en maatschappelijke cases te analyseren en te vergelijken met het theoretische kader. Deze aanpak is actiegericht, waarbij de interventies die zijn toegepast in het project geanalyseerd worden en van daar uit aanbevelingen worden gedaan. Een vergelijkende case studie aanpak is gekozen, waarbij een aantal cases geselecteerd en geanalyseerd zijn op overeenkomstige resultaten - of juist verschillende resultaten, maar dan om voorspelde redenen. In totaal zijn 14 bedrijfscases geanalyseerd op ecodesign adoptie. Voor facilitering en capaciteitsontwikkeling zijn de cases verdeeld in twee keer drie nationale cases. Voor case studie onderzoek is theorieontwikkeling vooraf essentieel. Dit is een soort blauwdruk voor de studie, en heeft een gidsfunctie voor het bepalen van onderzoeksvragen en dataverzameling. Voor het thema ecodesign in Midden Amerika zijn een aantal theorievelden relevant die allemaal een deel van dit complexe onderwerp belichten. Deze velden zijn bestudeerd en een selectie van de meest illustratieve theorieën is verder ontwikkeld in onderlinge samenhang. Een aantal factoren voor analyse zijn geformuleerd en toegepast op de resultaten van adoptie in de bedrijfscases en de faciliterings- en capaciteitsopbouw-cases. Omdat er in deze studie directe interventies in de cases zijn gedaan, heeft de studie ook elementen van actieonderzoek: probleemgericht, de cliënt centraal stellend, de status-quo ter discussie stellend, en tegelijkertijd gericht op empirisch toetsbare uitspraken.

Voor een complex onderwerp als de introductie van ecodesign in een regio, is de notie van 'soft systems' denken nuttig. Soft systems methodologie is gericht op het tot stand brengen van verbeteringen op terreinen waar maatschappelijk bezorgdheid over bestaat, door de betrokkenen in een altijd doorgaand leerproces te brengen' (Bulow 1989).

De kwaliteit van het onderzoek is getoetst op een aantal positivistische en constructivistische eisen:

- construct validiteit: zijn de juiste operationele maatregelen geselecteerd voor de onderwerpen die bestudeerd worden?
- Interne validiteit: zijn de patronen of relaties die we zien en concluderen in de analyse echt en niet het gevolg van een andere factor die we niet in beschouwing hebben genomen?
- Externe validiteit: vaststellen van het domein waarop de bevindingen van de studie generaliseerbaar zijn.
- Betrouwbaarheid: aantonen dat de verrichtingen in het onderzoek (zoals de procedure van dataverzameling) herhaalbaar zijn met dezelfde resultaten.
- Geloofwaardigheid: kan worden aangetoond dat de realiteit van de betrokkenen dezelfde is als die in de studie aan ze toegeschreven wordt?
- Eerlijkheid: zijn de constructies gemaakt in de studie duidelijk voor en bevestigd door de betrokkenen?
- Authenticiteit: hebben de betrokkenen de mogelijkheid gekregen te handelen, en leren ze gedurende het proces?

De conclusie van deze toetsing was dat het ontwerp van de studie een hoge kwaliteit heeft.

Hoewel in werkelijkheid vele iteratieve stappen in het project zijn gemaakt, wordt voor de duidelijkheid van deze thesis de lineaire logica van een theorie-gebaseerde verklarend en explorerend case studie benadering gevolgd: *Ontwikkel theorie – voer de case studies uit – analyseer de cases – trek conclusies en koppel terug naar theorie en doe aanbevelingen*. Dit leidt tot de vier delen van deze studie: Deel I Introductie – Deel II Theorie - Deel III Case studie resultaten – Deel IV Analyse en conclusies.

Innovatie en Ecodesign theorie

Innovatie, "het proces van ingebruikname van een nieuw, probleemoplossend idee" is een omvattend concept dat wordt gebruikt in verschillende betekenissen. De theorie ervan varieert van economische theorie, adoptie en diffusie theorie, management theorie tot marketing theorie. Deze studie richt zich op twee paradigma's: technologische en marktgeoriënteerde innovatie. De gepresenteerde theorie is vooral van toepassing op de onderzoeksvariabele *adoptie van ecodesign*. Het model voor productontwikkeling van Roozenburg en Eekels (1995) staat centraal in de cases, omdat dit model ook het hart van de gebruikte Ecodesign handleiding vormt. Analyse van het gebruik van dit model geeft duidelijkheid over het niveau van systematische productontwikkeling, en op het niveau van gelijktijdige technologische en marktontwikkeling. Het geschakelde model voor innovatie (Kline en Rosenberg 1986) laat ons de verschillende niveaus van informatie en kennisgebruik in de bedrijven analyseren. Dit is verbonden met het gegeven dat kopiëren van bestaande producten de belangrijkste vorm van productontwikkeling is, waarvoor gebruik van informatie van concurrenten en bedrijven buiten de eigen regio essentieel is (Romijn 1996). De invloed van intermediairen en andere betrokkenen op het innovatieproces is door verschillende auteurs benadrukt (Buys 1987, van Hemel 1998). Actief zoeken naar informatie buiten het eigen bedrijf is daarom een belangrijke factor voor innovatie. In de typologie van innovaties van Miller en Morris (1999) kunnen we vooral continue innovaties verwachten. Bedrijven beginnen voorzichtig met ecodesign, en zullen eerste een bestaand product herontwerpen. Rogers' model voor adoptie van innovaties (1995) wordt geldig geacht voor de bedrijven cases. De mate van adoptie bereikt is een indicatie voor de acceptatie van ecodesign, en van de mogelijkheden voor succes van het project. Het diffusie model van Rogers is in ons geval minder bruikbaar, omdat deze diffusie op veel meer berust dan een optelsom van individuele adoptieprocessen. Daarom is de literatuur van evolutionaire innovatie bestudeerd, waaruit het belang van innovatiediffusie netwerken naar voren komt (Nelson en Winter 1982, Mulder 1992, Silvester 1996). Hieraan gerelateerd is de notie dat de institutionele omgeving het verander- en innovatiegedrag van een bedrijf beïnvloedt (Powell en Dimaggio 1991).

Ecodesign is in deze studie gedefinieerd als het 'ontwerpen van producten, processen of systemen, gericht op de gehele levenscyclus van het product, met als doel het minimaliseren van de veroorzaakte milieuschade'. Het bevindt zich in het midden van het gehele spectrum aan benaderingen voor milieuverbetering van product-service systemen. Een factor 2 vermindering van milieuschade is het maximum dat doorgaans met ecodesign wordt bereikt. Voor meer reductie wordt gesteld dat een service en systeembenadering noodzakelijk is, maar ervaringen tot nu toe laten zien dat dit complexer is dan gedacht.

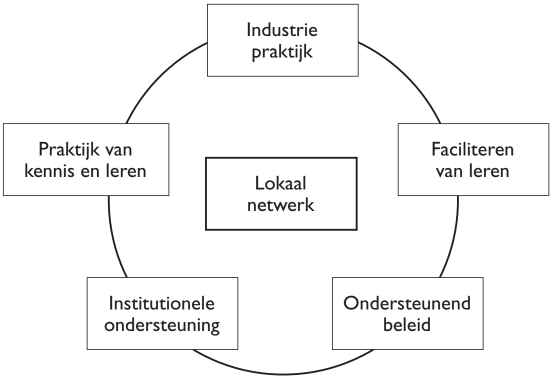
De stimuli en eigenschappen (bedrijfsintern en extern) die ecodesign bevorderen, zoals die door van Hemel (1998) beschreven zijn, zijn relevant voor onze cases. Veel van deze factoren worden ook in andere studies gevonden, zoals milieuverbetering, marktvraag, wetgeving en regulering en economische factoren zoals kostenreductie. Ook de eigenschappen van de directeur/eigenaar van het bedrijf zijn belangrijk voor de analyse.

Theorie over faciliteren en leren

In de praktijk van de eerste fase van het Ecodesign project in Midden-Amerika is de UNEP handleiding voor ecodesign (Brezet en van Hemel 1997) gebruikt. Baumann et al. (2001)noemt deze handleiding het standaardwerk voor ecodesign. De handleiding omvat richtlijnen voor de organisatie van een project, checklists, richtlijnen en analyse-instrumenten. Diehl en Brezet (2003) analyseerden 18 andere handleidingen en vonden veel van de instrumenten uit de UNEP handleiding terug. De handleiding volgt het gangbare traject voor productontwikkeling: beleidsontwikkeling – doelvinding – strikte ontwikkeling – realisering. Ook wordt zoveel mogelijk aangesloten bij de aanpak voor Schoner Produceren, om zo integratie van proces- en productbenaderingen te vergemakkelijken. Naast de stapsgewijze aanpak bevat de handleiding een aantal hulpmiddelen zoals de eco-portfolio matrix voor de productkeuze, de MET matrix (Materialen Energie en Toxische stoffen) voor een snelle milieuanalyse en het LiDS (Life Cycle Design) wiel voor het genereren van verbeteropties.

Uit theorie van CDE (Capaciteitsontwikkeling voor Milieu) en Technologie Transfer wordt duidelijk, dat faciliteren moet zijn aangepast aan lokale omstandigheden, en dat lokale projectpartners geleidelijk de leiding van het project op zich moeten nemen om ecodesign in hun industrie te implementeren. Om dat te kunnen, moet de methodologie zoveel mogelijk 'unpackaged' – uitgepakt – geïntroduceerd worden, dat wil zeggen dat lokaal die gedeelten moeten worden gebruikt die passen bij de omstandigheden, en dat tevens lokale kennis moet worden toegevoegd. Om ecodesign goed te kunnen faciliteren bij bedrijven, moet er een toegesneden configuratie van betrokken instanties worden opgebouwd op lokaal niveau. Gezien de achtergrond van het project zal dit in eerste instantie door sponsoren en onderzoeksinstellingen geleid worden. Leren is het verwerven van impliciete en expliciete kennis. Deze kan op velerlei wijze verworven worden, zoals door studie, instructie, praktijk of ervaring. Het omvat operationeel en conceptueel leren. Een andere indeling is 'single loop (enkelvoudig) en 'double loop' (teruggekoppeld) leren. Al deze vormen doen zich voor bij leren over ecodesign. De handleiding is een vorm van expliciete kennis, die kan worden gecombineerd met de bestaande impliciete kennis in het bedrijf. Ook omvat het zowel operationeel leren van de aanpak als conceptueel leren van de bedoeling, achtergrond en management van het proces, voor verschillende geledingen in het bedrijf. Om door het hele bedrijf organisatorisch leren mogelijk te maken moeten tevens randvoorwaarden zoals financiën, tijd, mogelijkheden en bedrijfscultuur in beschouwing worden genomen.

Een aantal centrale kenmerken voor lokale netwerken zijn gedefinieerd, waaronder doelstellingen, betrokkenheid relevante organisaties en personen, macht en invloed, wederzijds vertrouwen en communicatie. Hiermee kan in deze studie de kwaliteit van de nieuwe, zich ontwikkelende lokale (= nationale) netwerken worden geanalyseerd. Een model is ontwikkeld dat elementen van netwerken en leren verbindt (zie figuur S-2), het model onderscheidt een aantal niveaus waarop leren plaats kan vinden en die in onderlinge samenhang geanalyseerd kunnen worden.



Figuur Sv-1: Model voor leren in lokale netwerken (naar Röling en Jiggins 1998)

Onderzoeksmethode

De drie variabelen adoptie, facilitering en capaciteitsontwikkeling worden beïnvloed door een groot aantal onafhankelijke variabelen. Centrale stellingen uit de relevante theorieën zijn in 30 onderzoeksfactoren geformuleerd. Deze factoren zijn als volgt semi-kwantitatief geoperationaliseerd om de data van de case studies te analyseren: Voor iedere factor is een gedetailleerde onderzoeksvraag geformuleerd – zie tabel 1. een scoringssysteem van vier categorieën is voor iedere factor aangegeven, waarbij de verdeling zo gekozen is dat het in de verwachting ligt dat er verschillen in score zullen optreden tussen de cases. De factoren zijn gegroepeerd per onderzoeksvraag Q1 – Q10 (zie tabel Sv-1).

Tabel Sv-1: Onderzoeksvragen (Qs) en daaraan verbonden detailvragen over de factoren (Fs)

ADOPTIE:
Q1) Hoe verloopt het proces van adoptie van ecodesign – gezien als een productinnovatie proces – in bedrijven in Midden-Amerika?
F1. Hoe goed gebruikt het bedrijf de verschillende lagen van kennis die nodig zijn voor productinnovatie?
F2. Omvat het innovatieproces zowel technologische als marktontwikkeling?
F3. Zoekt het bedrijf actief naar informatie in zijn omgeving?
F4. In welke adoptiefase bevindt het bedrijf zich voor ecodesign?
F5. Maakt het bedrijf deel uit van een innovatie-diffusie netwerk?
F6. Gebruikt het bedrijf benchmarking strategieën om de markt te betreden?
Q2) Zijn de ecodesign projecten in de bedrijven een succes, gaan de bedrijven ermee door en verspreid de aanpak zich naar andere bedrijven?
F7. Welke verbeterfactor is bereikt?
F8. Op welke schaal heeft het bedrijf ecodesign uitgevoerd?
F9. Is ecodesign in het managementsysteem geïntegreerd?
F10. Is het bedrijf doorgegaan met volgende ecodesign projecten?
Q3) Wat zijn de interne sleutelfactoren die de adoptie van ecodesign beïnvloeden?
F11. Heeft het bedrijf de volgende vier interne karakteristieken: kostenbesparing, image, milieuvoordeel, positieve grondhouding?
Q4) Wat zijn de omgevingsfactoren die de adoptie van ecodesign beïnvloeden?
F12. Wordt het bedrijf gestimuleerd door: wetgeving, marktvraag, vraag van afnemers?
FACILITERING:
Q5) Hoe is de oorspronkelijke ecodesign methodologie gebruikt?
F13. Gebruikt/accepteert het bedrijf de gestructureerde aanpak (volledig of vereenvoudigd)?
F14. Gebruikt het bedrijf de MET en LiDS instrumenten en hebben ze de informatie hiervoor?
F15. Zijn er oplossingen voor de ontwerpstrategieën gevonden (8 LiDS opties)?
Q6) Welke elementen van de ecodesign aanpak kunnen worden verbeterd voor gebruik in Midden-Amerika?
F16. Voegt het bedrijf eigen instrumenten toe aan de aanpak?
Q7) Hoe verloopt de overgang naar locale facilitering? Is het optimaal?
F17. Is het programma in samenwerking uitgevoerd, waarbij de locale partners geleidelijk de leiding nemen?
F18. Zijn de programmastappen 'ontwerp, initiatie, implementatie, monitoring en evaluatie' uitgevoerd?
CAPACITEITSOPBOUW:
Q8) Hoe verloopt het proces van capaciteitsopbouw en bewustzijn over ecodesign in Midden-Amerika?
Q9) Wat zijn de belangrijkste betrokken partijen in dit proces en wat is hun rol?
Q10) Is de opbouw van capaciteit en bewustzijn een succes? Moet het geoptimaliseerd worden?
F19. Hebben alle netwerkleden overeenkomende doelen? ?
F20. Zijn alle belangrijke actoren vertegenwoordigd in het netwerk?
F21. Hebben alle actoren iets te winnen bij deelname aan het netwerk?
F22. Kunnen leden van elkaar leren in het netwerk?
F23. Is de invloed/macht redelijk verdeeld en voor iedereen duidelijk?
F24. Is er een basisvertrouwen in elkaar?
F25. Zijn er naast intensieve kontaken in het netwerk ook voldoende lijnen naar buiten?
F26. Wordt er helder gecommuniceerd?
F27. Past de configuratie van het netwerk met de doelen en activiteiten?
F28. Vindt er 'double loop' leren plaats in organisaties van het netwerk?
F29. Vindt er organisatorisch leren plaats?
F30. Wordt er geleerd op alle niveaus van het systeem?

Het oorspronkelijke onderzoeksmodel is vervolgens voor alle drie afhankelijke variabelen verfijnd op basis van de selectie van de onafhankelijke variabelen en hun onderlinge relatie. De lineaire voorstelling van figuur 1 is aangepast in een voorstelling van de factoren in een aantal concentrische cirkels rond de afhankelijke variabelen, om zo beter de complexiteit, de verschillende niveaus en de onderlinge samenhang tussen de factoren weer te geven. Dit model, dat is weergegeven in figuur 6-5 in hoofdstuk 5, is kwalitatief en beschrijvend van aard, en dient als hulpmiddel voor de verdere structurering van de analyse.

De wijze van analyse in deze studie is een vorm van 'patroonherkenning'(Yin 1994). In het verklarende onderzoeksdeel van ecodesign adoptie worden de empirisch vastgestelde patronen geconfronteerd met de verwachtingen uit theorie en praxis. De mate van adoptie en de invloed van de onafhankelijke variabelen kunnen dan onderling tussen de cases worden vergeleken. Bij de meer beschrijvende onderzoeksdelen van facilitering en capaciteitsopbouw worden op basis van de case studie bevindingen redeneringen opgezet die betrekking hebben op stellingen uit de theorie, die meer inzicht in en uitleg van bepaalde verschijnselen in de cases kunnen leveren. Naast patroonherkenning wordt ook een meer kwalitatieve en verhalende analyse van aanvullende data en inzichten uit de cases uitgevoerd.

