DESIGN FOR SUSTAINABILITY

A PRACTICAL APPROACH FOR DEVELOPING ECONOMIES

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ACKNOWLEDGEMENTS

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FINANCIAL SUPPORT

InWEnt - Capacity Building International, Germany

FOREWORD

It is clear that current patterns of consumption and production are unsustainable. The accelerating processes of globalization and trade liberalization, supported by advances in information technologies, have fundamentally changed the landscape of the private sector in all countries -developed and developing- providing new opportunities and challenges. Companies, large and small, have made impressive efforts to address sustainability issues with a triple bottom line focus. Design for Sustainability (D4S) has the potential to improve efficiencies, product quality and market opportunities (local and export) and at the same time improve environmental performance. In many developed countries, because of a high level of awareness, D4S efforts are linked to the broader concepts of product-service mixes, systems innovation and other life cycle-based efforts. In developing economies, due to limited awareness, more immediate technical support is needed to introduce the D4S concept. However, successful implementation of D4S requires working in partnership. This publication is an example of one such effort.

The growing attention paid to D4S is a natural outcome of UNEP's work on cleaner production, eco-efficient industrial systems and life cycle management. It is the next step in a progressive widening of the horizon of pollution prevention; a widening which has gone from a limited focus on production processes (cleaner production), to include products (ecodesign), product-systems (D4S incorporating transport logistics, end-of-life collection and component reuse or materials recycling) and systems innovation.

Building upon the work carried out with the Dutch Delft University of Technology and other experts in ecodesign, UNEP published the ground breaking manual 'Ecodesign: A Promising Approach to Sustainable Production and Consumption" in 1997. The concept of product re-design has since then spread as seen in the number of manuals and sector specific supporting materials now produced in many languages. As a result and based on experience gained, ecodesign has evolved through Design for Environment (DfE) to the broader concept of D4S – which encompasses issues such the social component of sustainability and the need to develop new ways to meet consumer needs in a less resource intensive way. D4S goes beyond how to make a 'green' product – and now strives to meet consumer needs through sustainability in a systematic and systemic way.

UNEP's activities in the D4S area include the development of an updated global manual for designers and other professionals working in the area of product development in industry and elsewhere to provide support and guidance on the evolved concept of D4S. It is useful to those new to ecodesign as well as those interested in breakthrough innovation for sustainability.

This practical approach for developing economies is based on the larger Design for Sustainability: A Global Guide but focuses on the specific needs of small- and medium-sized companies in developing economies. With all the progress in D4S, few targeted efforts have been made to introduce the benefits of D4S to business and business intermediaries in developing economies. Surveys of centres of excellence confirm that D4S is a service that they could sell to industry. Increasing focus of supply chain management efforts on resource use improvements reinforces this need. Whereas, in developed countries end-of-life regulations provide incentives for com-

panies to rethink what and how they are designing products, in developing economies products tend to be 'benchmarked' (copied) from those existing on the market. Companies are concerned about entering developed country markets. They need to take into account new market standards to have access. In general, there is also an overall lack of awareness in companies on how to improve efficiencies and improve environmental performance at the same time.

Developing economies have different and more immediate needs. Awareness about the implications of resource use – efficiency or environmental - is relatively low. Reaching companies in developing economies can best be done through intermediaries such as centres of excellence (UNIDO-UNEP National Cleaner Production Centres, for example) or through supply chain relations with larger companies including multi-nationals. Concerns for poverty alleviation and rapid environmental degradation underscore the potential in developing economies for integrating D4S into business development. D4S is one approach that enables 'leap frogging' over the resource intensive and pollution generating development patterns that have been followed by developed countries. UNEP, whose mandate is to work globally on environmental protection and poverty reduction, especially in developing economies, is one of the key international actors involved in developing this approach.

A draft version of the D4S approach was tested and modified based on the results of a training session sponsored by InWEnt in October 2005, on representatives from 9 countries. The publication introduces the D4S concept and outlines how to apply it in a company setting. It can be used by companies to pursue internal D4S efforts (via the supply chain or single operation context) and by intermediaries who work with companies. The initial dissemination of the D4S concept will be through the UNIDO-UNEP NCPCs, which operate as capacity building focal points in some 30 countries. To further adapt the training materials, relevant examples and case studies will be developed based on demonstration projects being carried out in Costa Rica and Morocco in 2006. The lessons learned from the projects will be integrated into the Spanish and French versions of the manual which will be available on UNEP's web site in 2007.

UNEP invites partners - companies, industry associations, governmental bodies, educators- to join in collaboration by using the material in their own training programs and developing additional sector/product specific guides on how to plan for and develop more sustainable products and services. In particular, we also welcome case studies of lessons learned and feedback on how to best apply the D4S concept in a practical setting.

Changing current unsustainable consumption and production patterns can benefit a lot from the D4S approach. We envision that, as a result of the joint efforts of all concerned partners, this publication will contribute to reversing the current negative trends.

Monique Barbut
Director
UNEP DTIE

D4S GRAPHIC DESIGN CONCEPT

The D4S graphic design of this publication is based on the sustainability concept and its consideration of the three elements of PEOPLE, PROFIT AND PLANET. The graphic design is comprised of 3 subjects and 3 colours to illustrate these elements:

PEOPLE are illustrated by the expressions of Human beings from different cultures and races.

PLANET is represented by different natural elements of the planet such as water, rocks, trees, sand and plants.

PROFIT is illustrated by views of the building environment taken from examples of highly developed sites from throughout the world.

The graphic design was developed by SUSDESIGN, an entity devoted to the promotion of Design for Sustainability and is illustrated with photographs of Carmen van der Vecht and SUSDESIGN.

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D4S
DESIGN FOR SUSTAINABILITY

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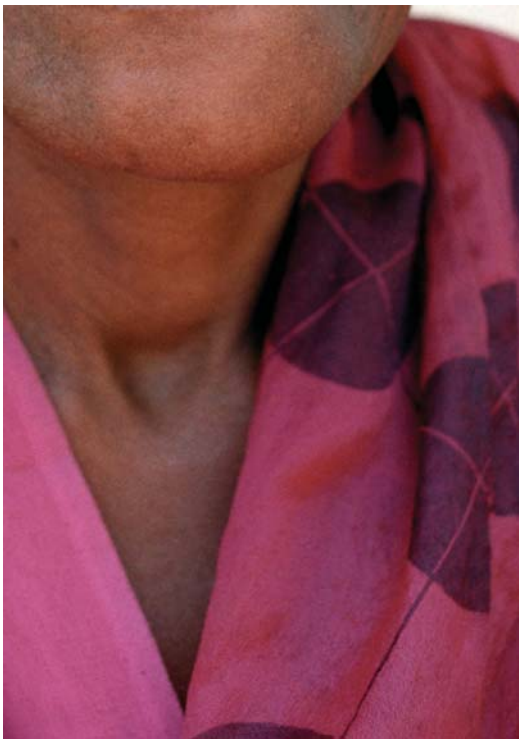

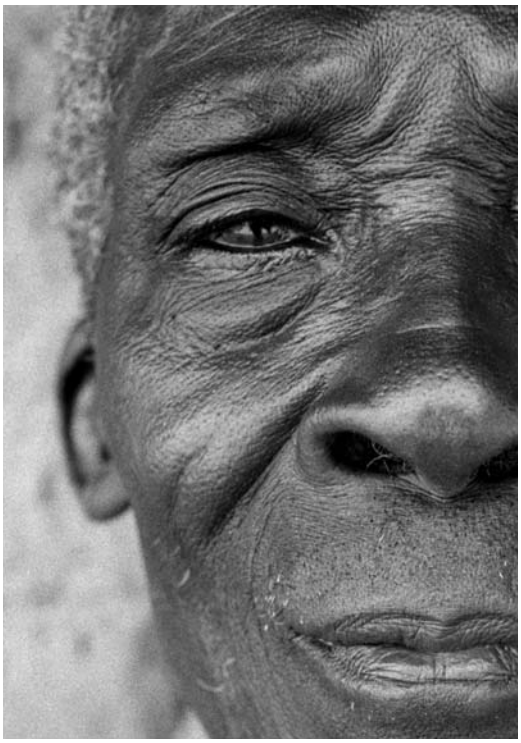

PEOPLE

PART I

WHAT IS D4S AND WHY DO IT

001 INTRODUCTION

Welcome to the joint UNEP and Delft University of Technology publication on Design for Sustainability: a practical approach for developing economies! In this introduction, the relevance of D4S for developing economies is highlighted. Next, the target groups of this publication are defined, and the overall structure of the publication is explained.

