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Personalised design knowledge transfer**

Diehl, J. C.; Brezet, J. C.

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INTERNATIONAL ECODESIGN EDUCATION: PERSONALISED DESIGN KNOWLEDGE TRANSFER

J.C. Diehl and Prof. J.C. Brezet

Keywords: *Ecodesign, Design for Sustainability, Education, Knowledge Transfer, Cultural Differences*

Abstract. *Since the beginning of the 90's Ecodesign Education and Knowledge has been built up based upon Ecodesign methodology developments and experiences in education and in practice in demonstration projects. During the end of the 90's first attempts took place to transfer the created Ecodesign education and knowledge from Europe to other parts of the world like Central & Latin America, India and Africa. Because of the differences in economical, social and cultural contexts the European Ecodesign approaches had to be adapted to the local situations in order to become effective and successful.*

Based upon these experiences we came to the conclusion that in order to transfer Ecodesign knowledge in an effective way to the local receivers (students, consultants, professionals), the specific background and characteristics of the receiver and the local context should be taken (more) in mind. For example in the case of the development of an international Ecodesign course one should consider the following variables of the local receiver in order to prepare appropriate educational materials and methods of transfer:

- *The profession background (designer or engineer),*
- *The experience (student or professional),*
- *The learning style (e.g. the local teaching style and interaction with professors),*
- *The local economical developments (levels of innovations, SMEs vs. big industries),*
- *The cultural context (like e.g. uncertainty avoidance, hierarchy, team work)*

As part of the PhD research of the first author, a model for "International Ecodesign Education Development and Transfer" is under development taking into consideration the above mentioned and other personal and contextual variables. The model has been used to evaluate 6 international Ecodesign education and training projects (in Colombia, Spain, India, Central America, Belgium and Africa). The outcomes of the research will be used to develop the new United Nations Environment Program Ecodesign Manual called "D4S".

1 Introduction

The amount of available knowledge, approaches and course materials in the field of Ecodesign has grown in such a way that it is not anymore easy to integrate it into one manual and might be beyond the interest and need of a single person. In the meantime we can observe a growing interest from universities worldwide to integrate Ecodesign in their curriculum or training activities. Taking in mind this growing amount of demand and at the same time an increase of available knowledge, it will be important to develop an efficient and effective way for the knowledge transfer from the knowledge systems (sender) to the receiver. However since the context of the recipient of this Ecodesign knowledge might be (totally) different in cultural, socio-economic and professional context aspects from the context of the knowledge

sender, it is essential to make the knowledge transfer tailor made to the context of the receiver.

2 Ecodesign

A still increasing world population together with an increasing use of product and services per person is leading to a considerable growth of consumption of products and accompanying environmental impact. It is estimated that as much as 75% of the environmental impacts (as well as the costs) that a product throws off throughout its entire lifecycle is determined at the design stage! This is the stage in which the materials are chosen, the manufacturing methods are designed, when it is determined how much energy will be used in the use phase and whether the product will be easy to recycle [1]. Design can play an essential role in preventing environmental damage and in the meantime to increase the social values of products.

Design for Sustainability

Design for Sustainability or Sustainable Product Development has the aim to take Environmental, Social as well as Economical aspects (triple bottom line) of the total lifecycle of a product or service into account during the development stage. At the moment most of the experiences, methodologies and tools are focussed on only two of the three above-mentioned aspects: ecology and economy. This approach is often called Ecodesign.

Ecodesign

Ecodesign focuses on the integration of Economical and Ecological considerations into product planning, development and design processes. The goal is to minimize the environmental impact of the total product life cycle by taking environmental consideration already into account in the beginning of the development of a new product.

2.1 Ecodesign Manuals and tools

The first initiatives in the field of Ecodesign started in late eighties in Europe and the USA. In the beginning of the 90's, a first range of 8 Ecodesign demonstration projects in different industrial sectors (like furniture, automotive and packaging) took place in the Netherlands. Based upon the experiences, a first serious attempt was made to develop Ecodesign methodology and tools. As a result the Design for Sustainability (DfS) program in collaboration with other Dutch partners published in 1994 the "PROMISE" Ecodesign manual [2]. Three years later an updated version has been launched in assignment of the United Nations Environment Program (UNEP) called "Ecodesign: a promising approach" [3].