Resultaten adoptie case studies in de bedrijven

Relevante sectoren en daarbinnen geschikte bedrijven zijn geselecteerd op basis van criteria, in drie landen in de regio – Costa Rica, Guatemala en El Salvador. 9 projecten zijn uitgevoerd in de eerste fase (1998-1999). Voor de tweede fase (2000-2002) heeft het projectteam besloten meer nadruk te leggen op functioneel en systeem niveau en op ketenbenaderingen. Dit vergroot de mogelijkheden voor milieuverbetering en de economische haalbaarheid. 5 projecten zijn uitgevoerd, een bij een toeristisch bedrijf dat wildwater rafting trips aanbiedt in Costa Rica (service aanpak), drie metaalbedrijven in Guatemala (sector aanpak) en een hacienda in El Salvador (zuivelproduktie en producten – ketenaanpak). De nadruk op toerisme en agro-voedsel is in overeenstemming met de Regionale Agenda voor Competititiveit (INCAE 1999). De bedrijven en producten staan weergegeven in tabel Sv-2.

De ecodesign cases zijn een succes. In de meeste bedrijven zijn producten herontworpen. In al die gevallen is milieuverbetering bereikt. Meestal scoren de producten tussen 10 en 20 % verbetering, twee producten behaalden 50% verbetering, wat een goed resultaat is. De kwaliteit van de meeste producten is ook verbeterd. Foto's van de producten zijn te vinden in hoofdstuk 7 en Annex A.

In 2001 is er contact geweest met de eerste 9 bedrijven om na te gaan wat er na het project gebeurd is. Onderzocht is onder andere:

- Is het product op de markt geïntroduceerd (alle 14 bedrijven) ?
- is het product of een opvolger nog op de markt?
- Heeft het bedrijf organisatorische capaciteit opgebouwd voor ecodesign projecten?

In tabel Sv-2 staan de resultaten weergegeven.

Tabel Sv-2 Bedrijven, producten en marktintroductie van de producten.

Bedrijf	Land	Product	Resultaat	Capaciteit ecodesign
Waiman	Costa Rica	Koelkast	Op de markt	Nee
Heliconia	Costa Rica	Export verpakking bloemen	Op de markt	Ja
Panel-ex	Costa Rica	Bureau	Prototype	Nee
Mafam	Costa Rica	Verpakking en distributie koekjes	Prototype	Nee
Venus	Guatemala	Verpakking en distributie snoepjes	Op de markt	Ja
REA	Guatemala	Koffieproductie machine	Op de markt	Ja
Mobelart	El Salvador	Keukenblok	Op de markt	Ja
Kontein	El Salvador	Plastic fles	Prototype	Ja
Bendig	Costa Rica	Koffieproductie machine	Op de markt	Ja
Av. Naturalis	Costa Rica	Rafting trip	Op de markt	Ja
Turbomac	Guatemala	Huishoud fornuis	Op de markt	Ja
Inmepro	Guatemala	Industrieel fornuis	Gepland	Ja
Executiv	Guatemala	Bureau	Alleen ontwerp	Nee
El Jobo	El Salvador	Room	Op de markt	Nee

Resultaten facilitering en capaciteitsopbouw cases

De ecodesign aanpak in de eerste fase is intensief begeleid, onder andere door:
Start workshop met managers van een aantal van de bedrijven

- 1 of 2 daagse workshop bij het bedrijf met het project team en personeel
- regelmatige bijeenkomsten met het projectteam van CEGESTI, TU Delft en de lokale partners
- Afstudeerproject van een student Industrieel Ontwerpen uit Delft – project van 6 maanden, waarvan 2 maanden voorbereiding in Nederland
- 1 dag afsluitende workshop in het bedrijf
- afstudeerrapport van de student, 2 maanden na afsluiting van het project.

De aanpak van de UNEP handleiding is in alle bedrijven van de eerste fase gebruikt. Alle bedrijven hebben een benchmark/kopieer aanpak voor productontwikkeling. Voor alle bedrijven was het de eerste keer dat ze milieuaspecten hierin meenamen.
De algemene instrumenten uit de handleiding konden worden gebruikt. Ook de ecodesign instrumenten MET en het Strategiewiel (LiDS) zijn toegepast, al was het moeilijk detailinformatie te vinden. Vereenvoudigde instrumenten zijn ontwikkeld en toegepast, zoals checklists, vuistregels en vragenlijsten.

Voor de facilitering van de tweede fase is een overgang gemaakt naar lokaal leiderschap en leren. Een regionale Spaanstalige handleiding is ontwikkeld op basis van de UNEP handleiding, aangepast aan lokale omstandigheden. In de eerste fase waren een beperkt aantal professionals van de partner-organisaties opgeleid, maar het aandeel van externe ondersteuning bleef hoog. Daarom zijn in de tweede fase 38 jonge professionals uit industrie en universiteiten opgeleid, en hieruit zijn de nieuwe projectpartners geselecteerd. Zij hebben voorstellen voor projecten ingediend, en op basis van deze competitie zijn projecten en de partners uitgekozen. Daarnaast zijn meer lokale studenten en minder Nederlandse studenten in de projecten betrokken.

Activiteiten voor capaciteitsopbouw in de eerste fase waren gericht op de directe projectpartners. Centrale activiteit was een train-de-trainer cursus in Delft. Daarnaast zijn contacten gelegd met meer dan 20 organisaties in de regio die een belangrijke rol in de verspreiding van ecodesign kunnen hebben. Op 28 en 29 Oktober 1999 is een regionale conferentie met meer dan 100 deelnemers georganiseerd in San José, Costa Rica (CEGESTI 1999). Hierin zijn de resultaten van de eerste fase gepresenteerd aan alle betrokkenen en geïnteresseerden, en is de discussie opgestart over toekomstplannen en activiteiten voor ecodesign.

In de tweede fase was capaciteitsopbouw gericht op het opzetten van lokale netwerken in de drie landen. De competitie om projectpartner te worden (zie boven) was hier een onderdeel van. Actieve betrokkenheid van universiteiten in de netwerken is een andere belangrijke ontwikkeling, zowel via directe betrokkenheid van studenten als via het integreren van ecodesign in curricula. In elk van de drie landen is een Nationale workshop over ecodesign gehouden. Daarnaast zijn een aantal ondersteunende deelprojecten uitgevoerd: een survey naar het gebruik van eco-indicatoren in de regio, de organisatie van een regionale ecodesign prijs voor de industrie, een regionale webpage en andere elektronische communicatie. Tegen het eind van de projectperiode zijn al verschillende nieuwe activiteiten op het gebied van ecodesign gestart, zoals een project in de voedingsmiddelensector in Costa Rica, het project 'Design Without Borders' (met Noorse ondersteuning) in Guatemala en cursussen en training door de NCPCs.

Analyse en conclusies van ecodesign adoptie

De resultaten van de ecodesign adoptie cases in bedrijven zijn geanalyseerd met behulp van het onderzoeksmodel en door verdere kwalitatieve analyse van de gegevens. Als eerste stap hiervoor zijn alle individuele cases geanalyseerd op de factoren die hierop van toepassing zijn (F1 -12). Vervolgens zijn de cases van de eerste en van de tweede fase als groep geanalyseerd, naast de onderzoeksfactoren ook kwalitatief. Verschillen tussen de twee groepen zijn ook geanalyseerd. De scores van de individuele bedrijven zijn weergegeven in tabel 9-2 in Hoofdstuk 9. Enkele algemene bevindingen zijn de volgende. Vanuit een milieustandpunt bezien gebruiken de nieuwe producten minder materialen, en zijn daardoor goedkoper, en in een aantal gevallen efficiënter te produceren. Ook hebben sommige producten minder milieubelasting tijdens de gebruiksfase, en in twee gevallen is het distributiesysteem minder milieubelastend. De milieuwinst ligt tussen 10 en 50% vergeleken met het referentieproduct, wat vergelijkbaar is met resultaten verkregen in de eerste Nederlandse Ecodesign project, het PROMISE project (te Riele en Zweers 1994). De producten in Midden-Amerika zijn in relatief korte tijd herontworpen, meestal binnen 4-5 maanden waar dat in Nederland gemiddeld een jaar duurde. Redenen hiervoor zijn de relatief grote mogelijkheden tot verbetering, de meer directe stijl van management (de directeur/eigenaar beslist) en ook het strikte tijdspad voor de afstudeerders, waardoor de bedrijven de prototypes snel moesten produceren.

De meeste projecten behelzen herontwerp van een bestaand product, met relatief kleine wijzigingen ten opzichte van het referentieproduct. Eén product, de koffie depulper van REA is een nieuw product vergeleken met zijn voorganger. Ook het bureau van Panel-ex en de medicinale fles van Kontein zijn nieuwe prototypes. Systeem benaderingen vonden plaats bij Aventuras en El Jobo, en ook het REA product kan gezien worden als het eerste element van een nieuw systeem.

Op basis van de analyse kunnen de volgende conclusies getrokken worden in antwoord op onderzoeksvragen Q1-Q4.

Q1 – Hoe verloopt het proces van adoptie van ecodesign – gezien als een productinnovatie proces – in bedrijven in Midden-Amerika?

Het proces van ecodesign is in de meeste bedrijven van het type benchmarking/kopieer aanpak. Herontwerpen naar voorbeeld van bestaande producten in de regio of uit Europa of de VS.Het gebruik van kennis en informatie is gericht op die informatie die nodig is voor het 'horizontale' productontwikkelingsproces in het bedrijf zelf, aangevuld met extra informatie over de producten van de concurrentie. Wat betreft de planning van ontwikkeling van product en markt (Roozenburg en Eekels 1999) kan worden gesteld dat een volgtijdelijke ontwikkeling plaatsvindt, eerst het product, daarna de markt. In de typologie van Rogers (1995) kan gesteld worden dat alle bedrijven tot de fase van kennisname over ecodesign zijn gekomen en overtuigd zijn geworden de aanpak tenminste een keer te proberen. Negen bedrijven zijn tot de beslisfase gekomen. Zes daarvan tot de bevestigingsfase, deze zijn doorgegaan met ecodesign of gerelateerde projecten. Betrokkenheid in innovatie-diffusie netwerken, in Europa als noodzaak gezien voor innovatieve bedrijven, kan niet worden gevonden in de case studie bedrijven. Blijkbaar is voor de benchmarking/kopieer aanpak deze betrokkenheid minder noodzakelijk.

Q2 – Zijn de ecodesign projecten in de bedrijven een succes, gaan de bedrijven ermee door en verspreidt de aanpak zich naar andere bedrijven?

Gezien als demonstratieprojecten zijn de cases een succes. Negen voorbeelden beschikbaar na 2 jaar, vijf meer na vier jaar, dit is een goed resultaat en vergelijkbaar met andere ecodesign projecten. (te Riele en Zweers 1994, Brezet en van Hemel 1997, Gertsakis et al. 1997). Vanuit milieuperspectief gezien zijn de projecten ook succesvol, met milieuwinsten tussen de 10 en 50%, doorgaans op factoren materiaalreductie. De projecten in de tweede fase scoorden vergelijkbaar met die van de tweede fase: de breder scope van deze projecten leidt niet automatisch tot hogere milieuwinst.

Autonome voortgang met ecodesign bij de bedrijven en integratie op strategisch management niveau is relatief beperkt. Dit komt deels door het eenmalige karakter van het project en de forse externe ondersteuning. Ecodesign in andere bedrijven vindt plaats in de vervolgactiviteiten.

Q3 – Q4 Wat zijn de interne en externe karakteristieken en factoren die de adoptie van ecodesign beïnvloeden?

Externe factoren die meestal erg belangrijk zijn in Europese context – wet- en regelgeving, marktvraag – ontbreken voor bedrijven in Midden-Amerika voor het grootste deel. Interne factoren zoals kostenbesparing, image, positieve grondhouding bestaan zeker wel, en vormen de belangrijkste factor voor het succes van ecodesign. Het behalen van milieuvoordeel als interne stimulus is in tegenstelling tot Europa geen factor van belang, en komt alleen voor in combinatie met bovengenoemde andere interne factoren.

Analyse en conclusies van ecodesign facilitering

De resultaten van facilitering zijn geanalyseerd met behulp van het onderzoeksmodel en door verdere kwalitatieve analyse van de (bedrijf en landen) case studies. Net als bij adoptie zijn eerst de individuele cases geanalyseerd en gescoord naar de onderzoeksfactoren F13 – F18. Deze scores zijn terug te vinden in tabel 10-2 van hoofdstuk 10.

Q5 – Hoe is de oorspronkelijke ecodesign methodologie gebruikt?

De focus op herontwerp en kopiëren is opgenomen in de nieuwe handleiding, en gekoppeld aan het bestaande stappenplan. Met deze aanpassing bleken de belangrijkste elementen van de UNEP handleiding goed bruikbaar en 'scenario vrij', dus zowel bruikbaar voor kopiëren als voor nieuw ontwerpen. De instrumenten in de handleiding waren allemaal nieuw voor de bedrijven. Ondersteuning bij het centrale instrument om verbeterstrategieën te genereren (het LiDS wiel) bleek nodig. Met deze steun is ook dit goed toegepast en heeft is ieder bedrijf tot minstens twee oplossingrichtingen voor het productherontwerp geleid – meestal in de categorieën materialenreductie, ontwerpen voor lange levensduur, en efficiëntere distributie.

Q6 – Welke elementen van de ecodesign aanpak kunnen worden verbeterd voor gebruik in Midden-Amerika?

Een aantal aanpassingen was nodig om de UNEP handleiding goed bruikbaar te maken in de regionale context, en zijn doorgevoerd in de regionale handleiding. Deze zijn:

- focus op interne stimuli
- meer nadruk op gestructureerde ontwerp proces
- benchmarking focus
- herontwerp focus
- vereenvoudigde instrumenten
- gebruik van regionale voorbeelden uit de eerste fase.

Het proces van het verder 'uitpakken' van de Europese methode is dus begonnen, en zal waarschijnlijk verder doorgezet worden. De projectpartners voegen meer lokale benaderingen in en veranderen schema's en instrumenten naar eigen inzicht.

Q7 – Hoe verloopt de overgang naar locale facilitering? Is het optimaal?

De overgang van de externe, internationale begeleiding in het begin van het project naar lokaal leiderschap aan het einde ging in twee fasen. In de eerst fase vond een overgang plaats van een 'Delft gedomineerde' situatie naar gemengd leiderschap van Delft en CEGESTI. Verdere overgang naar lokale partners was niet optimaal in deze fase. Daarom zijn in de tweede fase doelgericht lokale partners aan de leiding gekomen van de nieuwe projecten. Daarnaast is in die fase een bredere groep professionals opgeleid, en het kan worden geconcludeerd dat deze tweede ontwikkelingsfase grotendeels geslaagd is,. Landivar Universiteit nam de leiding in Guatemala, ondersteund door CEGESTI. In EL Salvador leidde AG-TECH de projecten, met een prominentere rol van CEGESTI.

Planning en ontwerp van de facilitering in het gehele programma en de n=individuele projecten was redelijk tot goed. Zwak punt hierbij blijft de monitoring en evaluatie door lokale partnerorganisaties.

Analyse en conclusies van capaciteitsopbouw.

Q8 – Hoe verloopt het proces van capaciteitsopbouw en bewustzijn over ecodesign in Midden-Amerika?

De analyse van capaciteitsopbouw is meer beschrijvend en exploratief van aard. In de eerste fase is een stakeholder analyse is uitgevoerd om de beste configuratie voor de tweede fase voor te bereiden. Vijf clusters zijn onderscheiden die ieder een functionele relatie met de industrie hebben:
- adviseurs en consultants: facilitering, technisch en management advies, projectontwikkeling
- kennisinstellingen: facilitering, innovatieonderzoek, informatieondersteuning
- Industrie organisaties: capaciteitsopbouw, projectontwikkeling, informatieondersteuning
- Overheid: wet- en regelgeving, ondersteunende maatregelen, capaciteit
- Financiële instellingen: financiering, ondersteuning projectontwikkeling

Hoewel alle clusters bij verschillende activiteiten in het project zijn betrokken, zijn met name overheid en financiële instellingen ondervertegenwoordigd.

De overgang naar een bredere netwerkbenadering voor capaciteitsopbouw vond plaats vanaf de regionale conferentie, eind 1999, en de gelijktijdige presentatie van de regionale handleiding. Gedurende de tweede fase lag de nadruk op vorming van lokale netwerken die ecodesign kunnen uitdragen. Verschillende nieuwe partner organisaties werden bij het project betrokken, om zo het netwerk te vergroten. Netwerkopbouw is een langzaam proces, zeker niet voltooid bij het afsluiten van het project.

Q9 – Wat zijn de belangrijkste betrokken partijen in dit proces en wat is hun rol?

De projectpartners waren de sleutelactoren in het proces van capaciteitsopbouw. Over het hele project genomen zijn dit met name TU Delft en CEGESTI, Landivar Universiteit en AG Tech en Don Bosco Universiteit. Van de zijde van de overheid neemt CCAD een vooraanstaande rol in, met name door het organiseren van een tweejarige regionale ecodesign prijs voor de industrie. Conclusie is, dat de basisconfiguratie gerelateerd aan het hele project een R&D georiënteerde configuratie is, met elementen van een sponsor configuratie. Kennisinstellingen zoals universiteiten spelen hierin dus een belangrijke rol, TEC in Costa Rica, Don Bosco in El Salvador en Landivar in Guatemala, met toevoeging van UCA en ITCA in de tweede fase in El Salvador.