1.1 THE RELEVANCE OF DESIGN FOR SUSTAINABILITY (D4S)

Product Innovation

Companies all over the world increasingly need to innovate their products and processes to: keep up with competitive pressure; increase productivity within the region or worldwide; defend or expand market share; and to create the ability to attract foreign investments. However, companies in developing economies can be left out of this cycle for a variety of economic and structural reasons.

Product innovation is becoming one of the key strategic options available to firms, supply chains and integrated industrial sectors in developing economies to compete better in today's global market. Through advances in information, communication and infrastructure, local and international markets are becoming more competitive and challenging - obliging companies to adapt.

The interest in product innovation has grown rapidly during the past decades. Industrialisation, open markets, higher (quality) requirements from customers and an increase in competitiveness between companies locally and globally have created a serious demand for a structured process for product innovation within industry. Industries cannot survive in the long-run without product innovation as an integral part of the company management and product development processes. International industries have reacted to these developments by creating their own product innovation departments or by consulting with external product innovation experts. Many medium-sized or large companies have at least one product innovation expert in their management team.

In developing economies the importance of product innovation is rapidly increasing as well. In India, for example, product innovation has become an important discipline, especially after the Indian market opened to international competition.

Small- and medium-sized industries (SMEs) will need to focus on product development as well. In addition to in-house product development expertise, this can be done by cooperating with sector organisations, or bringing in external experts from consultancies, universities and other expertise centres.

Products and Sustainability

Growing global concerns about environmental problems such as climate change, pollution and biodiversity loss and about social problems related to poverty, health, working circumstances, safety and inequity, have fostered sustainability approaches for industry. In the international policy arena, as illustrated by the World Summit for Sustainable Development, governments, industry and civil society have adopted the term sustainable consumption and production.

Improved product design which applies sustainability criteria - Design for Sustainability (D4S) - is one of the most useful instruments available to enterprises and

governments to deal with these concerns. D4S includes the more limited concept of Ecodesign or Design for the Environment. In many developed economies D4S is closely linked to wider concepts such as sustainable product-service systems, systems innovations and other life cycle based efforts. In developing economies a lack of awareness remains a stumbling block.

A broad definition of D4S would be that industries take environmental and social concerns as a key element in their long-term product innovation strategy. This implies that companies incorporate environmental and social factors into product development throughout the life cycle of the product, throughout the supply chain, and with respect to their socio-economic surroundings (from the local community for a small company, to the global market for a transnational company (TNC)).

UNEP and Delft University of Technology

This publication was drafted by the Design for Sustainability (DfS) Programme of Delft University of Technology for UNEP's Production and Consumption Unit of the Division of Technology, Industry and Economics. Both organizations have been active in the area of promoting more sustainable product design since similar concepts were introduced in the 1990s.

Many organizations have developed tools and approaches to help companies (and those who work with companies) rethink how to design and produce products to improve profits and competitiveness and to reduce environmental impacts at the same time. In 1997 UNEP, in conjunction with Delft University of Technology and other experts in Ecodesign, published the ground-breaking manual "Ecodesign: A Promising Approach to Sustainable Production and Consumption." The concept of product ecodesign has since then spread as seen in the number of manuals and sector-specific supporting materials that are available in many languages. As a result, and based on experience, Ecodesign has evolved to encompass broader issues of the social component of sustainability and the need to develop new ways to meet consumer needs in a less resources intensive way. D4S goes beyond how to make a 'green' product and now embraces how best to meet consumer needs more sustainably on a systematic level.

UNEP's activities in the D4S area are varied. At the core, is the development of a new global guide for designers and industry providing support and guidance on the evolved concept of D4S (Design for Sustainability: A Global Guide, UNEP 2006). It is useful to those new to ecodesign as well as those interested in breakthrough innovation for sustainability. The guide is the result of the long-term cooperation of international D4S experts from the Netherlands, Sweden, Italy, France, Germany, Japan and Australia, UNIDO, the Swedish EPA and InWEnt, Germany and reflects the evolution of the concept since the initial guide was produced in 1997.

However, many sector- and country-specific issues still need to be addressed. In developing economies products tend to be 'benchmarked' (copied) from those existing on the market. Companies are concerned about developed country markets. They need to take into account standards of developed country markets to gain access. In general, there is an overall lack of awareness in companies on how to improve efficiencies and improve environmental performance at the same time.

As a result, UNEP sponsored the development of this publication that provides a simple step-by-step methodology that focuses on the needs of small- and medium-sized enterprises (SMEs) specifically in developing economies. UNEP invites partners - companies, industry associations, governmental bodies, and educators - to join and collaborate in developing additional sector and/or product-specific packages to promote D4S more widely.

The DfS Programme of the Delft University of Technology in The Netherlands has extensive experience in sustainable product innovation in developing economies. Several product innovation programmes have been carried out in Africa, Asia and Latin America over the last ten years, and new projects are started regularly. The projects are carried out in close cooperation with partners from local industries, transnational companies, universities, governments and non-governmental organisations. Several of the company projects serve as case studies in this publication.

1.2 To whom is this publication addressed?

This publication has been written for intermediaries that work with SMEs in developing economies, such as

centres of excellence (UNIDO-UNEP's National Cleaner Production Centres), business associations, consultants or universities. Next to these intermediaries, the publication can also be used by companies that are partners in a product innovation project or programme. The chapters on how to do D4S Redesign and Benchmarking are specifically written to be used by a project team of company representatives and intermediaries to execute a product innovation project.

Ideally, the D4S approach can be used in a collaborative process with several partners for whom this publication can serve as a reference methodology, and a source of information and experience.

1.3 How is the publication organized?

This publication has three parts, and each part has three chapters.

The first part, **What is D4S and why do it?** (Chapters 1 to 3) describes the D4S concept in more detail and what might motivate companies in developing economies to adopt it. Chapter 2 provides an overview of the relationship between sustainability and product innovation, which lead to the concept of D4S. The reasons and opportunities for SMEs in developing economies are explained. For the companies involved in a D4S project it may be the first time they have been involved in a systematic product development process. Therefore, Chapter 3 provides basic information on the concept of product innovation, and explains the steps of a product development process. The insights gained from this part can assist companies and intermediaries who work with companies in identifying the appropriate approach to product development and sustainability.

The second part, **How to do D4S in practice** (Chapters 4 to 6) is the backbone of this publication. It explains three practical, step-by-step approaches to execute a D4S project in a company. Chapter 4, the D4S Needs Assessment shows how to evaluate the economic position of a country and how to prioritize industry sectors in order to target the selection of demonstration project companies. This chapter is intended for intermediaries who set up a D4S programme or project. Chapter 5 outlines the step-by-step approach to carry out a D4S Redesign project, aimed at the sustainability-driven, incremental improvement of an existing product. In Chapter 6, the D4S Benchmarking approach is presented. In short, the approach is to use competitors' efforts to develop new products. This approach is especially suitable for those companies that develop products based upon imitating existing products. The redesign and benchmarking approaches are complementary to each other and can be used in combination.