This "PROMISE" Ecodesign approach has been the starting point for the development of several other international and local Ecodesign manuals. Some examples of Ecodesign manuals that are based upon the PROMISE approach are:

- *Ecodiseño CentoAmerica*: An Ecodesign Manual based upon the experiences with Ecodesign in 15 SME's in Central America executed by CEGESTI (Costa Rica) and DfS.
- *Manual práctico de Ecodiseño*: Manual developed by IHOBE (Regional Spanish Government) to support Basque SME's with a special focus on the use of Eco-Indicators.
- *Ecodiseño; como estrategia de innovacion*: from the University of Los Andes in Colombia developed for educational purposes and industry in Latin America.

- *Ecodesign: a promising approach to sustainable production and consumption*: from NTNU in Norway for educational purposes.
- *Factor 10, information point for Ecodesign*: developed by the local government in Belgium for local companies.

Most of the above mentioned manuals are online available like for example the two Spanish version of IHOBE and CEGESTI (see figure 1). The web-site addresses of the online available manuals can be found in the reference list.



Figure 1: Ecodesign Manuals based upon the PROMISE approach in the North of Spain and in Central America available on-line.

The goal and main approach of the various manuals are the same, but related to the local context they differ in for example the (local) examples of Ecodesign in practice, focus on more qualitative or quantitative tools, writing style, structure and lay-out.

2.2 Ecodesign approaches

The PROMISE approach is a typical “EcoRedesign” approach. The methodology is based upon an existing product in an existing company as a starting point for redesign. Experiences with working with students and companies showed that there is a need for additional Ecodesign approaches besides the “EcoRedesign” approach. On one hand there is a need for a more simplified approach based upon the daily practice of many company to copy or imitate products from competitors. This new approach is called Eco-Benchmarking and has as goal to learn from the environmental characteristics of products of competitors in order to decrease the environmental impact of your own products. On the other hand there was a need for a method that would go beyond “EcoRedesign” in order to come to radical innovations with more environmental (and economical) benefits. This Eco-Innovation approach consists of several sub-approaches in order to come to new innovative products and services:

- Integrating new technological innovations like sustainable energy technologies or new sustainable materials.
- Sustainable entrepreneurship by setting up new sustainable businesses or by creating sustainable coalitions.
- By switching from products to product service systems.

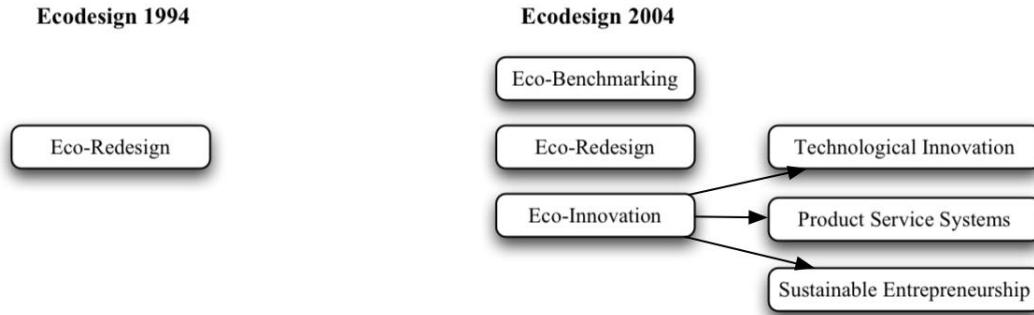


Figure 2: The evolution of Ecodesign approaches.

3 International Ecodesign Knowledge Transfer

As mentioned above, during the last 10 years a lot of experience with the Ecodesign approach in an international context has been gained and several new Ecodesign approaches and tools have been developed. This has led to a tremendous increase of knowledge, approaches and course materials in the field of Ecodesign. The collective Ecodesign knowledge has grown in such a way that it is not anymore easy to integrate it into one manual and might be beyond the interest and need of a single person.