Hoewel er een aantal pogingen gedaan zijn, is het direct betrekken van financiële instellingen bij het project niet gelukt. Wel gelukt is het betrekken van internationale samenwerkingsorganisaties: naast de Nederlandse ambassade zijn delen van het project gefinancierd door US EPA, US AID, en vindt informatie-uitwisseling plaats met het Duitse GTZ en het Noorse project 'Design Without Borders'.

Q10 – Is de opbouw van capaciteit en bewustzijn een succes? Moet het geoptimaliseerd worden?

Een eerst conclusie moet zijn dat er veel activiteiten op dit terrein zijn georganiseerd. Dat betekent dat van de doelgroep industrie een groot aantal bedrijven en professionals zijn bereikt. Enige cijfers (annex B, referenties 21-23):

- 50 getrainde professionals, waarvan 20 ecodesign adviseurs met ervaring
- regionale conferentie met 100 deelnemers
- workshops en lokale industrie bijeenkomsten, minstens 500 deelnemers totaal
- lezingen op verschillende universiteiten, waarbij vele honderden studenten en stafleden kennis hebben genomen.
- Opname van het onderwerp ecodesign in curricula
- Publiciteit, populaire en wetenschappelijke artikelen, deelname van 70 bedrijven in de ecodesign prijs
- Verspreiding van honderden exemplaren van de regionale handleiding.

Maar, informatie leidt niet vanzelf tot capaciteit. We hebben aangegeven dat hiervoor continue leren in lokale netwerken nodig is. De lokale netwerken die zich ontwikkeling zijn de kernen van leren en doen rond ecodesign. de kwaliteit van de netwerken bepaalt hun functioneren en de uiteindelijke resultaten voor ecodesign die daaruit voortkomen. In tabel 11-8, hoofdstuk 11, staan de scores voor de netwerken op onderzoeksfactoren F19-26. De netwerken zijn nog in een pril stadium, en de kwaliteit van alle netwerken kan en moet de komende jaren sterk verbeterd worden. De netwerken in Costa Rica en Guatemala zijn verder ontwikkeld dan in El Salvador. Als daar dezelfde configuratie nagestreefd wordt, ontbreekt daar nog een sterk kennisinstituut.

Aanbevelingen voor vervolg

De huidige situatie (status 2002) wat betreft vervolgactiviteiten staat weergegeven in tabel Sv-3

Tabel Sv-3: Vervolgactiviteiten per 2002

Activiteit	Voortgezet na 2002?	Betrokken clusters	Landen
Demo bedrijven Follow-up	Ja, in enkele van de bedrijven	Consultancy, Industrie	Costa Rica, Guatemala
Industriële follow-up (buiten demo)	Ja, in voedingsmiddelen ind. Costa Rica 'Design without borders' project GUA	C, I, Onderzoek	CR, GUA
Nieuwe projecten (onderzoek)	Nee		
Handleiding ontwikkeling	Nee		
Trainingsactiviteiten	Ja, gerelateerd aan nieuwe projecten en door NCPCs	C. I	CR, GUA, El Salvador
Curriculum ontwikkeling	Ja, verschillende universiteiten	O	CR, GUA, ES
Universitaire samenwerking	Gepland, nog geen activiteiten		CR, GUA
Eco-indicatoren	Nee		
Nationale Workshops of conferenties	Nee		
Ecodesign Prijs	Ja, geïntegreerd in prijzen CCAD	C, I, Overheid, Financ.	Regionaal
Webpage	Ja	C, Ov	CR

Om meer geavanceerde vervolgactiviteiten te stimuleren is het nodig dat de lokale netwerken strategische plannen maken voor toekomstige initiatieven. Eerst moeten deze netwerken zelf versterkt worden. Dan moeten er strategische keuzes gemaakt worden.

Een aantal mogelijkheden voor onderzoek in Midden-Amerika zijn:

- Verder onderzoek naar industrieprojecten (met name gericht op continuering en verspreiding)
- Vergelijkbaar onderzoek als de onderhavige studie met een controlegroep om adoptie issues verder te onderzoeken.
- Verder onderzoek in methodologie-ontwikkeling met de nadruk op benchmarking benaderingen versus innovatie benaderingen voor productontwikkeling, en methoden voor service en systeem projecten.
- Gedetailleerde studie naar het gebruik van methoden in bedrijven met betrekking tot kennis en informatiegebruik, aanleren van vaardigheden en culturele factoren.
- Onderzoek naar de factoren die het gebrek aan gelijktijdige markt- en productontwikkeling veroorzaken, en naar mogelijkheden dit te verbeteren.
- Onderzoek naar de wijze waarop bedrijven de ecodesign aanpak in hun milieumanagement kunnen integreren.

- Onderzoek naar de optimalisering van het netwerken en 'social learning' in de lokale netwerken
- Een beleidsstudie naar demogelijkheden om een effectief en ondersteunend beleidskader te scheppen voor ecodesign in de regio.

Mogelijke ecodesign projecten in de industrie hangen af van de doelstellingen van internationale sponsors en regionale industrie programma's. Hoewel ecodesign in verschillende programmatische lijnen past, zoals duurzaamheid, innovatie, concurrentiekracht, zullen individuele gefinancierde projecten niet leiden tot een samenhangend geheel van ecodesign activiteiten. Ook is er meer kans op financiering wanneer naar synergie met gerelateerde benaderingen gestreefd wordt. Grote kansen voor integratie zijn er met andere innovatie benaderingen. Andere mogelijkheden zijn integratie met Schoner Produceren of met activiteiten die plaatsvinden in het kader van de 'Regional Competitiveness Agenda' (INCAE 1999).

Annexes

Annex A: Fact sheets industrial case studies

Empresas:

- Industrias Bendig
- Heliconia del Caribe S.A.
- Industrias Mafam
- Möbelart
- Panel-ex
- Talleres REA
- Meubles y maderas Buenos Aires (ITCR proyecto)
- CIVCO (ITCR)
- Pizza Hut (ITCR)
- Material de desecho de la palma de pejibaye (ITCR)
- Fabrica Venus
- Industrias Waiman
- Kontein
- Aventuras naturalis
- El Jobo
- Turbomac
- Executiv
- Inmepro

Ecodiseño Centroamérica

Empresa: Industrias Bendig
País: Costa Rica
Productos: Maquinaria para beneficios de café
Proyecto: Ecodiseño de una oreadora de cascada

Beneficios:
- 20% reducción en utilización de materiales
- 20% reducción en tiempo de ensamble
- 30% de reducción en costos de fabricación
- Instalación, operación y mantenimiento más sencillos

El taller

La oreadora tradicional

Pre–secado del café en la oreadora

La empresa
Bendig es una empresa mediana que cuenta con 60 empleados. En total produce 60 tipos diferentes de maquinaria para la industria del procesamiento del café. El 75% de sus ventas se exporta a varios países y el 25% restante abastece al mercado nacional.

En Bendig se producen artículos especiales para empresas preocupadas por la conservación del ambiente y en la propia compañía se realizan esfuerzos para disminuir el impacto ambiental durante el proceso de producción. La empresa tiene un departamento de diseño formado por un equipo de cinco personas preocupadas por mejorar continuamente su línea de productos.

El producto
Se escogió una oreadora de cascada como objetivo del proyecto. En el procesamiento del café, esta máquina se emplea para el pre–secado del café, inmediatamente después del lavado y antes del proceso de secado del grano. El café entra al oreador completamente húmedo y sale con la superficie seca, pero todavía se mantiene húmedo. El secado se lleva a cabo haciendo pasar corrientes de aire caliente que circulan a través de los granos dentro de la máquina perdiendo de 2 a 4% de humedad.

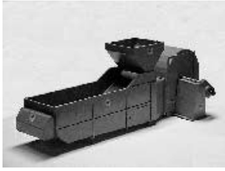
El precio de esta máquina oreadora oscila alrededor de los $13.000 y el 65% de este valor depende del tiempo de ensamblado. Para su construcción se utilizan principalmente hojas de acero, pero debido al tamaño de la máquina existe aún un impacto ambiental bastante importante.

Contexto ambiental
Uno de los aspectos más importantes que afecta al ambiente es el transporte de esta maquinaria. La oreadora es una máquina relativamente grande y pesada y se exporta a países distantes como Guatemala, México, República Dominicana y Hawaii.

Otros factores obvios son el consumo de energía y el impacto ambiental de las materias primas utilizadas para su fabricación.

Propuesta de diseño
El análisis demostró que las opciones mejores y con más potencial estaban relacionadas con la optimización de la producción y la reducción en la utilización de materiales y mecanismos que no estaban dando resultados positivos. Dentro de las áreas susceptibles de mejoramiento estaban el manejo de los desechos, el aprovechamiento de los materiales, el proceso de ensamblado y la facilidad de operación.

Procedimiento de secado alternativo



Oreadora de cascada ecodiseñada

Por estas razones en este proyecto surgió como primordial una estrategia de diseño que mejorara las técnicas de producción, considerando la eliminación de elementos innecesarios y la simplificación de los principios de funcionamiento de la maquina. La estrategia escogida contempló también una reducción en la utilización de materiales que significa también una reducción de los costos. A largo plazo Bendig desea integrar más innovaciones en el proceso de diseño para desarrollar un concepto completamente diferente.

Beneficios

El proyecto permitió elaborar un modelo y planes de producción completos. Muchas partes de la oreadora fueron eliminadas porque no eran necesarias o imprescindibles para que la máquina funcionara adecuadamente. En realidad, se eliminaron secciones completas y el nuevo diseño es por esto mucho más simple y compacto, tanto en lo relacionado con la producción como con el transporte.

La eliminación de elementos superfluos y la simplificación de su construcción también tiene como efecto secundario que la máquina se vea más firme y durable.

Las mejoras se centraron principalmente en el uso de materiales y en la simplificación del producto.

- El producto contiene aproximadamente el 20% menos de materiales.
- El ensamblado es aproximadamente el 20% más rápido.
- La capacidad podría haber disminuido, pero probablemente no más del 5%.
- El producto es mucho más pequeño y esto es muy apreciable con relación al transporte.
- Tanto la instalación como el mantenimiento son más sencillos. Algunas operaciones han sido eliminadas.
- Para el cliente es ahora más fácil de operar.
- El costo será de un 25 a un 30% más bajo, lo que significa una reducción de $4.000.

Ecodiseño en Centroamérica

El Ecodiseño se refiere a la integración de aspectos ambientales en el diseño de un producto, con lo cual se logra mejorar la calidad del mismo y, a la vez, reducir costos de fabricación. La metodología se basa en conceptos de ciclo de vida del producto y en producción sostenible. El proyecto en Centroamérica es una iniciativa de CEGESTI, Costa Rica y la Universidad Tecnológica de Delft, y es financiado por la Embajada de Holanda en Costa Rica.

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ecodiseño centroamérica

Ecodiseño Centroamerica

Empresa: Heliconia del Caribe S.A.
País: Costa Rica
Productos: Flores tropicales para exportación
Proyecto: Rediseño del empaque para el transporte de flores

Beneficios:
- 18% de reducción del costo de transporte
- 14% de reducción en la cantidad de cartón utilizado
- Mejor sistema de cierre y sellado de la caja
- Mejor imagen y comunicación con los compradores


Heliconia: flor tropical

La empresa
Heliconia del Caribe S.A. es una empresa costarricense dedicada al cultivo y exportación de flores tropicales a mercados europeos y norteamericanos. La empresa, que está pasando por una etapa de crecimiento, a la fecha cuenta con unos 12 empleados y se ubica en la zona de Siquirres, al este de San José.
La estrategia competitiva de la empresa está enfocada hacia la calidad y el servicio al cliente, a la vez que sus procesos y productos se desarrollan minimizando el impacto negativo al ambiente. En este sentido, sus principales oportunidades de mejora se encuentran en la logística y costo del transporte de las flores desde la finca hasta el cliente.

El producto
Las principales flores que la empresa produce y exporta son: Heliconias, Gingers, Aves del Paraíso, Flores de Banano y follaje de distintas variedades. Estas flores son particularmente vulnerables a la falta de agua, a los insectos, los golpes, el frío y la oscuridad. Contienen cerca de un 85% de agua, lo cual las hace muy sensibles (se cubren de manchas negras) a temperaturas por debajo de los 15!C, al contrario de flores como rosas, claveles y tulipanes.


Caja original

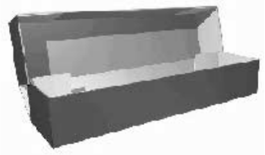
Las flores se exportan en cajas de cartón corrugado, las que están construidas en dos mitades que calzan una dentro de la otra. Para prevenir que la caja se abra durante el transporte, la misma es amarrada por dos flejes engrapados. Interiormente las flores se protegen con papel periódico blanco y un pliego de plástico.

Cerca del 50% del costo del producto corresponde a los costos de distribución: empaque y transporte.

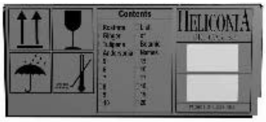

Proceso de empaque

Contexto ambiental
A partir del momento en que las flores salían de la planta de empaque, ubicada dentro de la finca, se hacía difícil lograr asegurar la calidad de las mismas debido a las condiciones de manejo en las aduanas y el personal de transporte aéreo y al transporte y almacenamiento en ambientes demasiado fríos, a partir del momento en que las flores completaban el trayecto en avión. En términos ambientales era necesario rediseñar un empaque que mejorar las condiciones de protección de las flores con el fin de lograr un máximo aprovechamiento de las mismas y de las actividades de transporte.

Pruebas al nuevo concepto



Nuevo concepto



Impresión del nuevo concepto

Producto final ecodiseñado

Por otra parte, al ser Europa uno de los principales mercado para Heliconia del Caribe, también resulta importante considerar las tendencias regulatorias en cuanto a materiales de empaque a corto y largo plazo: todos los empaques deben ser recuperables y/o reusables y un 90% de los desechos de material de empaque debe ser reciclable.

Propuesta de diseño
Uno de los principales objetivos del proyecto fue el de proveer una solución a las oportunidades de mejora de Heliconia del Caribe, a través del rediseño del empaque utilizado para transportar las flores, bajo un enfoque ambiental.

Dentro de este objetivo se establecieron como metas:
- Reducir la cantidad de material utilizado
- Prevenir los daños a la calidad de las flores
- Comunicar la marca a los compradores e incluso a sus clientes finales.

Inicialmente, dadas las condiciones de oferta de otros materiales en la región, se decidió realizar el rediseño del empaque manteniendo el cartón corrugado como el material principal. Además, el empaque sería producido localmente y cortado a mano para evitar grandes inversiones.

Beneficios
El nuevo empaque permite alcanzar los siguientes beneficios:
- 14% de reducción en la cantidad de cartón utilizado,
- 18% de reducción del costo de transporte,
- Una reducción proporcional en el impacto ambiental del producto, lo cual incluye la reducción en el consumo de combustible utilizado en el transporte de las flores,
- 9% de reducción en el costo del producto final,
- Mejor sistema de cierre y sellado de la caja,
- Mejores condiciones de protección para las flores,
- Mejor comunicación sobre las condiciones de transporte y preservación de las flores,
- Mejor imagen y comunicación con los compradores,
- La información impresa cumple con la norma ISO 780 de simbología de transporte,

Ecodiseño en Centroamérica

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ecodiseño centroamérica

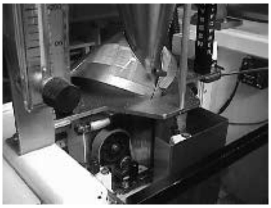
Ecodiseño Centroamérica

Empresa: ***Industrias Mafam***
País: Costa Rica
Productos: Galletas y bocadillos
Proyecto: Rediseño del sistema de empaque

Beneficios:
- 20% de reducción en el consumo de polietileno en el empaque secundario.
- 3% de reducción en empaque primario
- 7 000 cajas de cartón menos al año

El producto

La empresa
Mafam es una empresa familiar, mediana, con 32 empleados y fundada en 1992. Se dedica a la producción de galletas, bizcochos, palitos de queso y otros bocadillos. El mercado de la empresa es netamente nacional, sus principales clientes son las pulperías y supermercados y han algunas ocasiones se han realizado exportaciones dentro de la región.
Los productos de Mafam son hechos con ingredientes naturales, horneados y bajos en colesterol. La calidad es uno de los elementos más importantes dentro de su planificación estratégica, continuamente trabajan por mejorar la satisfacción de sus clientes y consumidores; al igual que la mejora de su gestión ambiental. Industrias Mafam posee equipo e instalaciones modernos y flexibles y está decidida a ser una empresa líder en la producción de alimentos nutritivos e innovadores.



Maquinaria de empaque

El producto
Para la gerencia, la razón más importante para desarrollar un proyecto en ecodiseño la constituyó la necesidad de reducir sus costos, en especial los costos de distribución, que representan el 20% del costo total.
El producto considerado dentro de este proyecto fue el sistema de empaque, el que está formado por el empaque individual de los productos (bolsitas de polipropileno impresas), el empaque para la distribución (bolsones de polietileno y cajas de cartón) y el modo en el que son distribuidos (pequeños camiones).
Los requerimientos que este sistema debe satisfacer incluyen:
- Conservar el contenido de las bolsas de la humedad y la oxigenación
- Proteger el contenido de los golpes y cargas excesivas, para prevenir que las galletas y bocadillos se rompan
- Funcionar como el principal medio de comunicación con el consumidor.