For each of the three practical approaches of Part II, a set of accompanying worksheets is available on the CD-ROM which is inserted at the back of this publication. All worksheets are referenced in the text.

In Part III, Reference information on D4S, additional information is provided that can support the execution of a D4S project. Chapter 7 provides the reader with D4S case studies from developing economies. These case studies are examples for specific phases and strategies that are explained in Part II. Chapter 8 presents 'rules of thumb' for carrying out a D4S project. These are basic suggestions to consider when identifying sustainable product improvement options. Chapter 9 gives an overview of creativity techniques that can be applied by a D4S team during a project to come up with creative and novel solutions for product innovation issues. Lastly, suggestions for further reading are given.

On several places in the text, reference is made to other publications by citing the authors' name and the year of publication. These and other references can be found in the section 'Resources and further reading' after Chapter 9 of the publication.

The publication is supported by additional materials on the accompanying CD-ROM, including a printer-friendly PDF file of the whole publication, which is also available on the web at: www.d4s-de.org

An overview of the publication is in Figure 1.

PUBLICATION OVERVIEW

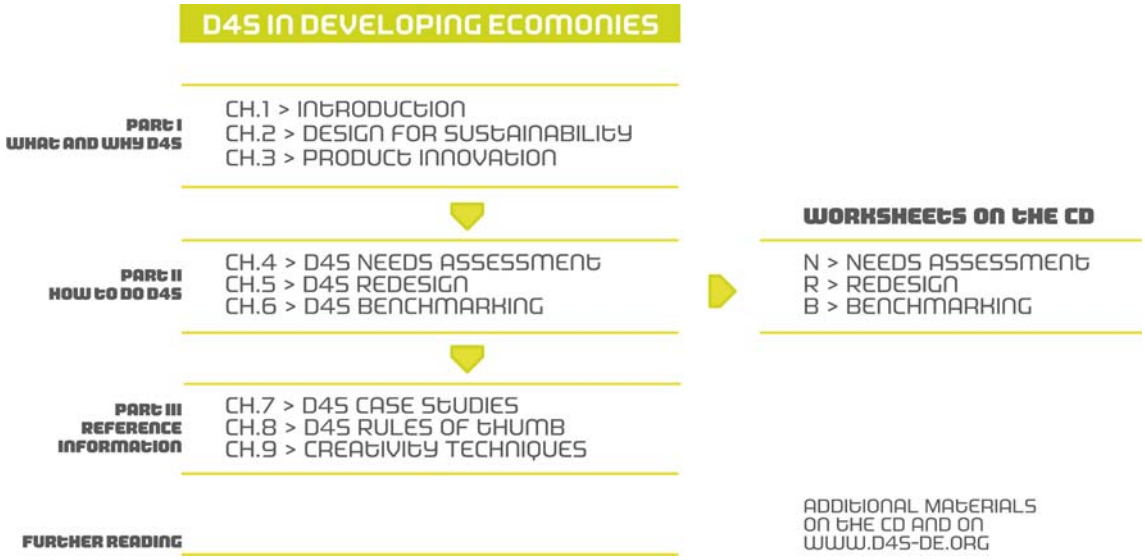

FIGURE 1 ___ PUBLICATION OVERVIEW

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DESIGN FOR SUSTAINABILITY (D4S)

D4S is based upon the combination of product innovation and sustainability. In this chapter the role of sustainability and its importance in product innovation are explored. Three key elements of sustainability are planet, people and profit. The relation of the first two - environmental and social aspects - and product innovation is explained. The 'profit' aspect will be explained in Chapter 3. The reasons and opportunities why a company should look into D4S are detailed.

2.1 PRODUCTS AND SUSTAINABILITY

It is clear that current patterns of consumption and production are unsustainable. The accelerating processes of globalization and trade liberalization, supported by the advances in information technologies, have fundamentally changed the landscape of the private sector in all economies - developed and developing - providing new opportunities and challenges to improve sustainability. Companies, large and small, have made impressive efforts to address sustainability issues with a bottom line focus. Through supply chain management, corporate reporting, and adopting related international standards, companies are improving the efficiency of current production and the design of new products and services to meet consumer needs.

These profit-driven strategies go by many names. Sustainable product design, also known as Design for Sustainability or D4S, including the more limited concept of Ecodesign, is one globally recognised way companies work to improve efficiencies, product quality and market opportunities (local and export) while simultaneously improving environmental performance. In many developed economies, because of a high level of awareness about the potential of efficiency and environmental concerns, D4S efforts are linked to wider concepts such as product-service mixes, systems innovation and other life cycle-based efforts. In developing economies, more immediate technical support is needed to introduce the D4S concept.

Many organizations have developed tools and approaches to help companies (and those who work with companies) rethink how to design and produce products to improve profits and competitiveness and to reduce environmental impacts at the same time. As a result, and based on experience gained, Ecodesign evolved to encompass broader issues such as the social component of sustainability and the need to develop new ways to meet consumer needs in a less resource intensive way. D4S goes beyond how to make a 'green' product - the concept now embraces how best to meet consumer needs – social, economic and environmental - on a systematic level. These 3 key elements of sustainability are also referred to as *people*, *planet* and *profit*.

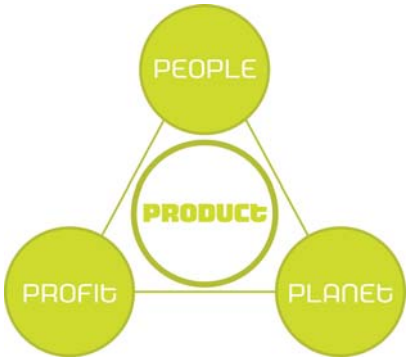


FIGURE 2 ___ PEOPLE, PROFIT, PLANET AND PRODUCT.

They are linked to the element of product innovation (see Figure 2).

Product innovation is directly linked to sustainability: both are oriented towards change and the future. Sustainability is concerned with the well-being of the future. Product innovation is concerned with creating new products and services that generate value only if they fit in this future. In this chapter, the focus is on the aspect of sustainability. In Chapter 3, the different product innovation approaches are explored and the product development process is explained.

To be sustainable, product innovation must meet a number of challenges linked to people, planet and profit: social expectations and an equitable distribution of value along the global value chain, and the innovation must work within the carrying capacity of the supporting ecosystems.

These challenges overlap and are distributed differently over the economic spheres in the world. The differences are large: the average American consumes 17 times more then his or her Mexican counterpart and hundreds of times more than the average citizen of the Congo. Examples of sustainability challenges include:

Create opportunities to meet social and equity requirements (people):

A> Developed economies_
> Increase urban and minority employment
> Improve safety and well-being
> Acceptation and integration of minorities
> Reduce income inequity

B> Developing economies_
> Enhance number of skilled workers
> Reduce income inequity
> Improve working conditions
> Abolish child labour
> Reduce illiteracy
> Basic health services
> Clean drinking water
> Reduce population growth
> Improve status of women
> Abolish large scale dislocation of people

Fit within the carrying capacity of supporting ecosystems (planet):

A> Developed economies_
> Reduce fossil energy use (climate change)
> Reduce use of toxics
> Clean contaminated sites
> Improve level of prevention, recycling, and reuse

B> Developing economies_
> Reduce industrial emissions
> Waste water treatment
> Stop overexploitation of renewable resources, water
> Stop deforestation, soil loss, erosion, ecosystem destruction
> Reduce dung and wood burning

Create equitable value for customers and stakeholders along the global value chain (profit):

A> Developed economies_
> Profitability
> Value for company, stakeholder
> Value for customer
> Fair business model

B> Developing economies_
> Fair share of and linkage to global value chains
> Linkage of SMEs to large and transnational companies
> Industrialisation of production, economies of scale
> Fair price for commodities and raw materials
> Ownership and credit opportunities for entrepreneurs

Many product innovation ideas would never be implemented if they were required to meet all the above criteria. Therefore, the goals and targeted elements of a D4S project need to be clearly defined.