In the meantime we can observe a growing interest from universities worldwide and other knowledge transfer organisation to integrate Ecodesign into their curriculum or training activities. Taking in mind this growing amount of demand and at the same time an increase of available knowledge, it will be important to develop an efficient and effective way for the knowledge transfer from the knowledge systems (sender) to the receiver.

This has been the starting for constructing a model for the international transfer of Ecodesign knowledge. The goal of the model is to make the knowledge transfer more efficient (with less costs) and more effective (more deeper learning) by taking into consideration the characteristics of the receiver and his or her local economical, professional and cultural context. Since manuals, course materials and tools play an important role in the knowledge transfer of Ecodesign, we will focus our research on these aspects. The receiver is the central focus point of this model:

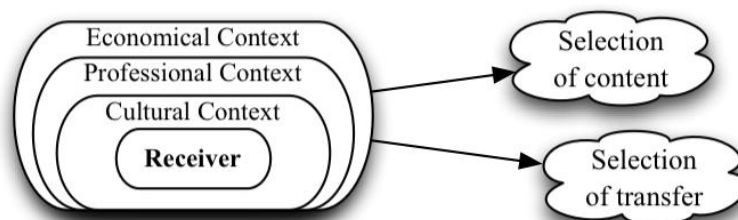


Figure 3: The context of the receiver and the relation to selection of content and mode of knowledge transfer.

These and other factors can provide directions for the knowledge transfer in a sense of:

1. What kind of specific Ecodesign knowledge is relevant for the receiver (selection of content)?
2. In which way should the knowledge be transferred to the receiver (selection of transfer method)?

In the following paragraphs we would like to illustrate how these factors can influence the content and mode of transfer.

3.1 The Professional Context

Depending on the current or future professional context of the receiver he or she might need knowledge and skills in different Ecodesign disciplines. The target group of Ecodesign courses and manuals are mainly those professions that are involved in the New Product Development (NPD) process, mainly Industrial Designers and Design Engineers.

1. Industrial Designers are involved in the early stage of the product development process, where the design brief is at its most flexible. Divergent thinking, innovation driven, concept based and looking towards the future are typical characteristics of the way of working of this target group. Industrial Designers normally try to develop knowledge and skills in many disciplines and to moderate level (in between awareness and expertise).
2. Design Engineers focus their activities on present day projects and the continuation of development and redesigns current (families of) products. The problems have been identified, clearly defined and the methods and process are convergent oriented. Design Engineers often specialize themselves in a specific field. They try to achieve expertise in a few sub disciplines.

As one can observe, the differences in profession can lead to a different selection, different amount and more or less profoundness in Ecodesign topics.

1. Industrial Designers would prefer to get awareness and basic knowledge of as much as possible different disciplines within the Ecodesign Field.
2. Design Engineers prefer to get in-depth information in specific fields (mainly the more technical oriented disciplines like Eco-Benchmarking, Eco-Redesign and Life Cycle Assessment).

In their daily practice Industrials Designers tend to use more “innovative tools” and Design Engineers more “adaptive tools”. Lopez-Mesa [4] has made an overview the differences of innovative and adaptive tools.

INNOVATIVE METHODS Industrial Designer	Divergent Methods		ADAPTIVE METHODS Design Engineer
	Facilitate the detachment of the problem from the way it is customarily perceived	Useful for further development of already known solutions	
	Stimulate the generation of a large amount of ideas	Develop further a single idea	
	Tend to produce imprecise ideas of wide diversity	Tend to produce concrete solutions within a focussed solution space.	
	Convergent Methods		
Require approximate or soft information on concepts	Require hard and precise information about concepts		

	Evaluation of a large amount of diverse ideas	Evaluation of a single concept	
	Gather together information that helps to take a decision	Give a numerical solution	

Table1: Classification characteristics of tools used by Industrial Designers and Design Engineers.

This classification clarifies also our own experiences with the selection and satisfaction of Ecodesign tools by these two target groups. For example there is wide range of Ecodesign tools available to make an environmental assessment of a product life cycle and to generate improvement options. Industrial Designers tend to prefer more to use qualitative Ecodesign approaches like for the example the MET-matrix for the environmental assessment and more innovative & future oriented Ecodesign tools like back-casting and brain-storming to develop conceptual solutions. Design Engineers might give preference to quantitative tools like Life Cycle Assessment for the environmental assessment that give a numerical solutions and prefer checklists and value engineering for generating improvement options.