Bolsas Grandes

Contexto ambiental
Si bien los materiales de empaque resultan necesarios para proteger, contener y publicitar un producto; su vida útil, por lo general, es bastante limitada y en el caso de los plásticos son materiales que al desecharse no se degradan. Esto implica, un gasto de materias primas, no siempre renovables, y de energía en su fabricación que, de una u otra manera, el consumidor y el ambiente pagan. En muchos casos el producto se vende con sobreembalaje, es decir, embalaje innecesario que el consumidor no puede rechazar y además debe eliminar posteriormente.
En nuestra región, aún falta mucho por hacer en cuanto a desarrollo de materiales de empaque y embalaje innovador: reutilizable, que utilice la cantidad mínima de material y que este material tenga un bajo impacto negativo sobre el ambiente.

Pruebas en el nuevo sistema display

El empaque en cajas

Transporte del producto

Asociado al sistema de empaque de un producto se encuentra su sistema de distribución, dentro del cual el consumo de combustibles fósiles representa un aspecto ambiental relevante, al igual que la generación de los gases producto de la combustión. Para Mafam, estos elementos formaron parte de su contexto ambiental, el cual incluyó consideraciones económicas y de calidad; como el continuo aumento en el precio de la gasolina, lo que hace necesario optimizar su consumo, y la protección del producto durante el transporte.

Propuesta de diseño

En Industrias Mafam se revisó la línea total de distribución, desde que el producto sale del horno hasta que llega a las manos del consumidor, considerando tanto los aspectos financieros como los ambientales. Para el desarrollo de mejoras en los aspectos ambientales, se puso especial atención en:

- El contenido energético de los materiales (es decir, el consumo energético durante su procesamiento como materias primas)
- La cantidad de material desechado después de realizar la distribución
- La forma en que los clientes y consumidores disponen del material de empaque después de su uso.

Beneficios

Como resultado del rediseño del sistema de empaque en Industrias Mafam se logró disminuir el impacto ambiental asociado al proceso de empaque y distribución de productos y a la vez, se obtuvieron beneficios económicos eliminando el embalaje innecesario.

Para los dos puntos de venta, supermercados y pulperías, se desarrollo un sistema de empaque en función de las diferentes necesidades, una vez implementadas los beneficios esperados son:

- 3% de reducción en el consumo de polipropileno, tinta y adhesivos, al ajustar la forma del agujero en la parte superior de las bolsas,
- 20% de reducción en el consumo de polietileno para los bolsones (equivalente a 367 kg.), al eliminar el uso de los bolsones en los supermercados,
- 7 000 cajas de cartón menos al año
- 5% de reducción en el costo de las cajas de cartón, reduciendo el espesor de las cajas para la distribución a supermercados,
- Reducción de costos en la distribución a las pulperías, al sustituir las cajas de cartón por cajas plásticas reutilizables

15% de reducción total en el costo del sistema de empaque

Ecodiseño en Centroamérica

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ecodiseño centroamérica

Ecodiseño Centroamérica

Empresa: Möbelart
País: El Salvador
Productos: Muebles para el hogar y oficina
Proyecto: Rediseño de muebles de cocina

Beneficios:
- 12% reducción de los costos de producción
- 15% reducción de peso
- Forma parte de un sistema 100% modular
- Diseñado para que sus partes puedan ser fácilmente reemplazadas


Construcción del prototipo

La empresa
Möbelart es una pequeña empresa situada en San Salvador que se dedica a la fabricación de muebles y en la que trabajan 26 empleados. Produce muebles de alta calidad para los segmentos más altos de dos mercados: el hogar y la oficina. La mayoría de sus productos se fabrican para el mercado local y se hacen a medida y gusto del cliente.

El gerente y propietario es una persona innovadora y preocupada por la conservación del ambiente y quiere que también lo sea su empresa. Esto lo motivó a involucrarse en el proyecto Ecodiseño Centroamérica.

El producto
El producto seleccionado para el proyecto fue un mueble pequeño para cocina. Normalmente, Möbelart hace este tipo de muebles, pero en grandes dimensiones, de acuerdo a las necesidades específicas del cliente; sin embargo en una oportunidad se fabricó uno de pequeñas dimensiones, con lo cual se pudo disponer de suficiente información para evaluar el prototipo y hacer comparaciones.


Construcción del prototipo

El producto ecodiseñado buscaría satisfacer a un mercado de clase media, en el que los aspectos económicos y de calidad son importantes. La empresa lleva a cabo el diseño completo, la fabricación de las partes e instrucciones de instalación.

Contexto ambiental
Möbelart cuenta con equipo de corte que absorbe el polvo generado en el proceso, sin embargo la absorción no es del 100% y existe cierta cantidad que es considerada como basura. También en la fabricación de muebles se generan algunos desechos de solventes y pegamentos.

Durante el proyecto, la empresa comenzó a separar la basura y a usar los pegamentos de una forma más eficiente. Actualmente Möbelart está tratando de que alguna otra empresa aproveche sus desechos de madera como fuente de energía.

Propuesta de diseño
El principal objetivo de la estrategia desarrollada era que Möbelart debía tratar de atraer a un área determinada del mercado: un mercado de alta calidad para productos estándar. La fábrica debía tener su propia línea de productos y venderlos a tiendas de departamentos.

Los muebles de cocina serían un producto de alta calidad, fabricado en el país para abastecer al mercado local. Estas características le darían una gran ventaja

Nuevo diseño

Muebles de cocina anteriores y nuevos

comparado con otros modelos disponibles en el mercado actualmente. A corto plazo sería un producto de diferentes colores con tiradores de distintos modelos.

Metas importantes:

- Reducir el peso y las dimensiones
- Reducir la cantidad de material utilizado
- Reducir el uso de energía

Beneficios:

El nuevo diseño presenta las siguientes mejoras:

- Tiene alturas ajustables
- Cuenta con mesadas o cubiertas de bordes redondeados
- Se ajusta mejor a un diseño ergonómico
- Forma parte de un sistema 100% modular
- Es fácil de transportar (se puede transportar desarmado)
- Fácil de instalar
- Diseñado para que sus partes puedan ser fácilmente reemplazadas

Dado que se utiliza menos material, que el tiempo de ensamblado es menor y que se consume menos energía durante la producción, se produce una reducción de:

- 12% de los costos de producción
- 15% de peso

El proyecto dio como resultado un nuevo diseño de muebles modulares de cocina que actualmente se venden a través de un nuevo canal de distribución: tiendas de departamentos. Los pasos venideros serán desarrollar nuevos productos por medio del enfoque de Ecodiseño a fin de completar una línea de productos estandarizados para Möbelart. A largo plazo, Möbelart planea exportar sus productos a otros países de Centroamérica.

Ecodiseño en Centroamérica

El Ecodiseño se refiere a la integración de aspectos ambientales en el diseño de un producto, con lo cual se logra mejorar la calidad del mismo y, a la vez, reducir costos de fabricación. La metodología se basa en todo el ciclo de vida del producto y en elementos de desarrollo sostenible. El proyecto Ecodiseño en Centroamérica es una iniciativa de CEGESTI, Costa Rica y la Universidad Tecnológica de Delft, y es financiado por la Embajada de Holanda en Costa Rica.

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Ecodiseño Centroamérica

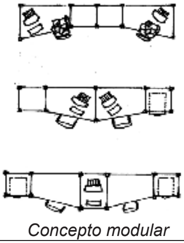
Empresa: ***Panel-Ex***
País: Costa Rica
Productos: Muebles y paneles de oficina
Proyecto: Diseño de una estación de muebles para oficina

Beneficios:
- 7% a 22% reducción de peso
- 3% a 6% reducción en el contenido energético de los materiales
- 57% reducción en el uso de formaldehído
- 27% reducción en el uso de melamina


Producto de referencia


Producción


Ensamblaje de los muebles


Concepto modular

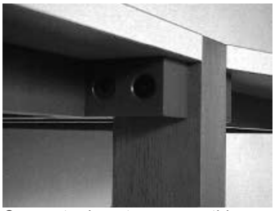
La empresa
Panel-ex es una empresa mediana del grupo Durman Esquivel, ubicada en San José. Se dedica al desarrollo, producción y venta de muebles para oficina, además cuenta con empresas distribuidoras de sus productos en Guatemala, El Salvador, Panamá y Nicaragua.

Panel-ex constantemente está mejorando sus procesos de producción, vende productos de muy buena calidad y desea desarrollar una línea de productos que se distinga por generar un menor impacto en el ambiente. La Gerencia tiene una orientación proactiva y está dispuesta a invertir en el futuro. En Panel-ex existe una orientación hacia la minimización del impacto ambiental de sus operaciones por el ambiente, lo cual se demuestra en varias de sus prácticas productivas, tales como: uso de adhesivos a base de agua, uso de maderas de rápido crecimiento y mejoras en el tratamiento de desechos.

La organización y estructura del trabajo en las áreas productivas es muy flexible, lo cual permite ser más creativo con las técnicas de producción o probar nuevas posibilidades.

El producto
Existe en Costa Rica un mercado creciente para muebles de oficinas pequeñas y medianas, en particular se buscan estaciones de muebles flexibles que le permitan al cliente ajustar el mobiliario al espacio y dimensiones disponibles.
En este proyecto no existió un producto patrón o referencia, sino que el proceso se enfocó en el desarrollo de uno completamente nuevo. Las características del producto a desarrollar se orientaron hacia el diseño de una estación de muebles modular, que se pueda usar con o sin paneles, fácil de instalar, fácil de expandir y ajustar, económica y con un menor impacto en el ambiente.

Contexto ambiental
En el marco ambiental existen importantes mejoras al ciclo de vida del producto, en especial relacionadas con el tipo de materiales seleccionados y el consumo energético durante el proceso de manufactura. La estrategia de ecodiseño de la estación se orientó por lo tanto, a una selección cuidadosa de los materiales y una optimización del consumo de los mismos.



Concepto de patas compartidas

Prototipo con patas de metal

Prototipo con patas de madera

Propuesta de diseño

Como estrategia de diseño se planteó el considerar los aspectos ambientales como uno de los principales factores que influirían al decidir sobre la selección de una u otra alternativa de diseño (materiales, dimensiones, etc.)

Además, se propuso el desarrollar una metodología de diseño que integrara las variables de mercado con los aspectos ambientales.

Dentro de este planteamiento se establecieron como metas:

- Desarrollar un sistema flexible, en el que las patas puedan ser compartidas por varios módulos
- Optimizar el uso del espacio en las oficinas
- Optimizar el uso de materiales, definiendo las medidas del mueble en función de las dimensiones de los materiales.
- Utilizar materiales con menor contenido energético
- Diseño ergonómico

Beneficios

Se desarrollaron dos conceptos a partir de la propuesta de diseño para validar la misma. Ambas propuestas tienen un menor impacto ambiental que el resto de los productos de Panel-ex y poseen:

- Mayor facilidad de instalación
- Mayor flexibilidad de la estación
- Menor costo de producción

Otros beneficios obtenidos a partir de los dos conceptos desarrollados son:

Concepto con patas de acero

- 7% Reducción de peso
- 3% Reducción en el contenido energético de los materiales
- 57% Reducción en el uso de formaldehído
- 27% Reducción en el uso de melamina

Concepto con patas de madera

- 22% Reducción de peso
- 6% Reducción en el contenido energético de los materiales
- 57% Reducción en el uso de formaldehído
- 27% Reducción en el uso de melamina
- Menor área que requiere ser pintada

Ecodiseño en Centroamérica

El Ecodiseño se refiere a la integración de aspectos ambientales en el diseño de un producto, con lo cual se logra mejorar la calidad del mismo y, a la vez, reducir costos de fabricación. La metodología se basa en conceptos de ciclo de vida del producto y en producción sostenible. El proyecto en Centroamérica es una iniciativa de CEGESTI, Costa Rica y la Universidad Tecnológica de Delft, y es financiado por la Embajada de Holanda en Costa Rica.

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ecodiseño centroamérica

Ecodiseño Centroamerica

Empresa: Talleres REA
País: Guatemala
Productos: Maquinaria para beneficios de café
Proyecto: Rediseño de un despulpador

Beneficios:
- 50% de reducción en el tiempo de manufactura
- 50% de reducción en el costo de materia prima
- 70% de reducción en el peso
- Trabaje en seco con alta calidad


Frutos de café recién cosechado

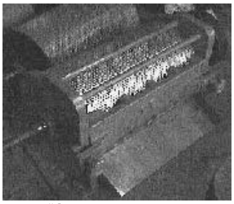
La empresa
Talleres REA es una empresa familiar guatemalteca, de 35 empleados, situada en Ciudad de Guatemala. Produce maquinaria tradicional para beneficiado y torrefacción de café. Actualmente, la empresa vende sus productos en el mercado local, pero ya se han iniciado las gestiones para explorar nuevos mercados.

A partir de 1998, se aprobó en Guatemala una nueva legislación en relación con el reducir drásticamente el consumo de agua en los beneficios, por lo que es de esperar que en unos pocos años no sea exista mercado para el despulpador tradicional. La competencia está innovando rápidamente y los "slogans verdes" dominan el mercado.

Despulpador tradicional

El producto
El despulpador es uno de los productos más importantes para Talleres REA, su costo de materias primas es muy elevado, es un equipo que requiere de agua para su operación y se trata de la primera máquina en el beneficio que entra en contacto con el café después de su cosecha. En este proceso la pulpa se separa del grano y éste continua su camino hacia los procesos de selección, lavado y secado.

El despulpador tradicional está hecho principalmente de hierro fundido, algunas partes pequeñas de aluminio y la "camisa" del cilindro de cobre. Se trata de una máquina pesada (635 libras), lo cual no sólo dificulta las actividades de producción y el transporte, sino que hace que el despulpador requiera una base de concreto para su instalación. Además, las características de diseño del producto, hacen que se consuma mucho tiempo de producción.

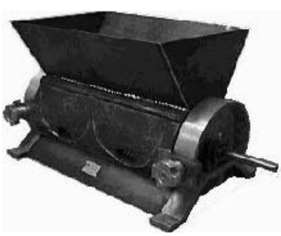

"Camisa" de cobre

Contexto ambiental
En los últimos años, la creciente preocupación por el uso del agua y la contaminación de los ríos causada por los proceso de beneficiado, a provocado un desarrollo orientado hacia soluciones más sostenibles ambientalmente. Tradicionalmente, el proceso utiliza más de 3000 litros de agua para producir un quintal de café (aproximadamente 60 kg.)


Equipo de ecodiseño

Creando el prototipo

Probando el nuevo concepto



El despulpador nuevo

Propuesta de diseño

El principal reto para el proyecto fue la innovación, esto es desarrollar una máquina que cumpla con las nuevas regulaciones, mejorar su desempeño ambiental y a la vez reducir los costos de materia prima y producción.

Dentro de este marco, se establecieron como metas:

- Reducir las dimensiones del despulpador, así como la cantidad de material utilizado y su peso
- Sustituir el hierro fundido por aluminio y el cobre por acero inoxidable.
- Lograr una mejor relación entre el diseño de la máquina y el proceso que desarrolla
- Ajustar el diseño a las facilidades de producción, de modo que se requieran menos pasos o menos tiempo de producción
- Facilitar su manejo e instalación

Beneficios

El nuevo despulpador es mucho más liviano y pequeño, pese a que tiene la misma capacidad de producción. Su manejo, instalación y transporte son mucho más fáciles y no requiere agua para operar. Puede ser integrado en cualquier sistema de beneficiado ecológico y se ha reducido radicalmente la cantidad de material utilizado.

Específicamente:

- 50% de reducción en el tiempo de manufactura
- 50% de reducción en el costo de materia prima
- 70% de reducción en el peso
- Mejor diseño: se aprecia mejor el proceso de despulpado, para supervisar la calidad del café
- Alta calidad de despulpado
- Menores dimensiones
- Importantes beneficios ergonómicos para el personal del taller de producción
- Más facilidad de manejo, instalación y transporte
- Fácil de promover dentro de las tendencias “verdes” del mercado.

Ecodiseño en Centroamérica

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Ecodiseño Centroamerica

Empresa: Muebles y Maderas Buenos Aires
País: Costa Rica
Productos: Muebles
Proyecto: Muebles para exteriores en madera de Melina.
Desarrollado por: Karol Montero

Beneficios:

4 Mejor aprovechamiento de un recurso de la empresa como es la madera Melina.
4 Desarrollo de un módulo genérico que reduce tiempos de producción.

Juego de exteriores ecodiseñado

Silla ecodiseñada

Silla doble ecodiseñada

La empresa
Ubicada en Buenos Aires de Palmares, está empresa se especializa en la fabricación de mobiliario doméstico. Cuenta con plantaciones de madera lo que le permite tener un control directo en el manejo de su propia materia prima.

El proyecto
Introducir una nueva línea de productos al mercado nacional, tomando en cuenta la abundancia y disponibilidad de la madera de Melina.

Propuesta de diseño
Para el desarrollo de la propuesta de diseño se tomaron en cuenta los siguientes parámetros:
• Diseñar un mueble en madera de Melina para la clase media alta.
• Utilizar madera de plantación.
• Utilizar solo madera de Melina en la medida de lo posible.
• Crear una nueva línea de diseño para la empresa.
• Emplear un proceso de producción en serie.
• Reducir costos en mano de obra y producción
• Diseñar de acuerdo a las características estructurales y dimensionales del material.