A carefully prepared D4S project can contribute powerfully to a company's future. A business that wants to become and/or remain competitive will need to address sustainability issues. Large companies, as well as customers, governments and international organisations, are increasingly building sustainability requirements into their supply chains. Investment in a sustainable product innovation strategy can have immediate and longterm benefits.

During the development of a new product, or the redesign of an existing one, the product development team is confronted with a variety of design criteria like quality, ergonomics, safety, aesthetics etc. With the D4S approach, environmental and social criteria are integrated into the product development process as well, minimizing the impacts of the product throughout its life cycle.

2.2 PRODUCTS AND ENVIRONMENTAL ASPECTS – PLANET IMPLICATIONS

In the late 1980s and early 1990s, sustainability largely was an environmental issue. Initially efforts focused on improving end-of-pipe technologies. The focus then shifted towards production improvements via concepts such as clean technology, cleaner production, and eco-efficiency. The next shift was to product impacts, thereby taking into account the whole product life cycle. Concepts like Ecodesign and Design for the Environment (DfE) were developed and put into practice.

Environmental impacts can be divided into three main categories: ecological damage, human health damage and resource depletion (see Table 1). Many of these types of impacts are relevant for SMEs in developing economies, such as eutrophication, land use, ecotoxicity, human health damage, and the depletion of fossil fuels and fresh water.

Another way to classify the different types of environmental impacts is to arrange them according to geographical scale levels – local, regional, fluvial, continental and global. Typically, the higher the scale level, the more sources that contribute to the impact and the longer it will take for the improvements to become visible – depending of course on the reversibility of the problem. Local problems like water pollution, soil pollution, and waste disposal have been dealt with successfully in industrialised countries. Global issues like climate change can only be tackled by agreement of the best solutions at the global level. Irreversible depletion problems, even when occurring locally (topsoil), cannot be easily solved.

TYPE OF IMPACT	DESCRIPTION
1_ ECOLOGICAL DAMAGE	
Global warming or climate change	Addition of greenhouse gases to the atmosphere from burning of fossil fuels, agriculture, industrial practices. Effects: temperature change, Increased incidence of storms, desertification, tropical disease, ocean current changes, sea level rise.
Ozone depletion	Stratospheric ozone depletion caused by emissions of CFCs. Effects: increased amount of UV radiation leading to increased cancer occurrence, reduced productivity of plants, marine algae and high altitude biota
Acid rain	Acidification of precipitation by emission of sulphuric and other substances, mainly from fossil fuels. Effects: dissolves metals from the soil which become toxic to plants and aquatic organisms
Water eutrophication	Addition of excess nutrients to water, leading to algae bloom and consequent reduction of available oxygen. Effects: killing of fish and other aquatic organism.
Habitat alteration (land use)	Physical modification or destruction of natural habitats for agriculture, forestry, roads and urban growth. Effects: Primary cause of loss of biodiversity
Ecotoxicity	Exposure of plants, animals and other biota to toxic substances. Wide range of effects.
2_ HUMAN HEALTH DAMAGE	
Smog and air pollution	Emission of nitrogen oxides and VOCs generates ground level ozone, other air pollutants include dust particles and sulphur dioxide. Effects in humans: increased incidence of Asthma and other health disorders
Health damaging substances	Non-cancer causing substances include skin irritants, growth inhibitors, endocrine disruptors.
Carcinogens	Cancer causing substances, Mutagens that cause genetic mutation (most of them are also carcinogenic), Teratogens cause defects in developing embryos.
3_RESOURCE DEPLETION	
Fossil fuels	Current consumption rates of oil, gas, coal convert fuels into materials, energy and CO2 at a rate millions of times faster then nature can replenish the fuel reservoirs
Fresh water	Consumption of fresh surface or groundwater converts theminto forms that are typically nonrecoverable. Access to clean, potable water is a fast growing international problem.
Minerals	Metal ores are cnverted into metals and alloys that are eventually oxidized or dispersed as waste that is often not recycled.
Topsoil	In many places, agriculture and forestry erodes topsoil at a rate much faster then natural processes replenish it

TABLE 1 ___ ECOLOGICAL IMPACTS CATEGORIES.

2.3 LIFE CYCLE AND IMPROVEMENT FACTOR THINKING

The D4S approach is based on taking a life cycle view of a product. The product life cycle starts with the extraction, processing and supply of the raw materials and energy needed for the product. It then covers the production of the product, its distribution, use (and possibly reuse and recycling), and its ultimate disposal. Environmental impacts of all kinds occur in different phases of the product life cycle and should be accounted for in an integrated way. Key factors are the consumption of input materials (water, non-renewable resources, energy in each of the life cycle stages) and production of output materials (waste, water, heat, emissions, and waste) and factors like noise, vibration, radiation, and electromagnetic fields.

FIGURE 3: THE LIFE CYCLE OF A PRODUCT.

EXAMPLE: LIFE CYCLE OF A SHIRT

Shirts are often a combination of natural and synthetic fibers. To produce natural fibers (e.g., cotton), energy, fertilizers, water and pesticides are needed. For the synthetic fibers, fossil fuels are needed. In the next step, fibers are combined into cloth or textile. During this process, water, energy and chemicals are used to give cloth its colour and other characteristics. From the cloth, shirts are being produced that are then packaged and distributed to retail shops. After the consumer has purchased the shirt, he or she will discard the packaging and will use the shirt. During the use phase, the shirt might be used about 100 times and washed, dried and maybe even ironed. Each of these steps has environmental impacts resulting from detergent, water and energy use. Finally, perhaps when some parts of the shirt have worn out, it will be disposed. It is not possible to compost it because of the synthetic parts, and it may not be easy to recycle because of the mixed materials. During its life time, components of the shirt may have traveled thousands of kilometers, since cloth production could have been in Asia, the production in North Africa and the retail in Europe.

TEXT BOX 1 ___ LIFE CYCLE THINKING

Raw material provision and factory production are only two stages of the product life cycle. In many cases, the distribution, use and disposal phases have higher environmental impacts than the production itself. The environmental challenge for D4S is to design products that minimize environmental impacts during the entire product life cycle.

Sustainability also requires taking into account the needs of future generations, meaning that current environmental impacts should be reduced as well as those impacts on future generations. Global environmental pressures are directly related to the size of the population which defines the level of consumption of each person, and the materials and energy efficiency that produces each 'unit' of consumption. Currently, it has been estimated that environmental pressure should be reduced by about half. Taking into account the growth rates of developing economies, the efficiency of products and processes would need to be improved by a factor of 4. In a world with a population of 9 billion, and a consumption level that is much higher than it is now, this would imply materials and energy improvements by a factor of 10 to 20!

This type of 'factor thinking' shows the magnitude of the task of reaching sustainability, and the critical need to improve production processes, product, and systems. For products, short-term incremental redesign of existing products can typically lead to improvements of a factor of 2 to 4. To achieve the long-term factors of 10 to 20, radical product innovation is necessary (see Chapter 3). This includes developing completely new products, improving the product as well as the services connected to it, and developing entirely new functional systems of products and services. See Figure 4 which illustrates the different degrees of environmental benefit and degrees of innovation required.