3.2 Available Ecodesign Tools

As mentioned above, different professions prefer different kinds of Ecodesign Tools. In order to check the availability of this needed range of Ecodesign Tools we have been evaluating current Ecodesign Manuals on Ecodesign Tools [5]. Within the evaluated Ecodesign manuals a serious amount of Ecodesign tools are being described in detail or just mentioned in general. Ursula Tischner [6] has earlier categorised Ecodesign tools into four categories. Based upon this categorisation 18 Ecodesign manuals have been screened on tools “explained in detail” or “just mentioned”. In total more than 60 Ecodesign tools are being referred. The next table shows the amount of available Ecodesign tools in each of the four categories.

Ecodesign tools	Amount
Tools for environmental analyses	39
Creativity techniques	6
Setting priorities & decision making	10
Cost accounting	6

Table 1: Amount of available different Ecodesign tools within each category.

Also the amount of times, that these tools are being explained “in detail” in the 18 Ecodesign manuals have been analysed.

Ecodesign tools	Freq.
Tools for environmental analyses	132
Creativity techniques	9
Setting priorities & decision making	28
Cost accounting	8

Table 2: Frequency of Ecodesign tools explained “in detail” in 18 Ecodesign manuals.

It was surprising to see how much more tools have been developed to analyse the environmental position of the company and its products compared to the other categories. The manuals do not provide many appropriate and creative tools for generating (design)

improvements for the environmental problems encountered during the analyses phase. It is also striking to see that there is a little or no attention for the financial aspects of Ecodesign, especially since most of the manuals are meant for companies.

3.4 Tools for environmental analyses	
MET-Matrix	13
Examples and case studies	12
Worksheets	10
Product Life Cycle	10
Ecodesign Strategy Wheel	10
Ecodesign Checklist	8
Rules of thumb	6
Creativity techniques	
Brainstorming techniques	3
Setting priorities & decision making	
Ecodesign feasibility matrices	10
Eco-portfolio matrix	6
Cost accounting	
Life Cycle Costing	3

Table 3: Most mentioned Ecodesign Tools

The MET matrix and the Ecodesign Strategy Wheel are the most mentioned specific Ecodesign tools. Both tools find their origination in the PROMISE Ecodesign Manuals.

3.5 The economical and political context

The local economical and political context does have its impact on amongst others the characteristics of the product development process and the local drivers for Ecodesign. For example in industrialising countries:

- Often Small and Medium Sized (SME) companies are the main majority of the industrial sector.
- Often it lacks of a structured product development process within these SMEs.
- They operate mainly in “low-tech” sectors like food-processing, metal processing, furniture etc.
- They often base their design upon local and international competitors.

In such a context, the Ecodesign course materials content should be focussed on a SME environment taking in consideration that it often lacks of a structured product development process. In this context copying is the most prevalent road to developing new products. Looking at the different Ecodesign approaches, EcoBenchmarking and EcoRedesign will be more relevant in this context than the more radical innovative Ecodesign approaches.

The selection of examples to illustrate the potential of Ecodesign should be in line with characteristics of the local industrial sectors. In the case the Ecodesign manual for Central America, an module on EcoBenchmark was added to be more connected to the local approach for product development.

3.6 Drivers

The internal (e.g. cost reduction) and external (e.g. environmental legislation) drivers for companies and organisations to initiate Ecodesign projects differ worldwide. In some regions there are several incentives in others they might lack. Normally, a mix of internal and external drivers motivates a company to initiate Ecodesign activities. Depending on the economical, social and political contexts they might differ in topics and more or less importance of external drivers compared to internal drivers.

From our experiences of working in Central America and in Europe we can see a clear difference in drivers for Ecodesign. In the absence of local external drivers for eco-design, such as legislation and supplier/customer demand, internal drivers are even more important for the introduction of eco-design in companies in Central America. The main internal drivers in the companies were cost reduction, innovation, new market opportunities and developing a competitive edge. The main external eco-design driver was the export market.