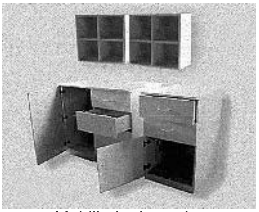
Beneficios
• Brinda confort al usuario a través de los elementos mínimos de apoyo.
• Al ser un módulo genérico, reduce el tiempo de producción ya que se pueden fabricar varias piezas simultáneamente.
• Se establece una estandarización de medidas a utilizar, para un uso racional del material de acuerdo a sus dimensiones.
• Optimización en el aprovechamiento de los recursos tecnológicos de la empresa.
• Una nueva línea con un carácter ambiental, que le permite a la empresa tener acceso a nuevos mercados.

Ecodiseño Centroamerica

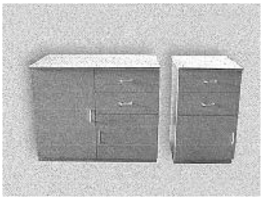
Empresa: Centro de Investigaciones en *vivienda y construcción, CIVCO; del ITCR.*
País: Costa Rica
Proyecto: Desarrollo de proyectos en el área en vivienda y construcción.
Productos Mobiliario de cocina
Desarrollado por: Katherin Arrieta y Andrés Castillo

Beneficios:

4 Reducción en el uso de materiales .
4 Dimensionado de las piezas con un aprovechamiento del 94% por lámina.
4 30% de fabricación es maquinado y el 70% manual,



Mobiliario de cocina



Muebles modulares

La empresa
El Centro de Investigaciones en Vivienda y Construcción, del Instituto Tecnológico de Costa Rica es una institución dedicada a la investigación en el campo de la vivienda de interés social. Los resultados obtenidos de dichas investigaciones no se comercializan, si no que se desarrollan en proyectos de viviendas sin fines de lucro.

El proyecto
La escuela de Diseño Industrial del ITCR le propone al CIVCO, , desarrollar el mobiliario de cocina para las viviendas diseñadas en el proyecto Asentamientos Humanos Ecológicamente sostenibles.

Contexto ambiental.
Utilización indiscriminada de maderas sólidas en la configuración de las diferentes partes del mueble y la sobre-estructuración de los mismos, influye directamente sobre los costos económicos y ambientales del producto.

Propuesta de Diseño.
• Una optimización de los espacios en cuanto a dimensiones, funcionalidad, flexibilidad y seguridad. • Uso racional de los recursos empleados en el proceso de fabricación.

Beneficios
• Aprovechamiento máximo del espacio por medio de un sistema modular
•Reducción en el uso de materiales, pues las piezas que configuran el mueble son a la vez estructurantes.
• Dimensionado de las piezas de acuerdo a las dimensiones del material con un aprovechamiento del 94% por lámina.
• Fabricación simple, de baja tecnología que permite la fabricación de los muebles en el sitio mismo de los asentamientos.
• En la fabricación del mueble el 30% es maquinado y el 70% manual, lo que reduce los costos pues ese 70% puede ser aportado por el usuario.

Ecodiseño Centroamerica

Empresa: Pizza Hut
País: Costa Rica
Proyecto: Restaurante de pizzas
Productos: Contenedor para transporte de pizzas utilizando motocicletas
Desarrollado por: Leonardo Rojas

ecodiseño centroamérica

Beneficios:

- Disminución de un 25% del peso total del contenedor.
- Disminución del consumo de combustible por kilometro recorrido.
- Aumento de la vida útil de la motocicleta con contenedor

TEC
Instituto Tecnológico de Costa Rica

Contenedor de pizzas


Interior del contenedor

La empresa.
La empresa Pizza Hut de Costa Rica cuenta con más de una veintena de restaurantes. Es una empresa transnacional, y en nuestro país presta servicio a domicilio.
Uno de los principales problemas por los que atraviesa la empresa debido al servicio ¨express¨ es el alto deterioro de su flotilla de motocicletas, con el agravante de altos costos por mantenimiento.

El proyecto
Luego de un previo análisis se enfocó el problema así:
• Disminuir el peso total del contenedor
• Definir y especializar espacios para contener.
• Incrementar la vida útil tanto de las motocicletas como las del contenedor.
• No alterar las condiciones de estabilidad de la motocicleta.
• El proceso de fabricación debe ser artesanal.

Contexto ambiental
El servicio express tiene en Costa Rica varias consideraciones importantes: las condiciones de la carretera, el tiempo de entrega. Esto llevó al proyecto a resolver el problema de interfaces contenedora - motocicleta.
El hecho de considerar la fabricación artesanal debido al bajo volumen y la reducción del peso, puso de manifiesto una fabricación y selección de materiales de consideración al ambiente.

Beneficios
• Disminución de un 25% del peso total del contenedor.
• Disminución del consumo de combustible por kilometro recorrido.
• Aumento de la vida útil de la motocicleta con contenedor de acuerdo a:
- la distribución de centros de masa, relación vehículo/contenedor
- las características topológicas estructurales del contenedor.
• La reparación y fabricación del sistema, se pueden resolver a través de los mismos talleres de mantenimieto de la empresa.
• Mejores condiciones aerodinámicas del contenedor.

Ecodiseño Centroamerica

Empresa: Instituto Tecnológico de Costa Rica.

País: Costa Rica

Proyecto: Aprovechamiento de material de desecho de la palma de pejibaye.

Desarrollado por: Ivonne Madrigal y William Calvo

Beneficios:

- Aprovechamiento de material de desecho.
- El material no requiere de acabado.
- Se consume el 90% del material propuesto.

Productos varios de escritorio

Porta lápices

Bandeja

El proyecto

La intención de este proyecto nace por iniciativa de los estudiantes, con la finalidad de mejorar la utilización de los recursos, la manufactura artesanal y la protección de la cultura.
Inicialmente este proyecto toma como punto de partida el proceso artesanal en Costa Rica como insumo para reconocer actividad, las condiciones maderables su disponibilidad, tipo de infraestructura, aprovechamiento de los recursos.

Contexto ambiental.
Dentro de las posibilidades de estudio se seleccionó la palma del pejibaye. Esta planta de tradición indìgena, produce un fruto que representó parte de la base alimenticia de nuestros ancestros. La planta se cultiva hoy principalmente para la comercialización de su fruto por lo que existe gran cantidad de troncos disponibles pues el ciclo de vida de cada planta es muy corto. Hasta la fecha no existe un medio o razón para explotar los troncos o tallos de esta palma de manera que esta no represente un desecho. Las empresas o familias dedicadas a la producción del pejibaye desechan grandes cantidades de esta planta.

La propuesta de Diseño.
Luego de un previo análisis se enfocó el problema así:
• Reconocer del medio nuevas posibilidades tanto en materiales como de proceso.
• Utilizar un mínimo de materiales con bajo impacto en el ambiente.
• No utilizar sistemas de producción no tradicionales.
• El proceso de fabricación debe ser artesanal.

Beneficios.
• Aprovechamiento de material de desecho.
• El material no requiere de acabado.
• El modo de construcciòn y el aspecto formal de los objetos responden a la fisonomía de la palma, con lo que se disminuye el desperdicio.
• La realización de cada objeto consume un 90% del material propuesto y se disminuyen los costos de producción

Ecodiseño Centroamerica

Empresa: Fábrica Venus
País: Guatemala
Productos: Dulces y chocolates
Proyecto: Rediseño del empaque para los dulces

Beneficios:
- Mejor diseño publicitario
- 33-40% de reducción en el uso de material
- Mayor rapidez en producción
- Mejor identidad con la línea de productos


Proceso de empaque

Transporte en camión


Producto de referencia


Estudio de color & diseño

La empresa
Venus es una mediana empresa guatemalteca, fundada en 1928, que actualmente produce 150 tipos diferentes de dulces, en una planta ubicada en Ciudad de Guatemala. Venus vende la mayoría de sus productos en Centro y Sudamérica, pero también una parte de sus productos es vendida en Estados Unidos y se hacen gestiones para exportar a mercados europeos.

Los productos de Venus se sitúan en el mercado popular creciente, al cual le ofrecen dulces de alta calidad a un bajo precio, una de sus fortalezas es la capacidad de altos volúmenes de producción y bajos costos. Pese a lo anterior, últimamente el número de competidores ha aumentado considerablemente, en especial de competidores de origen externo en el mercado local, el cual es relativamente fácil de penetrar. Para Venus es importante aumentar su nivel de exportaciones y competir fuertemente en el mercado local a través del desarrollo de sus productos.

Venus es una empresa con amplia experiencia en el mercado, con maquinaria de producción altamente flexible

El producto
El sistema de empaque de Venus está constituido por tres elementos: el empaque individual de los dulces, las bolsas en que se empaca una determinada cantidad de dulces y las cajas o bolsones donde se empaca una cantidad de bolsas.

Para el empaque individual, existen tres posibilidades: la “almohadita” (pillow pack), el de un doblez (single twist) y doble doblez (double twist). Venus utiliza diferentes tipos de diseños y materiales para sus empaques individuales y bolsas, en los cuales la calidad depende del material utilizado y el diseño gráfico.

Los costos de transporte constituyen una importante parte del costo total de los dulces, por lo que es importante buscar las posibilidades de ahorrar en estos costos y optimizar la capacidad de transporte.

Contexto ambiental
En el contexto ambiental del proyecto, se destacan las siguientes variables externas e internas:
- 100% del producto en proceso rechazado se recicla
- Un nivel de desechos de material de empaque bajo: 2-5%
- Uso de materiales de empaque “buenos” para el ambiente
- Subutilización de la capacidad de producción instalada
- Aumento de la legislación europea en materiales de empaque para productos importados

Prototipo del nuevo empaque

Productos terminados bajo el nuevo diseño

El nuevo y el viejo diseño

Propuesta de diseño

La propuesta de diseño se planteó tomando en cuenta las funciones que el empaque debe cumplir:

- Garantizar la calidad del producto durante un determinado período de tiempo.
- Contener el producto hasta que llegue a su destino
- Apoyar la gestión de ventas y crear interés en el consumidor.

El interés de Venus se ubicó principalmente en la producción de dulces a un bajo costo, minimizando el uso de materiales de empaque individual y en las bolsas.

Se planteó desarrollar una nueva línea para los dulces duros, a través de un diseño de empaque básico en el cual, para diferenciar los diferentes sabores, sólo es necesario cambiar los colores. Adicionalmente, se busca que estos empaques tengan una mejor presentación, más atractiva para los nuevos mercados y que enfoque la atención del consumidor en el contenido de las bolsas; lo cual incluye mejorar el diseño de los logos de la empresa.

Si bien el empaque tradicional de Venus tiene una función y forma simples, es posible reducir la cantidad de tinta utilizada en su impresión, lo cual permitiría facilitar las posibilidades de reciclaje de las bolsas, además las bolsas poseen mucho aire y espacio libre, lo cual también podría ser minimizado.

Beneficios

A través del nuevo sistema de empaque es posible obtener los siguientes resultados*:*

- 40% de reducción en el empaque individual
- 33% de reducción en la cantidad de material utilizado en las bolsas
- La producción del empaque individual es más rápida que el diseño anterior
- Reducción en la cantidad de desechos de material de empaque
- Mayor área para publicidad en el empaque individual
- El nuevo diseño de impresión de la bolsa permite que el consumidor identifique más fácilmente la marca Venus y su línea de productos

Ecodiseño en Centroamérica

El Ecodiseño se refiere a la integración de aspectos ambientales en el diseño de un producto, con lo cual se logra mejorar la calidad del mismo y, a la vez, reducir costos de fabricación. La metodología se basa en todo el ciclo de vida del producto y en elementos de desarrollo sostenible. El proyecto Ecodiseño en Centroamérica es una iniciativa de CEGESTI, Costa Rica y la Universidad Tecnológica de Delft, y es financiado por la Embajada de Holanda en Costa Rica.

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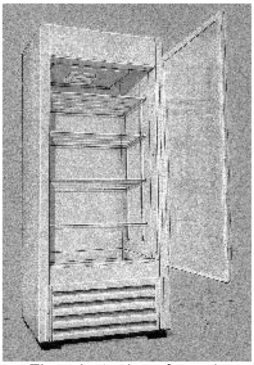
Ecodiseño Centroamérica

Empresa: Industrias Waiman
País: Costa Rica
Productos: Utensilios de cocina eléctricos y de gas
Proyecto: Rediseño de la Cámara de Refrigeración

Beneficios:
- Uso más eficiente de energía
- Mantenimiento más fácil
- Mas fácil de limpiar
- Mejor imagen de calidad

INDUSTRIAS
Waiman


El producto de referencia


Proceso de producción


Detalle del ventilador

La empresa
Industrias Waiman es una empresa costarricense del sector metalmecánico, con 20 empleados ubicada en San José. La empresa se dedica a la producción de equipo para calentar, enfriar y preparar bebidas y alimentos.

El mercado de la empresa está compuesto por sodas, restaurantes, sector doméstico y sector industrial costarricense, sin embargo se tiene interés de explorar nuevos mercados en el futuro cercano.

La gerencia de Industrias Waiman está muy interesada en la innovación tanto de productos como de procesos. Todas las operaciones de producción se realizan internamente, por lo que tienen control y flexibilidad en sus operaciones.

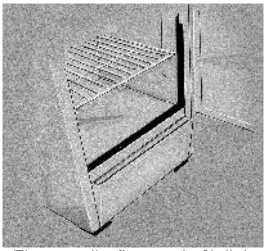
El producto
Con el fin de aprovechar las oportunidades de mercado existentes y frente a las posibilidades de mejora en el desempeño ambiental, se escogió la cámara de refrigeración vertical como el producto a rediseñar.

La principal oportunidad de mejora de la cámara la constituyó el desempeño del sistema de enfriamiento, ya que éste operaba con considerables variaciones de temperatura en diferentes áreas del interior de la cámara.

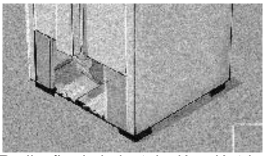
Contexto ambiental
En los últimos años el mercado nacional se ha vuelto más sensible hacia la problemática ambiental del país y en especial hay un gran interés hacia productos que sean eficientes y de buena calidad. El consumo energético de la cámara durante su uso se consideró como aspecto ambiental prioritario, ya que es el que genera el mayor impacto y presenta las mejores oportunidades de mejora.

Otra área de mejora importante era el mantenimiento de la cámara. Algunas pequeñas partes de la cámara que requieren ser cambiadas con cierta frecuencia, no eran de fácil acceso, lo cual implicaba desperdicios de material (principalmente espuma aislante) al reemplazar estas partes.

Pruebas al producto de referencia



El nuevo diseño es más fácil de limpiar



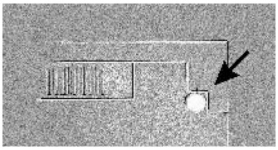
Rediseño de la instalación eléctrica para facilitar el mantenimiento

Propuesta de diseño
La propuesta de diseño se basó en un proceso de "benchmarking", a través de la investigación y aprendizaje del trabajo de los competidores y de las buenas prácticas alrededor del mundo. La idea era alcanzar mejoras rápidas y fáciles de implementar en el corto plazo.

El rediseño del producto se enfocó principalmente en los siguientes aspectos: mejorar la eficiencia de enfriamiento de la cámara, reducir el consumo energético durante su uso, mejorar el aprovechamiento de los materiales y facilitar el mantenimiento: limpieza y reparación.

Beneficios
La nueva cámara de refrigeración alcanzó los siguientes logros:

- Enfriamiento más rápido
- Mejor distribución del aire
- Uso más eficiente de energía: cumplimiento de su función de enfriamiento, haciendo un mejor trabajo
- Se crearon oportunidades para eliminar la resistencia de la puerta, la cual consumía el 28% de la energía total consumida por la cámara anterior
- Mantenimiento más fácil: limpieza y reparación
- Mejor imagen de calidad, lo cual permite a Waiman acercarse a clientes mayores



Reposicionamiento de la luz interna

Ecodiseño en Centroamérica
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ecodiseño centroamérica

Ecodiseño Centroamerica

Empresa: Kontein
País: El Salvador
Productos: Envases plásticos/ botellas
Proyecto: Botella de plástico

Beneficios:

- De 30% a 72% de reducción del peso del envase, según el tamaño de botella
- Los sobrantes de PP son completamente reciclables
- Eliminación de 800 kg. de desechos de PVC anuales
- 54% de reducción en los costos de materia prima (para botella de 32 g.)

Productos de Kontein

Botella original

La empresa
Kontein fue fundada en 1978 con el propósito de fabricar envases y tapas de plástico, utilizando el polietileno, el PVC , el polipropileno y el poliestireno como materias primas. La planta está ubicada en almacenes de desarrollo en Soyapango, San Salvador, capital de la República de El Salvador, América Central.

La empresa cuenta con maquinaria moderna para la fabricación de envases, tapaderas y otros productos de plástico para diversas ramas de la industria (alimenticia, farmacéutica, cosmética, agrícola, agroquímica). Un completo taller especializado de matricería, facilita la fabricación de diferentes tipos de moldes de inyección y soplado, de acuerdo a los requerimientos específicos del cliente con relación a la forma, el tamaño y a otras características especiales. Los logotipos y leyendas se imprimen directamente en los envases por medio de un moderno y rápido sistema de serigrafía.