This publication focuses on incremental innovation, redesign and the benchmarking of existing products, since these are the prevalent ways SMEs in developing economies currently work. However, the need for more radical product innovation will continue to grow. These and other related approaches are presented in detail in the publication *Design for Sustainability: a Global Guide*, UNEP 2006.

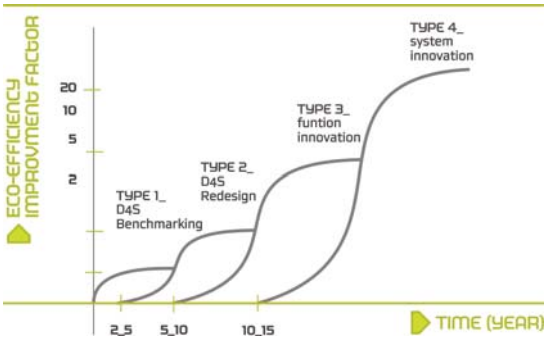


FIGURE 4 ___ DEGREES OF ENVIRONMENTAL BENEFIT AND OF INNOVATION REQUIRED.

2.4 PRODUCTS AND SOCIAL ASPECTS – PEOPLE IMPLICATIONS

Social and societal aspects of sustainability have increasingly received attention in the last 10 years from the media as exemplified by negative articles on issues of child labour, companies running 'sweatshops', workers' rights and on indigenous peoples. Company strategies increasingly include corporate social responsibility in addition to economic and environmental priorities.

A useful tool to visualise socio-economic and societal aspects that are relevant to sustainability is presented in Figure 5.

On the vertical axis the social aspects relevant to the product supply chain are presented. The following issues are relevant to all stakeholders:

> Human rights

The protection of the basic human rights of employees, such as the right to lead a dignified life, the freedom to express independent beliefs, and the absence of racial, ethnic and gender discrimination.

> Minimisation of child labour

> Health and safety at the workplace/Human Resource Management

The pro-active fostering of a high-quality work environment, workplace diversity, opportunities for vocational education, and work-life balance for the employees.

> Governance and management

Setting in place systems and processes on accountability for shareholders and government.

> Transparency and engagement of business partners

The degree to which a company involves its business partners in carrying out the company's sustainability strategy.

> Abolishing of corruption and bribery (see also: Sustainability, 2005)

On the horizontal axis, the social aspects of the company in its local surroundings are expressed, from micro (within the company itself) to meso-level (the community within which the company exists) to macro-level (the country within which the company exists, or for a transnational corporation, within the global environment.

> Local economic growth

The ways a company shares the benefits from its investments with local businesses or provide tools for economic growth to local communities.

> Community development

Support of the company through provision of health, education, water and sanitation, helping to fight corruption in the community and upholding indigenous and human rights.

> Stakeholder engagement

Consulting with non-business stakeholders on key sustainability issues: this could be in the form of open dia-

logue with societal partners (NGOs, government, community groups).

> *Distributed Economies*

DE is a strategy to distribute a selected share of production to regions where in parallel a range of activities are organized to support small scale, flexible units that are connected with each other and prioritize quality production. It can offer sustainability advantages such as social diversity, increased quality of life, focus on regional assets, maximizing social capital and 'collective spirit'.

2.5 WHY SHOULD A COMPANY LOOK INTO D4S?

Sustainability, corporate social responsibility and related trends are part of the business agenda for an increasing number of companies worldwide. Understanding how to integrate these concepts into business planning can be an important part of a successful business. Pressure to integrate sustainability requirements will come from government, business partners, non-governmental organizations and citizen groups.

Motivation (or pressure) to implement D4S can come from two different directions: from within the business itself (internal drivers) or from outside the company (external drivers). Although there are overlaps amongst the people, planet and profit aspects of sustainability, usually a driver is connected to one of them. Knowing the most influential drivers can provide valuable information on what are the best types of D4S projects and activities to initiate. Table 2 presents common drivers.

In general, the experience with industry in developing economies is that internal drivers are more decisive for the initiation of D4S projects than external drivers because external drivers currently are less developed in many developing economies.

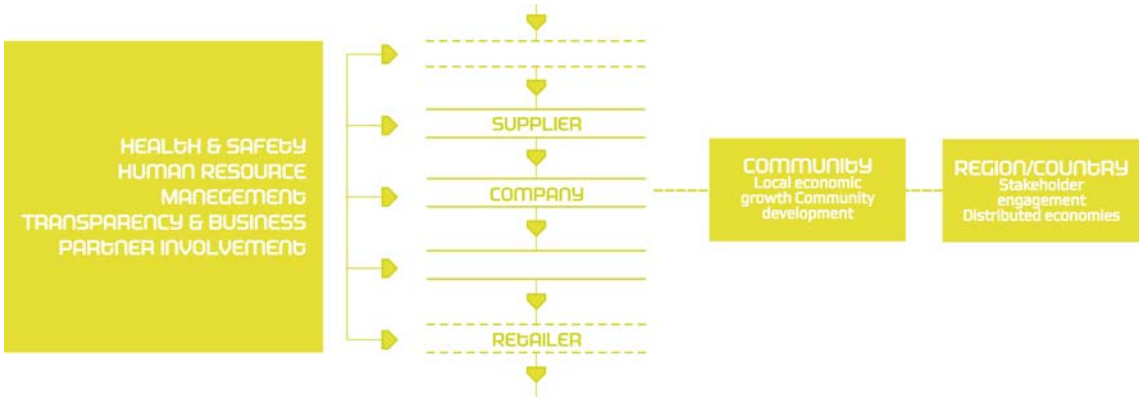


FIGURE 5 ___ SOCIAL ASPECTS RELEVANT TO SUSTAINABILITY.

INTERNAL DRIVERS FOR D4S

'PEOPLE' ASPECTS_

Social equity Can reduce risks on social and labour problems. As a result it can help avoid liability and reputation problems.
Strong social policy Can increase employee motivation. Employees can gain energy and experience from social projects and programmes launched by a company.
Governance and management systems on social aspects Can make company achievements more visible to shareholders and stakeholders.

'PLANET' ASPECTS_

Green marketing The design and production of products with environmental value-added elements can boost brand value and reputation.
Environmental awareness Managers often are aware of the importance of environmental issues and want to act accordingly.

'PROFIT' ASPECTS_

Reach new consumers Surveys demonstrate that consumers are increasingly ready to purchase on ethical grounds.
Product quality improvement Reliability and functionality often go together with a more sustainable product.
Saving costs Cost reductions can be made on material use, energy, waste treatment charges, transport and the distribution system.
_Boost brand value and reputation
Product innovation New possibilities from product innovation can find solutions to meet customer needs and wants.
_Brand differentiation
_New opportunities for value creation

EXTERNAL DRIVERS FOR D4S

'PEOPLE' ASPECTS_

Public opinion Consumers are increasingly interested in the world that lies behind the product they buy, which is leading companies to take environmental and social issues into account.
NGO pressure For years industries have been under fire from NGOs for controversial practices and the related impacts on the environment. For example: Irresponsible company practices may lead to boycott campaigns which can cause significant damage to a company reputation.