In the European context external drivers for eco-design are important. EU and national product oriented environmental policies, market demand, activities of competitors, quality demands from suppliers and pressure from ‘civil society’ (environmental organisations, public pressure) all can motivate companies to start eco-design. In most Central American projects, external drivers for eco-design have been absent. Legislation is basically effect- instead of prevention-oriented and certainly not focused on integral environmental aspects of products. Existing industry related environmental policy is generally not very well established, nor strictly implemented.

Because of the importance of the internal motivators in the context in Central America, an additional Ecodesign tool was developed called Product Improvement Tool (PIT) [7] focussing on the internal drivers quality and cost reduction.

3.7 The cultural context

Cultural differences influence the way we communicate and learn. The models on cultural differences from Geert Hofstede [8] and Edward Hall [9] can be translated to (cultural) differences in teaching and learning. This might be of relevance for example when course materials and instructions from North Europe are being transferred to Central or Latin America. To give some ideas: Geert Hofstede refers to five dimensions of cultural differences:

- Small Power Distance versus large Power distance
- Individualism versus Collectivism
- Masculinity versus Femininity
- High Uncertainty Avoidance versus low Uncertainty Avoidance
- Long term versus short term pragmatic

Geert Hofstede has translated these dimensions also to teaching and learning [8]. Latin American Countries have in general an opposite score in these dimensions of North European countries. Latin American countries are characterised by a relative high power distance, a masculinity and collectivism society and high uncertainty avoidance. The effect of these cultural differences on the education is illustrated in the next table.

Latin America	North Europe
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Large Power Distance societies	Small Power Distance societies
<ul style="list-style-type: none"> • Students expect teacher to initiate communication • Students expect teacher to outline paths to follow • Teacher is never contradicted nor publicly criticized 	<ul style="list-style-type: none"> • Teacher expects students to initiate communication • Teacher expects students to find their own paths • Students may speak up in spontaneously in class • Students allowed to contradict or criticize teacher
Collectivist Societies	Individualist Societies
<ul style="list-style-type: none"> • Students expect to learn how to do • Diploma certificates are important and displayed on walls 	<ul style="list-style-type: none"> • Students expect to learn how to learn • Diploma certificates have little symbolic value
Strong Uncertainty Avoidance Societies	Weak Uncertainty Avoidance Societies
<ul style="list-style-type: none"> • Students feel comfortable in structured learning situations: precise objectives, detailed assignments, strict timetables • A good teacher uses academic language • Students are rewarded for accuracy in problem-solving 	<ul style="list-style-type: none"> • Students feel comfortable in unstructured learning situations: vague objectives, broad assignments, no timetables • A good teacher uses plain language • Students are rewarded for innovative approaches to problem solving

Table 4: Cultural differences in learning and education (Hofstede, 1986)

This kind of insight in differences in learning and education can help to make the development of new Ecodesign course materials more appropriate for the receiver.

4 The new UNEP Ecodesign Manual

At the moment an international team is working on the follow up of the in 1997 published UNEP Ecodesign manual.



Figure 4: The new logo and name for the new UNEP Ecodesign Manual.

The goal is to integrate new developments in the field of Ecodesign but also to make the content dynamic in such a way that it can be adjusted to need and the profile of the knowledge receiver. Within this interactive manual the user will get guidance to collect the appropriate Ecodesign content and mode of transfer. Depending on the personal characteristics different

Ecodesign topics and different levels of profoundness will be offered. It is expected that the new UNEP Ecodesign Manual, named “D4S”, will be online by the of 2005.

5 Conclusion

There is a serious interest and need for Ecodesign knowledge transfer cross-border and cross-cultural. However the Ecodesign knowledge transfer will be often not successful if the context if the receiver has not been taken into consideration. This PhD research is a first attempt to support the selection of appropriate knowledge content and mode of transfer.

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J.C. Diehl and J.C. Brezet
Design for Sustainability program
Industrial Design Engineering
Delft University of Technology
Landbergstraat 15
2628 CE, Delft, The Netherlands
+31 15 278 2231
j.c.diehl@io.tudelft.nl