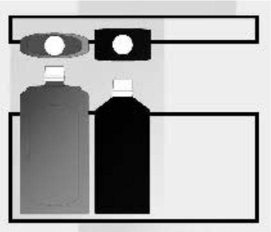
El producto
La botella Farma, hecha de PVC, es un producto con buenas probabilidades para el mejoramiento ambiental. Este envase se vende junto con el producto de mayor venta de la empresa: la tapa con sistema de cierre Farma Plus. El producto está disponible en droguerías, centros nacionales de salud y supermercados. La botella + el contenido + la cubierta se comercia como un producto OTC (sigla que corresponde a: “over the counter”: sobre el mostrador), es decir un tipo de ‘medicina’ que no necesita prescripción médica, como es el caso de los suplementos vitamínicos, jarabe para la tos, tónicos reconstituyentes, etc.

El producto existente se fabrica en PVC, ámbar, de 480 cc de capacidad, a razón de 285.000 productos al año. El mismo se vende junto con el producto de mayor venta de Kontein: la tapadera o sistema de cierre Farma Plus.

Contexto ambiental
No existe un sistema de reciclado de PVC en El Salvador. Esto significa que desde el punto de vista ambiental, la etapa del fin de la vida del producto es crítica. El PVC también representa un importante desperdicio interno y la empresa ha desarrollado una estrategia para disminuir la proporción utilizada en estos productos. La producción de este envase representa un desperdicio anual de 800 kilos de sobrantes de PVC no reciclable (material resultante del proceso).

Propuesta de diseño
Luego del análisis, se concluyó que era importante hallar nuevos materiales. Si no se utilizaba PVC se reduciría drásticamente el desperdicio. El plástico conocido como PP (polipropileno) surgió como una opción favorable que brindaba importantes mejoras, tanto en relación al ambiente como a los costos. La estrategia de diseño se puede resumir de la siguiente manera:

- Material de bajo impacto (PP)



El nuevo (verde) y viejo diseño

Botella nueva

- Reducción en el uso de material
- Aspecto de producto farmacéutico
- Verde o ámbar traslúcido

Beneficios

La utilización de PP reciclable tanto en la botella como en la tapa significa una mejora radical en la fase final de la vida del producto. El PP también representa la ausencia de impacto corrosivo tanto en moldes como en maquinaria. Este material también tiene mayor absorción de la luz que el PVC, propiedad importante para conservar los productos medicinales.
El frente de la botella se ha incrementado en 28 – 38% y el diseño da la impresión de mayor volumen.

Resumen de los beneficios con relación al producto de referencia:

- Reducción del peso (de 30 a72% según la presentación)
- Igual capacidad
- Los sobrantes de PP son completamente reciclables
- No hay desperdicios de PVC (800 kilos al año)
- Reducción en los costos de materiales 54% (32g en la botella)
- PP es amigable con el ambiente
- PP se utiliza para el frasco y para la tapa
- No produce impacto corrosivo ni en los moldes ni en las maquinarias
- El PP tiene mayor absorción de la luz que el PVC

Ecodiseño en Centroamérica

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ecodiseño centroamérica

FACT SHEET AVENTURAS NATURALIS

Empresa: Aventuras Naturales
País: Costa Rica
Productos: Operación de servicios turísticos
Proyecto: Mejoramiento ambiental de servicio de rafting en el Río Pacuare

Beneficios
- Separación y reciclaje de todos los desechos generados durante el tour, uso de productos de limpieza biodegradables.
- Consumo de productos de la zona en beneficio de microempresario local.
- La empresa está próxima a obtener el Certificado de Sostenibilidad Turística que otorga el Instituto Costarricense de Turismo.
- Lanzamiento de un nuevo producto con fuerte componente educacional en biodiversidad.

La empresa
Aventuras Naturales se fundó en 1987, es una de las empresas pioneras que ofrece servicios de rafting en Costa Rica y actualmente se considera una de las empresas más grandes y serias del país en este campo. Laboran en total 25 empleados en planta más aproximadamente 30 guías turísticos los cuales son subcontratados. La empresa cuenta con instalaciones en San José, donde se concentran la labores de mercadeo, reservaciones y contabilidad. En el Río Pacuare tienen un albergue, *el Pacuare Lodge*, con 7 habitaciones (boungalows) y dos ranchos de servicio en donde se hospedan los turistas que optan por recorrer el Río Pacuare en dos o más días. También la empresa posee dos bodegas donde se guardan los equipos de rafting.
Aunque el principal servicio que ofrece la empresa es el rafting en diferentes ríos, también ofrecen tours en bicicleta, caminatas en bosques y canopy tours en el *Pacuare Lodge.*
Más del 50% de los clientes de Aventuras Naturales proviene de los Estados Unidos, 40% son europeos y únicamente 2% son costarricenses. En su mayoría los turistas que llegan a Aventuras Naturales lo hacen a través de las agencias de viajes, sin embargo cada vez más se realizan reservaciones a través de internet.
A pesar de que Aventuras Naturales ofrece un servicio que se considera de alta calidad y el turismo de aventura en Costa Rica experimenta ha experimentado un importante crecimiento en los últimos años, la empresa se ve amenazada por la operación de varios competidores más informales que ofrecen servicios de inferior calidad a precios bajos y han sido responsables de recientes accidentes que han dañado la reputación del rafting.

El producto
Se seleccionó el servicio de rafting en el Río Pacuare de dos días. El servicio comprende el transporte de los turistas de San José al río, desayuno en un restaurante durante el trayecto, rafting, hospedaje y alimentación en el *Pacuare Lodge,* almuerzo a la orilla del río en segundo día y transporte de vuelta a San José.
Una parte importante de los costos del servicio lo constituye la alimentación y el transporte de los turistas.

Contexto ambiental
El producto que ofrece Aventuras Naturales se enmarca dentro del Ecoturismo, según esto la empresa debe ser consecuente en todos sus detalles del servicio con la protección de la naturaleza y la optimización de los recursos. En el estudio del ciclo de vida del producto, se encontró que los principales impactos ambientales que genera la compañía se generan en el transporte en bus de los turistas y en los empaques de los alimentos que se consumen. Dado que el albergue no cuenta con electricidad se dificulta la conservación de los alimentos y se hace imposible comprar los alimentos en presentaciones grandes, las cuales son más económicas y favorables en términos ambientales.
Cabe destacar que existen otras consideraciones ambientales que la empresa ha demostrado una actitud muy proactiva. En la construcción del albergue no se talaron árboles sino que se adquirió un terreno que había sido una plantación de cacao y se utilizó madera de árboles caídos para la construcción de los ranchos. Ante la amenaza de la deforestación en los alrededores del Pacuare, la empresa adquirió30 hectáreas de bosque virgen para asegurar su conservación. La empresa continuamente se preocupa por ayudar a la comunidad indígena a través de fuentes de trabajo y mantenimiento de instalaciones educativas.

Propuesta de diseño
El proyecto se enfocó en implementar todas las opciones posibles para disponer adecuadamente los desechos de la alimentación, hacer uso de materiales biodegradables e investigar opciones para generar energía en el albergue que al menos permitieran iluminar los senderos y mantener en refrigeración los alimentos. Además surgieron ideas para el diseño de nuevos productos explotando al máximo el componente de educación en temas de biodiversidad y conservación.

Beneficios
El servicio de rafting cuida todos los detalles de forma que existe congruencia entre el concepto de calidad del servicio y protección del medioambiente.
Entre otras cosas se implementaron las siguientes acciones:

- Utilización de productos de limpieza biodegradables
- Campaña de reutilización y reciclaje del papel de la oficina en San José
- Separación de la basura en el albergue y durante el almuerzo a la orilla del río.
- Transporte de desechos de vidrio, plástico y aluminio para su reciclaje.
- Estudio preliminar de generación hidroeléctrica en el albergue.
- Consumo de productos de la zona tilapias, beneficiando a un pequeño empresario local.
- Inicio de gestiones para optimizar el servicio de transporte en conjunto con otra empresa.
- La empresa está próxima a obtener el Certificado de Sostenibilidad Turística que brinda el Instituto Costarricense de Turismo.
- Lanzamiento de un nuevo producto con fuerte componente educacional en biodiversidad.

FACT SHEET EL JOBO

Empresa: Cooperativa Yutathui, s.c. de r.l. / Hacienda El Jobo
País: El Salvador
Productos: queso, leche fluida y crema
Proyecto: Ecodiseño de la crema de 45% de grasa

Resultados

- Disminución de 30% de consumo de agua
- 20% más de aprovechamiento de crema
- Desarrollo de dos productos para el complemento de la línea de cremas: crema especial con 30% de grasa y liviana con 18% de grasa
- Mejor imagen del producto con su nuevo diseño.
- Menos uso de tintas en el empaque.
- Ahorro en la factura de electricidad por un monto de USD 1,000 por mes.

La empresa

En 1979 se constituyó la Sociedad Cooperativa Yutatui que posee la planta láctea, fincas de 324 hectáreas y un rastro modular. La empresa se ha caracterizado por utilizar tecnología avanzada en el manejo de los potreros, mejoramiento genético y producción de pastos, lo cual permite la producción de leche de excelente calidad. Actualmente la industria láctea produce quesos frescos, leche fluida y crema de 45% de grasa. Sus productos se caracterizan por su buen sabor y su tradición en el mercado.
La producción diaria de leche es de 5000 a 7000 litros diarios, se emplean aproximadamente 20 empleados en la planta.
Ante la presencia de nuevos productos en el mercado y bajos precios, la empresa tiene diferentes estímulos para mejorar sus productos, entre ellos la necesidad de reducir costos, mejorar la imagen del producto, necesidad de formulación de nuevos productos y cumplir con la nueva legislación aplicable a los productos lácteos.

El producto
El producto seleccionado es la crema del 45% grasa, este producto es uno de los líderes en el mercado salvadoreño y es el producto que genera más ventas para la empresa.
La elaboración de la crema comprende las siguientes etapas: ordeño, transporte de leche, descremado, estandarizado, pasteurizado, envasado, refrigeración, despacho y transporte a los puntos de venta. Se realizó un estudio de mercado que permitió conocer la situación de las cremas en el mercado meta y su situación en los puntos de ventas, para con ello identificar la

necesidad de complementar el productos con otros de menor contenido de grasa, pero manteniendo una imagen de marca.

Contexto ambiental

Durante todas las etapas de producción de leche, procesamiento de la crema y transporte del producto se generan diversos impactos ambientales, los más relevantes para el medio ambiente son: generación de estiércol (2-3 toneladas diarias), aguas con alta carga orgánica del lavado de equipo y zona de ordeño, generación de suero, fugas de vapor y desecho de empaques plásticos.

Propuesta de diseño

Se sugieren mejoras en dos direcciones: uso eficiente de los recursos y diseño de una línea de nuevos productos basado en un estudio de mercado realizado por un estudiante de la Universidad Landívar de Guatemala, quien formó parte del equipo de Ecodiseño.

Las medidas para hacer un uso eficiente de los recursos incluyen: reparación de fugas de agua en la planta, cambio de mangueras más delgadas, colocación de pistolas de presión en las mangueras, colocación de contadores de volumen de agua, reparación de pisos para facilitar las tareas de lavado y mejora la higiene, retornar los condensados para alimentar el agua de la caldera, reparar fugas de vapor en el pasteurizador, colocación de cortinas en cuartos fríos, regalar el suero a finqueros de la zona y otros.

Los requerimientos para elaborar nuevos productos que le produzcan a la empresa mayor rentabilidad son:

- Producir tres tipos de crema: alta en grasa (producto actual que tiene mucha aceptación) con 45% de grasa, especial con 30% de grasa y liviana con 18% de grasa.
- Optimizar el empaque de manera que se utilice menos material.
- Minimizar el uso de tintas de impresión del empaque a través de un nuevo diseño gráfico del empaque.
- Incluir en el empaque toda la información que las instituciones gubernamentales solicitan al aplicar una nueva legislación.

Beneficios

La empresa tomó conciencia de los diferentes impactos que generan sus actividades de procesamiento de lácteos y está generando un plan de acción para implementar las medidas recomendadas. No obstante, en el corto plazo la empresa ha logrado disminuir de 2 a 3 metros cúbicos de agua por día con la colocación de pistolas en las mangueras. Instalación de capacitores que demando una inversión de USD 4600, con un ahorro mensual de USD USD 1100, por lo que la inversión se recuperó en 5 meses.

Por otro lado, la empresa diseñó un nuevo producto que le generará beneficios en su competitividad ya que logra optimizar el uso de la crema y mejorar de imagen del empaque. Por mencionar algunos:

- Disminución del tamaño del empaque.
- El nuevo diseño gráfico del empaque requiere de menos tintas.
- 20% más de aprovechamiento de materia prima con la nueva formulación.
- Una expectativa de crecimiento en ventas en la línea de cremas en 2,000 botellas por año.

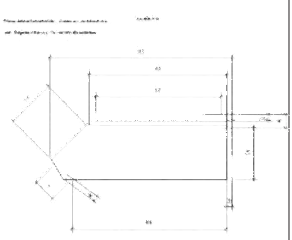
Ecodiseño Guatemala

Empresa: Turbomac
País: Guatemala
Productos: Estufas, comales
Proyecto: Ecodiseño de estufa semi industrial

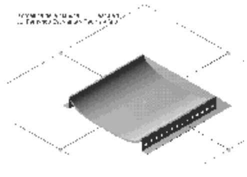
ecodiseño centroamérica

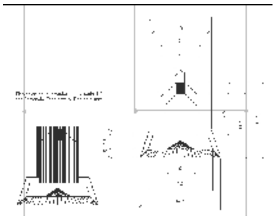
Resultados:

- ❑ Nuevo producto modular que reduce el tiempo de producción
- ❑ El cliente puede adicionar más quemadores a su estufa y puede ahorrar 30% en el consumo de gas
- ❑ Potencial de incrementar las ventas anuales totales de la empresa
- ❑ Colaboración con otras empresas de metalmecánica para el troquelado de piezas
- ❑ Instalación del sistema de quemadores fabricado por Turbomac en una empresa metalmecánica que redujo el consumo de gas en 30%
- ❑ Aplicación del enfoque de ecodiseño en toras estufas



Evita la deforestacion mediante el uso de gas natural.





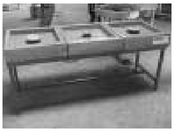
La empresa
- Es una pequeña empresa familiar del sector metalmecánico que produce estufas, quemadores y comales principalmente.
- Busca producir objetos que reduzcan la deforestaciòn y que sean eficientes.
- La misiòn consiste en aumentar sus ventas, ampliar su segmento del mercado y transmitir los beneficios ecològicos y econòmicos de sus productos.

El producto
- Es una estufa de un quemador, de multiples usos para comercios pequeños.
- Está elaborada principalmente de lámina y tubo de hierro.
- No es desarmable, es pesada y de estética no estudiada.
- No está estandarizada
- Las características de diseño del producto, hacen que no sea desarmable, ni ergonómico,ni estético.
- Sus costos de producción no están claros.

Contexto ambiental
- Utiliza soldadura en su producciòn.
- No es fácilmente desarmable (por lo tanto reparable y desarmable)
- Aprovecha material, en su forma y en el uso de materiales de desecho.
- Su quemador es eficiente en el uso de gas.

Propuesta de diseño
El principal reto para el proyecto fue la innovación:
- *Cumplir con los requerimientos propuestos,*
- *Mejorar su desempeño ambiental,*
- *Mejorar la estética y funcionalidad*.

Metas
- Que la estufa sea armable, ensamblable, modular y de fácil transporte.
- Reducir o eliminar los métodos de producción que no sean ecológicamente limpios o contaminantes.
- La estufa debe de cumplir con aspectos de diseño como ergonomía, facilidad de producción y mejoras de funcionalidad.
- El nuevo producto tomará en cuenta la vida del producto después de su uso.



▪La manipulación del producto y su reparación no debe de ser complicado, debe de poderse hacer con herramientas sencillas.

Beneficios

ESTRUCTURA EXTERNA
Los paneles fueron diseñados para ser fácilmente fabricados por medio de cortes rectos y dobleces. Su forma permite troqueles de 45 grados o cortes por medio de guillotina. Esto tiene el propósito de facilitar la producción trabajando con la maquinaria disponible. Los paneles permiten una apariencia de mayor calidad y vistosidad sin comprometer la estructura. También facilita el concepto de modularidad. Otra ventaja es la facilidad de reemplazo de piezas, que contribuye a las metas de la empresa de reciclar estufas usadas.

ESTRUCTURA DE SOPORTE
Este sistema de patas se adapta al concepto de modularidad. Permite además la fabricación de piezas estandarizadas, apilables y aplicables a los tamaños posibles. Este sistema facilita el transporte y almacenaje del producto.

ACCESORIOS
El producto se adapta fácilmente a las necesidades del cliente por medio de los accesorios.•Los accesorios son de fácil ensamble, se instalan fácilmente y no afectan la circulación de aire, por lo que •la limpieza se hace rápidamente con un trapo común.

AHORRO DE ENERGÍA: el sistema de quemadores consigue un ahorro del 30% en el consumo de gas

VENTAS: La empresa espera vender 100 estufas por mes y en su mayoría serían de 2 quemadores, ya que recibió buena aceptación del público en las ferias donde se ha presentado el producto.

Ecodiseño en Centroamérica

El Ecodiseño se refiere a la integración de aspectos ambientales en el diseño de un producto, con lo cual se logra mejorar la calidad del mismo y, a la vez, reducir costos de fabricación. La metodología se basa en conceptos de ciclo de vida del producto y en producción sostenible. El proyecto en Guatemala es una iniciativa de CEGESTI, Costa Rica y Guatemala la Universidad Tecnológica de Delft.