'PLANET' ASPECTS_

_Legislative requirements on environment will increase in many developing economies and can force a company into a more proactive stance.
_Disclosure requirements of environmental information towards suppliers and customers can start an improvement process in the company.
_Ecolabelling schemes can be an additional element for a companies' marketing strategy.
_Consumer organisation requirements such as safety, low toxicity and recyclability of products can be an incentive for D4S. Products failing to get 'a good score' on these aspects may no longer qualify as a 'good choice' in consumer tests.
_Pressure from dedicated environmental groups have forced industry to eliminate substances like CFCs from their products. These often highly professional organisations will continue to expose environmental harmful products.
_Direct community 'neighbour' pressure is often directed towards environmental and safety risks of the company and can have a large impact on production and products.

'PROFIT' ASPECTS_

_Norms and standards on sustainability aspects of products will continue to become stricter and may force companies to improve products.
_Subsidy schemes are available in some countries to improve sustainability aspects of products and production. At the same time, subsidies on energy and raw materials are ending, forcing companies improve materials and energy efficiency.
_Suppliers competition is evolving to enter or remain in the supply chain, pushing companies to become more sustainable.
_Customer demand for healthier, safer and more environmental and socially responsible products is increasing in specific product categories.
_Market competition is growing as competition increases at local and global levels. Industry may look to improve innovative performance, which might include reviewing the sustainability aspects of their products.

TABLE 2 ___ INTERNAL AND EXTERNAL DRIVERS FOR D4S.

03 PRODUCT INNOVATION

D4S is based on a combination of product innovation and sustainability. Understanding the underlying concept of product innovation can help in implementing D4S projects. This chapter discusses different (product) innovation approaches and explains the product development process. These insights can assist during the Needs Assessment (Chapter 4) to identify the appropriate innovation level and D4S approach for the participating companies in demonstration projects.

3.1 INNOVATION

Product innovation is essential for a country's economic growth and for the competitive position of industry. Companies operate in a rapidly changing world in which customers' needs and wants are not fixed and where they face increasing competition due to open markets and globalization. Companies that effectively integrate innovation in the product development process can gain significant competitive advantage.

Innovation is a broad concept that is used in many different contexts. As a result, there are many definitions of innovation. One useful definition is: "*the commercial or industrial application of something new– a new product, process or method of production; a new market or source of supply; a new form of commercial, business or financial organization*".

Most definitions of innovation emphasize 'newness' and 'successfulness'. There are distinctions made between *product* versus *process* innovation and sometimes amongst *market*, *business* and *management* innovation. For example:

> **Product innovation** is the introduction of *new products* that have characteristics and/or use applications that differ from existing products on the market.

> **Process innovation** is the introduction of a *new method* of production, that has not previously been used and/or a new way of handling a commodity commercially to make production more efficient or to be able to produce new or improved products.

> **Market innovation** involves entering *new markets*, new ways of serving customers, and/or market expansion.

> **Business and management innovation** involves developing new reward systems, organizational structures, ways of handling responsibilities and human resources etc. that positively affects product sales.

Within D4S the focus is on product and market innovation. Process innovation is often more linked to cleaner production and management innovation to environmental management systems like ISO 14000.

3.2 INNOVATION LEVELS

Innovation happens in different degrees and can be categorized into three levels: incremental, radical and fundamental (see Figure 6). Each category is progressively more significant and more far-reaching.

1> **Incremental innovation_** Entails step-by-step improvements of existing products and tends to strengthen market positions of established companies in the industry.

2> **Radical innovation_** Drastically changes existing products or processes. The risks and required investments in radical innovation are usually considerably greater than those needed for incremental innovation but they offer more opportunity for new entrants to the market.

3> **Fundamental innovation_** Depends on new scientific knowledge and opens up new industries, causing a paradigm shift. In the early stage of fundamental innovation, the contributions of science and technology are important.

The majority of innovation efforts take place in companies that work from the incremental or radical innovation perspective. There is a wide range of innovation possibilities between these two extremes. Fundamental innovation often takes place only in large multinational companies, company clusters or (inter)national research programs because of the large human and capital investment needed. For D4S in developing economies it is less relevant.

Successful incremental or radical innovation requires different kinds of thinking, ways of working, and risk taking. To get more insight and a better understanding of both types of innovation, they are discussed in more detail below.

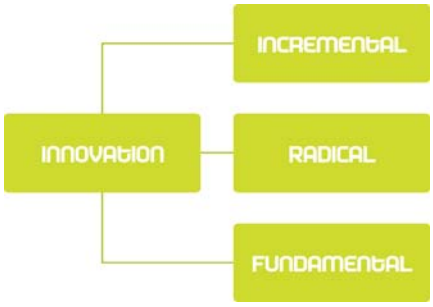


FIGURE 6 ___ DIFFERENT DEGREES OF INNOVATION.

3.2.1 INCREMENTAL INNOVATION

As the name suggests, this type of innovation makes small changes at one given time and is sometimes referred to as continuous improvement. A simple product may be improved (in terms of better performance or lower costs) through the use of higher performance components or materials. A complex product that consists of integrated technical subsystems can be improved by partial changes at one level of a sub-system. Incremental innovations do not involve major investments or risk. User experience and feedback is important and may predominate as a source for innovation ideas. As an example, customer wants can be identified and added as features to the existing product.

Incremental innovation and the redesign of existing products are economically and commercially as important as radical innovations. Incremental innovation and design improvement are known as the 'bread and butter' of new product development for many firms. Many firms do not even attempt to explore radical innovation for a variety of reasons having to do with their size and resources, the nature of the industry, the level of research and development necessary, or the amount of risk involved. Even firms that successfully introduce radical innovation may not do so very often. Incremental innovation projects, due to the low level of involved risk usually follow a structured and predictable process.

3.2.2 RADICAL INNOVATION

Radical innovation involves the development of key new design elements such as change in a product component combined with a new architecture for linking components. The result is a distinctively new product that is markedly different from the company's existing product line.

A high level of uncertainty is associated with radical innovation projects, especially at early stages. Due to high levels of uncertainty, the process cannot be described as an orderly structured process. Radical innovations are confronted with uncertainties on different levels. To be successful, uncertainty must be reduced in the following dimensions:

> **Technical uncertainty_** are issues related to the completeness and correctness of the underlying scientific knowledge and the technical specification.

> **Market uncertainty_** are issues related to customer needs and wants.

	INCREMENTAL INNOVATION	RADICAL INNOVATION
EMPHASIS	Cost or feature improvements in existing products, services or processes.	Development of new businesses, products and/or processes that transform the economies of a business
TECHNOLOGY	Exploitation of existing technology	Exploration of new technologies
TRAJECTORY	Linear and continuous: evolutionary	Sporadic and discontinuous; revolutionary
KEY PLAYERS	Formal cross-functional team	Formal and informal cross-functional teams and individuals
TIME FRAME	Short term	Mid- to long-term
RISK & SUCCESS	Predictable	Unpredictable and highly uncertain
PROCESS	Formal, phase-gate model	Informal, flexible model at early stages due to high uncertainty more formal at later stages after uncertainties have been reduced.

TABLE 3 ___ COMPARISON OF INCREMENTAL AND RADICAL INNOVATIONS CHARACTERISTICS.

> Organisational uncertainty_ refers to organizational resistance that stems from conflict between the mainstream organization and the radical innovation team.

> Resource uncertainty_ includes project discontinuities that influence the project's funding, staffing, and management requirements. Radical innovations need a number of enabling factors such as a high level of technological capability, strong R&D and a pool of multidisciplinary skills whereas the incremental innovation adoption process needs less.

3.2.3 PRODUCT INNOVATION

The product innovation process involves a series of sub-processes dominated by the product development process followed by the realization (see Figure 7).

Product Innovation = Product Development + Realization

In the following paragraphs a general step-by-step product development process will be outlined.

3.3 PRODUCT DEVELOPMENT PROCESS

Product development can be defined as "the process that transforms technical ideas or market needs and opportunities into a new product and on to the market". It includes strategy, organization, concept generation, product and marketing plan creation and evaluation, and the commercialization of a new product.

The product development process is a disciplined and defined set of tasks, steps, and phases that describe how a company repetitively converts ideas into salable products and/or services. The product development process itself can be split up into three phases: policy formulation, idea finding and strict development (see Figure 7).

Every step has two different kinds of activities (see Figure 8): first a divergent activity, followed by a convergent activity. These approaches identify relevant information in a creative way and then evaluate it. Divergent methods search for ideas and include searching for information, to explore the problem, to redefine it, to generate ideas and to combine concepts. Convergent methods impose value judgments and include methods to make sense of information, to prioritize items, to compare solutions, to assess ideas and to reject or select concepts. The product development process is often presented as a linear process. However, in practice it is often characterized as a linear process with iterative cycles, meaning that design teams often go back to earlier stages and decisions in the product development process to re-evaluate previous decisions that have been made.

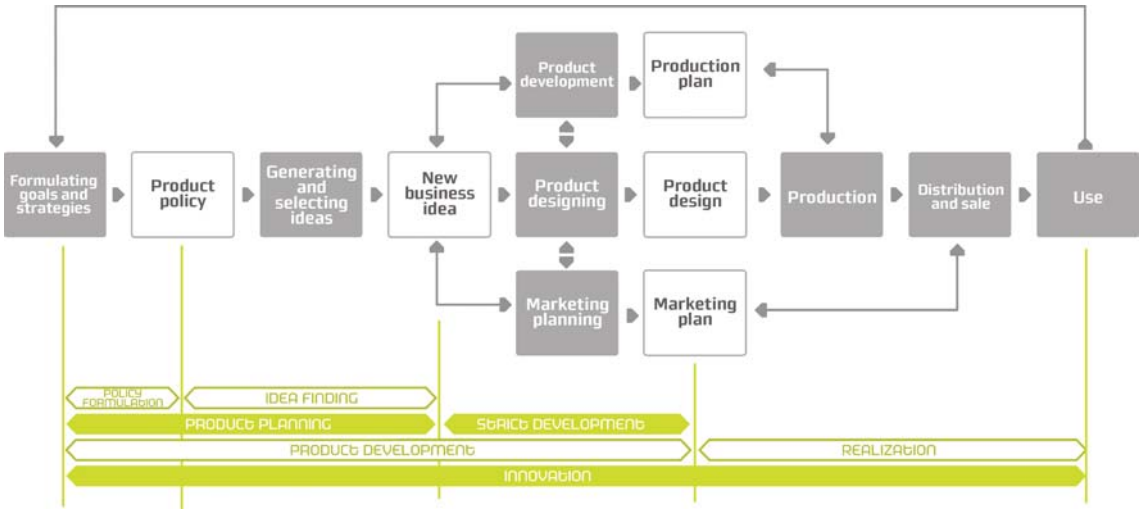


FIGURE 7 ___ PRODUCT DEVELOPMENT PROCESS AS PART OF THE INNOVATION PROCESS.

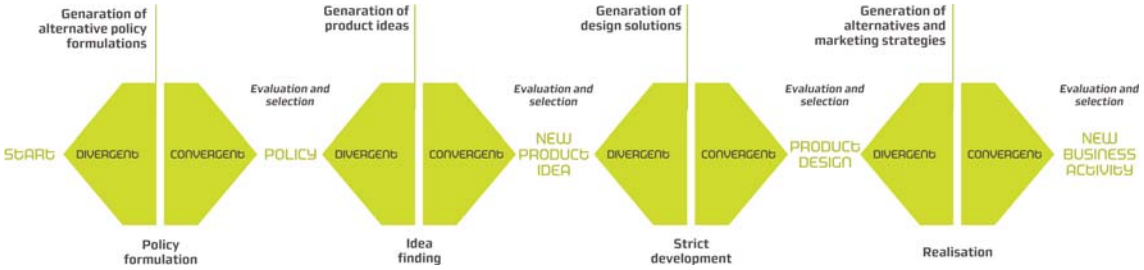


FIGURE 8 ___ STEP-BY-STEP DESIGN APPROACH CHARACTERISED DIVERGENT AND CONVERGENT ACTIVITIES.

3.4 POLICY FORMULATION

The product development process starts with formulating goals and strategies. Developing new or redesigned products without having clear goals and product strategies may lead to unsuccessful products and failures. For this reason, it is essential for a company to define its vision, mission, goals and (product) innovation strategies (see Figure 9).

3.4.1 MISSION STATEMENT

A company's mission is its reason for being. The mission often is expressed in the form of a mission statement, which conveys a sense of purpose to employees and projects a company image to customers. The mission statement defines the purpose or broader goal for being in existence. It serves as a guide in times of uncertainty or vagueness. It is like a guiding light. It has no time frame and can remain the same for decades if crafted correctly.

FIGURE 9 ___ MISSION, VISION, GOALS AND STRATEGY.

When defining its mission statement, a company can consider including some or all of the following aspects:
> The moral/ethical position of the enterprise;
> The desired public image;
> The key strategic influence for the business;
> A description of the target market;
> A description of the products/services;
> The geographic domain; and
> Expectations of growth and profitability.

THE MISSION STATEMENT OF A PLASTICS MANUFACTURER IN TANZANIA_

> Our mission is to become a world-class provider of proprietary and innovative solutions in the East and Central African market.
> We will double turnover every three years.
> We shall take pride in becoming preferred partners to all our stakeholders and in exceeding their expectations.

TEXT BOX 2 ___ EXAMPLE OF MISSION STATEMENT.

3.4.2 VISION STATEMENT

The vision statement describes how the company management sees events unfolding over 10 or 20 years if everything goes exactly as hoped. A vision statement is short, succinct, and inspiring about what the organization intends to become and to achieve at some point in the future stated in competitive terms. Vision refers to the category of intentions that are broad, all-inclusive and forward-thinking. It is the image a business has of its goals before it sets out to reach them. It describes future aspirations, without specifying the means that will be used to achieve them.

A vision statement for a new or small firm spells out goals at a high level and should coincide with the founder's goals for the business. Simply put, the vision should state what the founder ultimately envisions the business to be, in terms of growth, values, employees, and contributions to society. This vision may be as vague as a dream or as precise as a goal. The vision may contain commitment to:

> Developing a new product or service;
> Serving customers through the defined service portfolio;
> Ensuring quality and responsiveness of customer services;
> Providing an enjoyable work environment for employees; or
> Ensuring financial and sustainable growth of the company for the benefit of its stakeholders.

3.4.3 GOALS AND OBJECTIVES

After defining (or redefining) the company's mission and vision, it is time to set practical goals and objectives for the organization based on these statements. The goals often lack specificity. The objectives are aims that are formulated exactly and quantitatively including timeframes and magnitudes. For example, the objectives of an annual earning growth target should be challenging but achievable. They also should be measurable so that the company can monitor its progress and make corrections as needed.

Once the firm has specified its objectives, it can analyze its current situation to devise a strategic plan to reach the objectives. This can be done for example with a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis or by evaluating the product life cycle stage of its product portfolio.

3.4.4 SWOT ANALYSIS

In order to succeed, businesses need to understand their strengths and where they are vulnerable. Successful businesses build on their strengths, correct weaknesses and protect against vulnerabilities and threats. They also understand the overall business environment and spot new opportunities faster than competitors.