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Ecodiseño Centroamérica

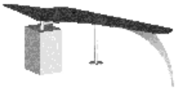
Empresa: Executiv S.A.
País: Guatemala
Productos: Mobiliario y accesorios de oficina
Proyecto: Ecodiseño de un excritorio para asistente gerencial

Beneficios:

- 60% reducción en utilización de materiales
- 70% reducción en tiempo de ensamble
- Instalación, operación y mantenimiento más sencillos.
- Implementacion de materiales reciclables.
- Armado y ensamble mas sencillos.

Los Muebles

Escritorio de Asistencia Gerencial con capacidad de modulación y accesos faciles para ubicar una



La empresa
Executiv es una empresa mediana. Produce muchos tipos diferentes de mobiliario para oficina, modulares e individuales, ejecutivos y gerenciales. Actualmente cuenta con dos plantas de producción y posee la única maquina CNC para perforacion metálica así como el innovador proceso de pintado en polvo en Guatemala. El mercado es local, sin embargo exporta parte de su producción a El Salvador.

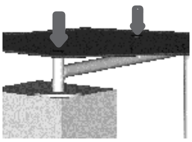
En Executiv producen accesorios especiales para empresas y oficinas preocupadas por la imagen y la funcionalidad eficaz. Las nuevas oficinasson capaces de modular espacios y proyectar una mejor imagen corporativa atraves de los escritorios y demás accesorios. Se realizan esfuerzos para disminuir el impacto ambiental durante el proceso de producción, así como mejoras en la distribución y mantenimiento de los muebles. La empresa tiene la visión de incrementar un mercado internacional a través de Internet, un catalogo digital, y una sala de ventas virtual. La nueva organización de bodega será por medio de un inventario que, por medio de Internet, proveera de producto al extranjero. Esto permitirá la expansión del mercado y grupo objetivo. Procurandose mejorar continuamente su línea de productos.

El producto
Se escogió un escritorio para asistente de gerencia, como objetivo del proyecto. Este poseera la posibilidad de ser utilizado con una computadora o no, sin dejar de verse funcional. En las oficinas actules, este mueble se usa para la recepcion de personal ajeno a la empresa y muchas veces para dividir visualmente los espacios arquitectonicos de la oficina. Usualmente se utiliza un archivero y papeleras adyacentes. Contiene conductos de cableado para las computadoras y las instalaciones electricas y telefonicas. Los materiales varían desde metales, hasta maderas y plásticos.

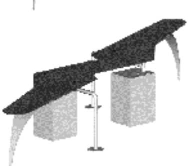
El precio de este mueble oscila alrededor de los Q. 600 y Q. 1000, dependiendo de la calidad y tamaño del mueble, así como los accesorios adicionales. Para su producción se utilizan principalmente hojas de metal, pero los acabados son usualmente de madera en la superficie de trabajo, y cantos y tapones plásticos.

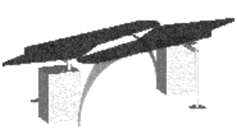
Contexto ambiental
Uno de los aspectos más importantes que afecta al ambiente es el desperdicio de material en la producción. También algunos procesos de fabricación, pero ya están siendo controlados así como la pintura y la utilización de desechos para otras cosas. Otro factor importante es el transporte de estos muebles. Los escritorios son muebles relativamente grandes y pesados, que usualmente se distribuyen armados y ensamblados, reduciendo el espacio de transporte y repercutiendo en varios viajes de distribución por mueble.
Otros factores obvios son el consumo de energía y el impacto ambiental de las materias primas utilizadas para su fabricación.

Reducción de materiales. Utilización de materiales reciclables. Optimización de la vida útil a través de piezas ensamblables que pueden ser sustraidas y remplazadas sin afectar el mueble completo.



Muebles rediseñados de formas modulares y bajo conceptos innovadores.





Propuesta de diseño

El análisis demostró que las opciones mejores y con más potencial estaban relacionadas con la reducción en la utilización de materiales y mecanismos de ensamble demasiado complejos. También el desarmado y armado para mantenimiento. La utilización de materiales para proyectar una mejor imagen corporativa de los usuarios. Para esto se penso en el aprovechamiento de los materiales, un posible cambio en los mismos, el proceso de ensamblado y la facilidad de utilización.

Por estas razones en este proyecto surgió como prioritario una estrategia de diseño que mejorara las técnicas de transporte y ensamblado, considerando la eliminación de elementos innecesarios. La simplificación de los accesorios para su optimo funcionamiento. La estrategia escogida contempló también una reducción en la utilización de materiales que significa también una reducción de los costos. A mediano plazo Executiv desea integrar más innovaciones en el proceso de diseño para desarrollar un concepto completamente diferente, innovador y vanguardista, pero conservando la línea de Diseño con detalles con los que los usuarios se sientan identificados.

Beneficios

El proyecto permitió elaborar un modelo nuevo y planes de producción completos. Muchas partes del escritorio fueron eliminadas por ser innecesarias o imprescindibles para que la función del escritorio fuera adecuada. Se Diseño y propuso dos alternativas modulares de escritorios bajo conceptos completamente nuevos, que satisfacieran las nesecidades de los usuarios, así como los parámetros de producción. El nuevo diseño es por esto mucho más simple y compacto, tanto en lo relacionado con la producción como con el transporte.

La eliminación de elementos superfluos y la simplificación de su construcción también tiene como efecto secundario que el escritorio se vea más elegante y permita la modulación del mismo.

Las mejoras se centraron principalmente en el uso de materiales, las formas de la superficie de trabajo, y en la simplificación del producto.

- El producto contiene menos de materiales.
- El ensamblado es aproximadamente el 50% más rápido.
- La capacidad modular aumentó considerablemente, proporcionando mas opciones de armado y opciones más interesantes de modulación.
- El producto contiene menos piezas de ensamble y esto es muy apreciable con relación al transporte.
- Tanto la instalación como el mantenimiento son más sencillos. Algunas operaciones han sido eliminadas. Además permite la compostura y mantenimiento de partes individuales sin necesidad de dejar al usuario sin mueble por el tiempo de mantenimiento.
- Para el cliente es ahora más fácil redistribuir los espacios con sus muebles.
- El costo podrá ser aumentado redundando en mayores utilidades para la empresa.

Ecodiseño Guatemala

Empresa: Inmepro
País: Guatemala
Productos: Cocinas de Acero Inoxidable
Proyecto: Ecodiseño de una estufa industrial de gas, de acero inoxidable

Beneficios:
- reducción de materiales
- mejoras en procesos de producción
- reducción de costos
- reducción de soldaduras
- reducción de peso
- eliminación del piloto de gas


Muestra


La estufa industrial tradicional

La empresa
Fundada en 16 de febrero de 1989.
INMEPRO es una empresa orientada a satisfacer con eficiencia el suministro de equipo y servicios para el proceso de preparación, cocción, conservación y servicio de alimentos. Realiza e importa cocinas industriales de acero inoxidable y otros metales, para restaurantes, además algunos de los productos que fabrican contienen accesorios de madera, plásticos y otros acabados.

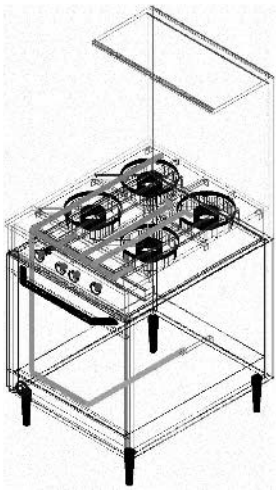
El producto
El producto elegido para ser ecodiseñado es una estufa industrial de acero inoxidable.
Hasta el momento Inmepro solo ha importado estufas industriales, no se ha producido ninguna en su planta, por lo que se espera el rediseño de la estufa, sea competitva con las marcas existentes.
La estufa realiza las funciones de cocinar alimentos, en algunos casos guardar utensilios de cocina; gratinar, asar, hornear y/o freir alimentos. Pero, por ser de carácter industrial, es necesario que tenga un tiempo de vida largo (un mínimo de 15 años).

El rediseño de la estufa industrial presenta un reto para la empresa, ya que es la primera vez que lanzará al mercado el producto, realizado por ellos mismos. Por lo tanto las prioridades que se le dieron al producto fueron:
- reducción de costos, materiales, peso y soldaduras del producto convencional
- eliminación de los pilotos de gas (factor ambiental y de seguridad)
- implementación de funciones opcionales del producto (modularidad)

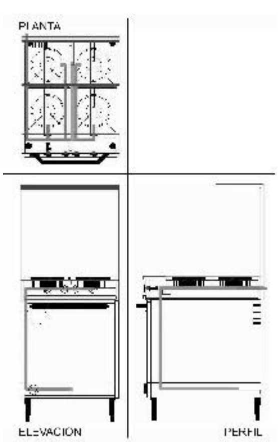
Contexto ambiental
Los factores que más afectan al producto ambientalmente es el proceso de fabricación, ya que se utiliza soldaduras, pinturas nocivas al medio ambiente. Además el peso del producto, por los materiales utilizados y las cargas que tiene que soportar, es relativamente alto.

Propuesta de diseño
El análisis demostró que las mejores opciones y con mayor potencial estaban relacionadas con la optimización de la producción y la reducción en la utilización de materiales, soldaduras y peso.

Por lo tanto, se buscó la reducción de las soldaduras del producto, por medio de ensambles con dobleces y tornillos; y en el caso de tener que utilizar soldaduras, éstas se reducen a los puntos mínimos necesarios; permitiendo que el proceso de ensamblaje sea más rápido. También el concepto de modularidad aplicado al producto, permite su agilización en la producción.



Estufa industrial de acero inoxidable ecodiseñada



Es importante mencionar que la reducción de materiales utilizados, abrió el margen de posibilidad para la reducción del peso y el costo del producto. Finalmente, se concluyó que no eran necesarios los pilotos de gas en la estufa, siendo estos factores ambientales positivos, así como de seguridad y costo.

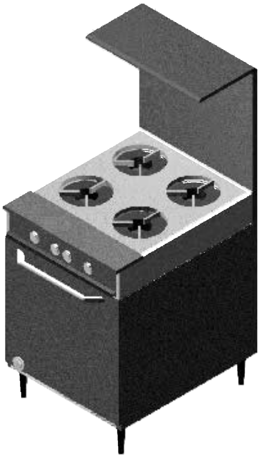
Beneficios

1ero.las prioridades que se tomaron en cuenta para el ecodiseño de la estufa industrial son:

- •reducción de materiales
- •reducción de procesos de producción
- •reducción de costos
- •reducción y/o eliminación de soldaduras
- •reducción de peso
- •utilización de procesos durante la vida del producto que tengan el menor impacto ambiental posible.
- • Eliminar el piloto de gas

2do.los cambios que se realizaron al rediseñar el producto, fueron:

- •estufa:
  - •concepto modular. Existen tres posibilidades para la estufa industrial básica: horno, un gavetero o simplemente la estructura.
  - •Hornillas, se redujo el material a utilizar, se eliminaron soldaduras y se aprovechó al máximo la forma para que sea funcional en la limpieza del producto.
  - •Estructura de soporte. Para los quemadores y las hornillas, se redujo al máximo la cantidad de material.
  - •Quemadores. Se negociarán con suplidores, con el fin de aumentar la eficiencia y el ecodiseño de los mismos.
  - •Switches. Se redujo material y se estilizó la forma de los que responden a los quemadores de la estufa.
  - •Cuerpo de la estufa. Se eliminó completamente la estructura, las uniones se harán por medio de dobleces y tornillos(incluso la unión con alguna de las tres opciones).
  - •Timer. Adición del elemento a la estufa industrial
  - •pilotos de la estufa y el horno. En la última sesión se planteo la posibilidad de eliminar los pilotos de la estufa, siendo ésta prendida por medio de fósforos(como normalmente se realiza). Esto no solo permitirá la reducción de costos, de materiales, de impacto ambiental del gas, sino ayudará a la seguridad del cliente; evitando las fugas posibles de gas.
- •horno
  - •estructura de soporte. Se redujo la dimensión del diámetro del tubo que se utiliza, sin cambiar las propiedades de la misma.(de 1” a _”).
  - •Paredes internas. Ya que las paredes internas se deben moldear para aprovechar el calor del horno, la misma forma de moldeo servirá para dar lugar a la estructura de soporte de las parrillas.



•Parrillas. Se redujo el material, eliminando las dos últimas varillas de los laterales de la parrilla y utilizando para el cuerpo varillas de 3/16” en lugar de 1/4”, que únicamente se usará en la estructura base.
•Puerta del horno. Se redujo el grosor de la puerta a 1 1/2”. El mango o agarrador del horno se disminuyó en grosor(3/4”) y tamaño (en lugar de abarcar todo el ancho, tiene de largo 16”).
•Switche. Estará colocado en la parte baja del horno, cerca del quemador; lo cual permitirá ahorro de materiales y efectividad al prenderlo, ya que se eliminó el piloto del horno.

Ecodiseño en Centroamérica

El Ecodiseño se refiere a la integración de aspectos ambientales en el diseño de un producto, con lo cual se logra mejorar la calidad del mismo y, a la vez, reducir costos de fabricación. La metodología se basa en conceptos de ciclo de vida del producto y en producción sostenible. El proyecto en Guatemala es una iniciativa de CEGESTI, Costa Rica y Guatemala la Universidad Tecnológica de Delft.

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Annex B Project Reports

Case study graduation and internship reports

1. Augustijn, C.D. And I. Uijttewaal (1998). Ecodesign at Venus company, Guatemala, internship report, Delft University of Technology.

2. Baas, L. (1998). Development of an appropriate ecodesign approach for Panel Ex Costa Rica, graduation report, DfS Delft University of Technology.

3. Baas, M. (1999). Thermoplastic packaging design for a medicine bottle at Kontein, El Salvador, graduation report, DfS, Delft University of Technology.

4. Bijma, A. (1999). Development of an Ecodesign Tool for Costa Rica: The PIT method, graduation report, DfS Delft University of Technology.

5. CEGESTI and Prop, J. (1999). Ecodesign at Industrias Bendig, project report, CEGESTI, Costa Rica.

6. Dijk, L. van and C. Dresselhuys, (2001). Ecodesign projects in three metal companies in Guatemala, internship report, DfS, Delft University of Technology.

7. Garvik, T.I. (1999). Ecodesign of Talleres REA Guatemala Pulpero (depulper in coffee processing) graduation report, DfS, Delft University of Technology.

8. Hoornstra, P.C. (1998). Ecodesign of professional cooling equipment in Costa Rica, graduation report, Delft University of Technology.

9. Mendes da Costa, M. (1998). Ecodiseño Tropicalizado. An analysis on barriers and stimuli for ecodesign in Costa Rican firms, graduation report, DfS Delft University of Technology.

10. Raangs, A. (2001). Analysis on possibilities for ecological improvements at Aventuras Naturalis Internship report, DfS, Delft University of Technology.

11. Ruyter de Wildt, T.R.J. de, (1999). Environmental friendly kitchen cabinet for MöbelArt, El Salvador, graduation report, Delft University of Technology.

12. Sagone, F. (2001). Ecodesign of cream and packaging at El Jobo, El Salvador, internship report, Landivar University.

13. Verveer, S. (1999). The redesign of a transport packaging for tropical flowers at Heliconia del Caribe, graduation report, Delft University of Technology.

14. Wijnans, D. (1999). Environmental sound packaging and distribution concept for MAFAM cookies in Costa Rica. Graduation report, DfS, Delft University of Technology.

Project reports and deliverables to the Dutch Embassy

The following reports have been prepared by the project team and submitted by DfS, CICAT and CEGESTI to the Dutch Embassy at Costa Rica:

15. Project proposal (July 1997)

16. Progress report 1998 (Feb 1999)

17. First phase mid-term evaluation report (Apr. 1999)

18. First phase final report (Feb. 2000)

19. Project extension document (March 2000)

20. Progress report 2000 (Feb. 2001)

21. Project Extension mid-term review report (July 2001)

22. Progress report 2001 (Feb. 2002)

23. Final executive report (June 2002)

24. CEGESTI, M. Crul and J.C. Diehl (1999) Manual para la Implementación de Ecodiseño en Centroamérica (in Spanish). CEGESTI, San José, Costa Rica.

25. Fact sheets of ecodesign results in each company (in Spanish)

26. Ecodesign website

Other project documents

27. Course programme and evaluation Delft course (1998)

28. Course programme and evaluation Regional courses (2000)

29. Course programme and evaluation Delft High-level course (2000)

30. Report Regional Conference (1999)

31. Reports National Workshops (2001)

32. Report Eco-indicator workshop (2000)

33. Ecodesign award scheme (extended into Environmental technology and innovation award scheme) (2001-2002)

Annex C: Project People, Facts and Figures

PEOPLE

Dutch Embassy in Costa Rica
Mr. Henk Lolkema, project officer 1999-2002
Mr Jan Bauer, project officer 1998

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Theresia Twickler (2002)
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Liselotte van Dijk
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Jildou de Raad
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Elske Schotte

Inge Uijttewaal
Sijmen Verveer
Dinand Wijnans

Landivar University:
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Rocio Jimenez
Francisco Sagone
Luci Ventura
Andres Zea

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James Anderson (Heliconia)
Ingrid Hoffmaister (Mafam)
Manuel Roldan (Panel-ex)
Victor Bendig (Bendig)
Daniel Peyer and Roberto Fernandez (Aventuras)
Eduardo Weymann (Venus)
Alfredo Echeverria (REA)
Marco Alvarado (Turbomac)
Juan Kolter (Executiv)
Oscar Vasques (Inmepro)
Mauricio Dada (Möbelart)
Luis Cienfuegos (Kontein)
Lino Osegueda (El Jobo)

FACTS AND FIGURES

Project proposal: July 1997
Project period: January 1998 – April 2002
Budget: 617.275 Euro

Missions TUD: 30
Regional missions: 50

Project reports
Project proposal (July 1997)
Progress report 1998 (Feb 1999)
First phase mid-term evaluation report (Apr. 1999)
First phase final report (Feb. 2000)
Project extension document (March 2000)
Progress report 2000 (Feb. 2001)

Project Extension mid-term review report (July 2001)
Progress report 2001 (Feb. 2002)
Final executive report (June 2002)

Activities and outputs:
Region-specific Spanish ecodesign manual
14 Fact sheets on product/service improvement, and 4 more form ITCR Ecodesign projects
14 Ecodesign projects in industry: 6 in Costa Rica (including one service-oriented project), 5 in Guatemala (including a metal sector approach) and 3 in El Salvador (including a chain-oriented approach)
Regional Conference on Ecodesign with over 100 participants
National Workshops on Ecodesign in Costa Rica, Guatemala and El Salvador, 40 participants each
Over 20 skilled Ecodesign advisors in the region, and over 50 trained professionals in the region
Courses on Ecodesign held in Delft (initial course and high-level course) and several courses held in the region
Survey on the use of regional eco-indicators
Organisation of a regional Ecodesign award contest – now embedded in a regional CCAD award scheme also for environmental innovation and energy efficiency
Ecodesign webpage
A variety of awareness raising activities including industry conferences, workshops, reaching hundreds of companies
Publications in local industry magazines and scientific conferences
Reports on all phases of the project and mid-term review reports
Counterparts in Guatemala, El Salvador and Honduras have activities in Ecodesign supporting local companies.

CO_2 emissions caused by the international flights for the project:
Each (one to two weeks) mission to Central America caused approximately 10-12 Tons of CO_2 to be emitted (transatlantic plus regional flights). In total, we executed about 30 missions, and in addition to this 16 Dutch students flew to the region and 20 people from Central America flew to The Netherlands to follow courses.
Other regional flights included flights from CEGESTI personnel to other countries and flights from other counterparts to the regional conference. About 80 return flights were made, each contributing 1 Ton CO_2.
In total, approximately 1.000 Tons of CO_2 were emitted caused by the transatlantic and regional flights for this project. To neutralize these emissions about 10 Euro has to be invested per Ton CO_2 in sustainable carbon-reducing projects. (source: Johannesburg Climate Legacy 2002 website). 10.000 Euro is needed to neutralize these emissions, about 1,5 percent of total project budget. The project partners should consider investing this amount locally on sustainable carbon-reducing projects.

Annex D: Counterparts in the project

CEGESTI, Costa Rica

CEGESTI was the main counterpart of the project in Central America, and regional project coordinator.
CEGESTI is a private, independent non-profit organisation, established in 1990 to support competitiveness of Costa Rican and regional industry. It offers integrated services on consultancy, certification, research and information to private and public organisations and companies.
CEGESTI provides services in the following fields:

- Quality management
- Financial management
- Organisational culture
- Environmental management
- Innovation
- Internationalisation
- International cooperation projects

Website: www.cegesti.org

ITCR, Costa Rica

ITCR, technological Institute of Costa Rica, also called TEC, is the most important technology university and institute in Costa Rica. Founded in 1971, it is dedicated to education, research and extension of technology and science.
The school of industrial design was the counterpart in the project. They offer education and services in the field of graphic design and packaging and product design.
Website: www.itcr.ac.cr

UTEPYME, Guatemala

UTEPYME is the technical unit for SME development at the Chamber of Industry in Guatemala. Working areas are: Competitiveness of SMEs, Environmental diagnosis, quality management, product design, process analysis, waste water treatment systems.
Website: www.industriaguate.com

University Don Bosco, El Salvador

University Don Bosco is a public university of Christian inspiration, founded in 1984. Counterpart in the project was the engineering faculty, school of mechanical engineering. Also, involvement took place by personnel of the environmental research programme of the university.
Website: www.udb.edu.sv

FIDE, Honduras

Although no project were executed in Honduras, participation in courses took place by people from FIDE – the Foundation for Investments and Development of Exports, a non-profit organisation with close connection to the government. Its mission is the improvement of the competitiveness of Honduras. Services are offered to local and foreign industry and investors.
Website: www.hondurasinfo.hn

FEPYME, Guatemala

FEPYME – Federation of SMEs of Guatemala – is an independent industry organisation. Services include education and certifcation, organisation of sector groups, technical support, and information.
Website: www.fepyme.org

University of Landivar, Guatemala

University Rafael Landivar is a private university. Counterpart is the department of industrial design of the faculty of architecture and design, providing the sole industrial design curriculum in the country.
Website: www.url.edu.gt

AG-TECH, El Salvador

AG-TECH is an association of technical advisors for industry, a public non-profit organisation.
Services include formation of professional associations, education and certification, execution of technological and environmental projects in industry, networking and information.
Website: www.geocities.com/ag_tech_el_salvador/AG-TECH.html

ITCA, El Salvador

ITCA (Technological Institute Central America) is a private educational institute with a variety of technical careers. It supported AG TECH in the project by providing internship students to the project.
Website: www.itca.edu.sv

DfS, Delft University of Technology, The Netherlands

DfS, the Design for Sustainability programme, is a section of the Product Innovation and Management department, faculty Design, Engineering and Production, Delft UT. The group is responsible for a part of the Industrial Design Engineering (IDE) programme taught at Delft University of Technology. Research includes topics such as sustainable service systems, end-of-life systems, ecodesign methodology and systems design.
DfS was overall project coordinator of the Ecodesign project.
Website: www.io.tudelft.nl/research/dfs

CICAT, Delft University of Technology, The Netherlands

CICAT is the central liaison office of the Delft University of Technology (DUT) providing its faculties and departments with management support in the field of development cooperation activities. The activities implicate long lasting cooperation projects with universities and research organisations in Africa, Asia, Latin-America and to some extend in Eastern Europe.
CICAT was administrative and financial coordinator of the project.
Website: www.cicat.tudelft.nl

Annex E:

The Regional Competitiveness Agenda for Central America

The Competitiveness Agenda (INCAE 1999) resulted from a decision made by the Presidents of Central America after signing the declaration on the Alliance for Sustainable Development in Central America (ALIDES) in August 1994. The purpose, stated by the Presidents in the declaration, was the focusing of regional efforts on the achievement of more sustainable human development. According to the Presidents, economic development must be pursued together with social welfare, political democracy, and environmental balance. In essence, the Agenda is a strategy proposing concrete steps to jump-start the economic progress of the region. The strategic programs formulated are aimed at supporting the Central American countries in their efforts to take advantage of their competitive strengths and to quickly achieve higher levels of competitive development. The studies in the Agenda on the position of Central America in the global economy confirm the opportunities of the region based on three sources of competitive advantage. These are its privileged geographical location, its ecological diversity that includes a large number of resources not found anywhere else, and its forest and agricultural potential that can be exploited throughout the entire year.

Since most of the actions proposed by the Agenda are national in nature, domestic agendas were developed in each country. They were created by teams of professionals who discussed them in consultation with governments and business groups. They agreed with the authorities and the Committees of Competitiveness in each country of the content of these agendas. Particular features of each country are recognized, as well as different priorities, speed, and way to implement reforms.

In the development process for the Agenda an effort was made to propose only those tasks that are viable both politically and economically. These must also have enough transformational potential to produce significant improvements in the current business climate of Central America. The region already has a significant number of investment-driven companies that compete satisfactorily in international markets. It is increasingly obvious that many companies that participate in international markets on the basis of inexpensive, abundant, and unsophisticated resources have clear options to strengthen their competitive positions. To do so, they will be based on higher investment levels allowing them to sophisticate and increase the value of their products. Several world trends indicate that in the long term the pattern of competitiveness prevailing in Central America (basic factor driven, mainly cheap labour, cheap resources) will be decreasingly viable and capable of creating welfare.

Trends felt in Central America include the increase of population and the deterioration of the base of natural resources of the countries. Other trends felt are increasing demands for quality in international markets for goods based on natural resources and the effects of the technological revolution on the erosion of comparative advantage based on abundant and inexpensive resources. In the future these trends threaten to reduce the comparative advantage and the levels of profitability of activities based on the unsophisticated use of abundant and inexpensive resources. The strategy in the Agenda aims at halting and reversing this trend.

High potential clusters

Studies on Central American economic activities most likely to profitably penetrate the international market led to the identification of four production sectors where several clusters with high competitive potential focus.
These are:

- tourism,
- textile industry,
- high-value-added agribusiness, and
- industries of electronic components and software production.

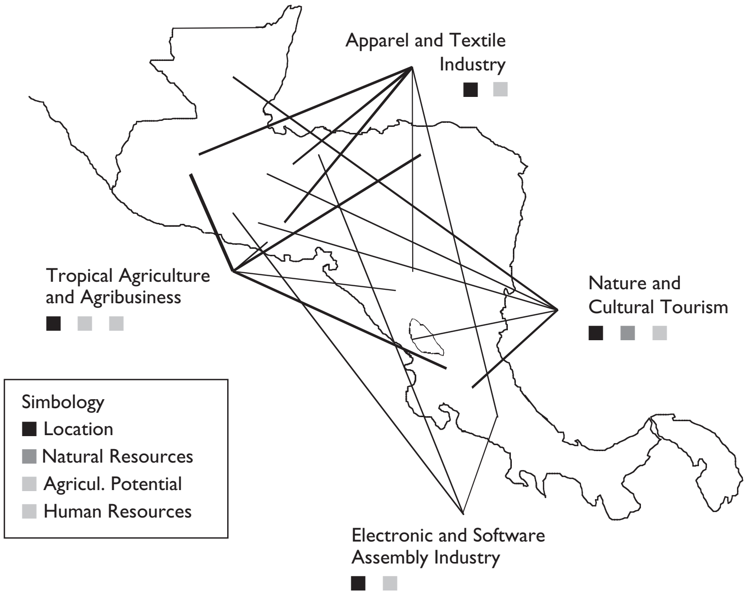
The Agenda fostered in depth studies regarding these activities, as well as inquiries to business chambers, institutions, and different organisations related to them. In addition, strategic proposals have been made to develop them.

The tourism cluster owes its huge potential to the region's geographic location, endowment of natural resources, and climate. These factors allow Central America to offer a particular type of nature-based tourism with a strong and increasing demand. Other categories such as archaeological tourism, colonial cities, diving, and living cultures, are an ideal complement to nature tourism. The strategic proposals of the Agenda regarding this cluster aim at turning tourism in the main source of foreign exchange in the region. They also aim at reaching a regional income from tourism of approximately US$4 billion in 6 years and give tourism a unique position in the world, reaching world-class standards.

Historically, the agribusiness cluster has served as the pivot for the economy in the region. Its potential is based on exceptional climate conditions in the region. Agribusiness clusters are the major clusters in Central America. However, their true potential remains untapped to a large extent. Trends in the world market and previous experience provide new opportunities for the region. The Agenda proposes a strategy to speed the advance of these clusters to enhance investment and productive-innovation levels. This will result in better positions for business firms in the international market and will increase economic and social benefits for all Central Americans.

The textile and apparel cluster takes advantage of Central America's privileged position to export to the United States. It is undergoing a favourable transition toward selling complete packages including basic design and supply services. Conditions are favourable for it to evolve toward a cluster with high worldwide competitiveness. The Agenda proposes a regional strategy to make the industry evolve toward a more sophisticated one, providing better-paid jobs to more qualified personnel and increasing its contribution to the wealth and welfare of Central American countries.

Figure: Potentially Competitive Central American Clusters



Clusters of software and electronic services are just beginning. However, this is a promising cluster in Central America. The direct investment from Intel Corporation to a Central American country—Costa Rica seems to serve as a catalyser to the development of this industry in that country, where already 30 firms exist, many of them world-class. Other countries in the region have very real options for this type of development. This makes it valuable to promote this beginning cluster at a regional level. In addition, the growth of software exports in different countries led to giving special attention to this promising trend in the Agenda.

The four clusters presented are an example of Central America's sustainable-competitiveness strategy potential. However, the clusters will not achieve their potential without serious efforts by the private and public sector leaders to overcome critical restrictions in the Central American business environment. Although development possibilities in each of the clusters are unique, "bottlenecks" imposed by the underdeveloped business environment will be limitations bearing on each of the four sources of competitiveness in the business climate.

Some action areas are:
- Improve infrastructure for trade logistics – build a ‘ Central American Logistics Corridor’
- Improve the base for technology and productive innovation – by improving funding mechanisms for R&D in this field
- Attracting foreign investment to energize competitiveness

Competitiveness and the environment

For competitiveness to persist in the long run, it is imperative that business strategies include environmental variables. Sustainable productivity is only possible when natural resources are efficiently used and when degradation of the natural resource base can be avoided in the long run. This base underlies productive activity and differentiates the region from its competitors.

Recent research has shown that the conventional view is that improved environmental standards in developing countries hinder competitiveness and discourage foreign investment is not currently true. Presently, it is certain that by adopting stable and stringent environmental requirements, Central America can greatly enhance its business climate and better attract and support foreign investment capable of upgrading the competitive profile of the region. Three basic reasons underlie this statement.
- The competitive countries in the world are also those with the most stringent environmental standards. Stringent rules that are flexible in their means to achieving results appear to be those leading to the highest increases of competitiveness.
- Leading firms around the world now come to expect stringent but fairly enforced standards to be a part of a desirable business climate.
- Central America’s most competitive firms are already engaged in improving environmental management and performance in response to customer demand, foreign country import rules, and international level expectations about firm environmental responsibility.

Lack of involvement of the leading firms in the region’s environmental matters signal instability to high quality foreign investors. The table below summarizes the findings from a recent survey of 100 leading firms in each country of the region. In comparison with the results obtained, world-class competitive economies consistently show awareness levels of environmental requirements close to 100 percent and compliance levels of over 90 percent.

Results of the survey of a hundred business leaders in each central american country regarding the environmental practices of their companies (percent of affirmative answers in the survey)

Countries	% with written plan to reduce env. impact	% with specific programs in place	% familiar with env. laws	% with plans to comply with env. laws and regulations	% training workers in health and safety	% with written emergency plan
Guatemala	29%	39%	48%	45%	88%	33%
El Salvador	48%	24%	59%	31%	82%	20%
Honduras	42%	39%	60%	42%	91%	23%
Nicaragua	40%	25%	55%	26%	61%	24%
Costa Rica	62%	33%	70%	40%	97%	24%
Central America	**42%**	**31%**	**58%**	**36%**	**82%**	**24%**

Numbers represent percentages of firms claiming to have the listed attributes. Total sample population was approximately 100 per country for a total of approximately 500 responses.
Source: Survey of Central American Business Leaders on Business Climate (1997)

Analysis of 16 leading industries across Central America found general levels of environmental performance to be low. In all countries, and in most of the industries, environmentally related information and supporting services were found to be weak. Environmental rules were found to be unclear, frequently out of date and largely irrelevant for most of the industries. Market pressure and access to international markets were found to be more important drivers in most instances. Of particular concern were the conflicting signals received by the private sector that influenced behaviour deemed environmentally unsound or conflicting. For example, subsidized water, and implicit subsidies for imported chemical inputs are leading to a distorted resource allocation that causes environmental harm. Financial policies and banking practices were also found to cause environmentally harm, and in some cases even environmentally illegal, behaviour.

According to CLACDS research, there is convincing evidence that reorientation of the role of the environment in the region's competitive strategy will greatly enhance its competitive position for the future. The challenge for Central America is to leverage international market forces to rapidly create value based on natural resources endowment. The environment agenda should include the following four key areas to help Central America improve its competitiveness and its environmental sustainability in a mutual reinforcing manner.

The four areas are:

- Creation of the correct business climate to stimulate foreign investment and trade
- Competitive success in the tourism sector
- Competitive success in the agricultural sector
- Successful participation in global climate change markets.

Curriculum Vitae of Marcel Crul

Marcel Crul (1957) graduated as MSc in Biology at the University of Nijmegen in 1983. He has his private consultancy Aries Environmental Innovation (1990 -2003), based in Nijmegen, The Netherlands, and is co-operating with various other research and consultancy colleagues throughout the world on joint projects. He is performing consultancy, research and education in the field of preventative environmental approaches, Environmental Innovation, Cleaner Production and Clean Products in industry. Marcel Crul was and is involved in the project coordination and performance of several national cleaner production/products programmes and projects, and in related policy studies and research programming. Also, he has participated in the development of cleaner production and ecodesign methodologies and dissemination of knowledge of these approaches. He has a central position in research, networking and capacity building of these types of approaches in Europe, and has experiences in the fields of Technology Assessment, Network building and Policy formulation on Innovation issues. Marcel Crul is expert consultant and evaluator for several development co-operation projects (a.o. for UNIDO, Worldbank) in Asia, Africa and Latin America on the issues of innovation and sustainability.

Previous positions of Marcel Crul are:

- Part-time appointment at Delft University of Technology, Design for Sustainability Programme as project leader for the project Ecodesign in Central America (1998-2002).
- Senior staff member of the Dutch Advisory Council for Research on Nature and Environment (1990-1992).
- Senior staff member at University of Amsterdam, Interfaculty Department on Environmental Science (1985-1990)
- Associate of the Institute of Applied Extension Science, Wageningen (1983-1985).