	POSITIVE	NEGATIVE
INTERNAL FACTORS	**STRENGTHS** Technological skills Leading Brands Distribuition channels Costumer Loyalty/Relationship Production quality Scale Management	**WEAKNESSES** Absence of important skills Weak Brands Poor access to distribution Low costumer retention Unreliable product/service Sub-scale Management
EXTERNAL FACTORS	**OPPORTUNITIES** Changing costumer tastes Liberalisation of geographic markets Technological advances Changes in government politics Lower personal taxes Changes in population age-struture New distribution channels	**THREATS** Changing costumer tastes Closing of geographic markets Technological advances Changes in government politics Tax increases Changes in population age-struture New distribution channels

FIGURE 10 ___ EXAMPLE OF SWOT MATRIX.

A tool that helps in this process is the SWOT analysis.
Strengths are attributes of the organization that are helpful to achieve the objective. They have to be maintained, built upon, or leveraged.
Weaknesses are attributes of the organization that are harmful to the achievement of the objective. They need to be remedied or stopped.
Opportunities are external conditions that are helpful to the achievement of the objective. They need to be prioritized and optimized.
Threats are external conditions that are harmful to the achievement of the objective. They need to be countered or minimized.

In addition, the company can explore its core competences - those capabilities that are unique to it and that provides it with a distinctive competitive advantage and contribute to acquiring and retaining customers (see Figure 10).

3.4.5 Product life cycle from a market perspective

A new product progresses through a sequence of stages in the market from introduction to growth, maturity and decline (see Figure 11). After a period of development, the product is introduced or launched into the market. It gains more and more customers as it grows. Eventually the market stabilizes and the product becomes mature. Then after a period of time, the product is overtaken by development and the introduction of superior competitors, and it goes into decline and is eventually withdrawn. It is essential for a company to be aware of at which stage the products in its product portfolio are in order to start up new innovation initiatives in a timely manner.

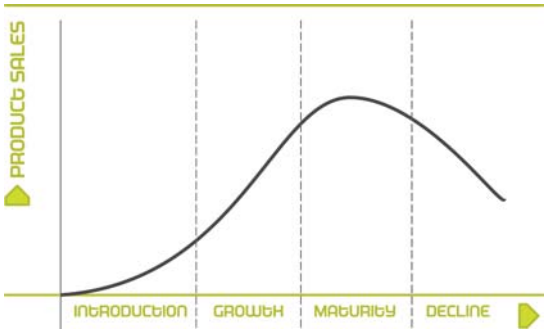


FIGURE 11 ___ PRODUCT LIFE CYCLE (MARKETING PERSPECTIVE).

This product life cycle perspective from a marketing point of view should be not be confused with the 'sustainability' life cycle approach (from cradle to cradle) as introduced in Chapter 2.

3.4.6 Strategic innovation gap

Product innovation is necessary to survive and grow in a competitive market. Because sales of recent products tend to decline due to competitors development, a 'strategic innovation gap' develops, which interferes with growth. The strategic gap of a company can be measured as the difference between expected and desired turnover and profits from currently planned new products and the company objectives (as stated in the vision statement) (see Figure 12).

If there is a gap between future desired sales and projected sales, a company will have to develop or acquire new businesses and innovation activities to fill this strategic gap.

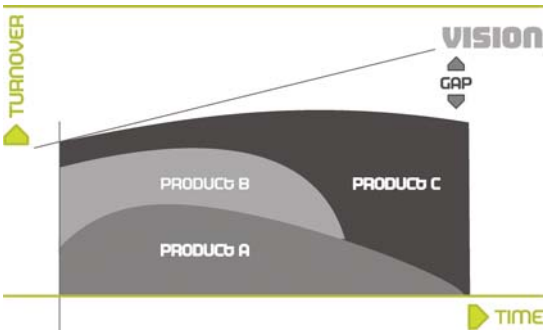


FIGURE 12 ___ INNOVATION GAP.

3.4.7 Product innovation strategy formulation

Once a clear picture of the firm and its environment is in hand, specific product innovation strategy alternatives can be developed. There are different (product) innovation strategies for companies to innovate in order to become more competitive (see Figure 13). The competitiveness of companies in the long-run is often directly related to their new product development capabilities.

While firms may develop different alternatives depending on their situation, generic categories of strategies exist that can be applied to a wide range of firms. The innovation models of Ansoff and Porter are two approaches that companies and organizations can apply to analyse their current (and competitors') product portfolio and can provide direction to new product innovation strategies.

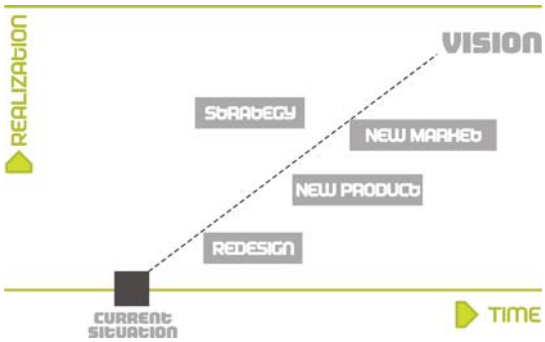


FIGURE 13 ___ INNOVATION STRATEGIES TO CLOSE THE INNOVATION GAP.

3.4.8 GROWTH MATRIX

The Ansoff Growth matrix is a tool that can help a business choose a product and market growth strategy. A company can address the innovation gap in 4 different ways that are based upon a combination of market and product innovation:

First, a company can determine performance improvement opportunities. The growth matrix proposes 3 major intensive growth strategies:

> **Market penetration strategy_** Management looks for ways to increase the market share of its current products in their current markets.

> **Market development strategy_** Management looks for new markets for current products.

> **Product development strategy_** Management considers new product possibilities.

Diversification can offer strong opportunities outside the business. Three types of diversification exist. The company could seek new products that have technological and/or marketing synergies with existing product lines, although the product may appeal to a new class of customers. Second, the company might search for new products that might appeal to its current customers though technologically unrelated to its current product line. Finally, the company might seek new businesses that have no relationship to the company's current technology, products, or markets.

FIGURE 14 ___ ANSOFF GROWTH MATRIX (ANSOFF, 1968)

3.4.9 COMPETITIVE STRATEGIES MATRIX

Another potentially useful approach is the Porter matrix that describes common types of competitive strategies as 'overall cost-leadership', 'focus', and 'differentiation' (see Figure 15):

> **Overall Cost Leadership_** The business works hard to achieve the lowest production and distribution costs so it can have a lower price than its competitors and win a larger market share. Firms pursuing such strategy must be good at engineering, purchasing, manufacturing, and physical distribution. They have less need for marketing skills.

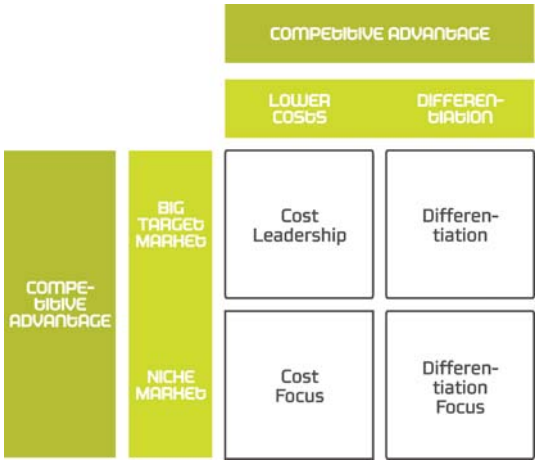


FIGURE 15 ___ PORTER STRATEGY MATRIX (PORTER 1980).

> **Differentiation_** The business concentrates on achieving superior performance in an identified customer benefit area valued by a large part of the market. It strives to be a leader in quality, technology, service, style etc. The firm cultivates the strengths that give it competitive advantages. Thus, the firm that wants to be a quality leader will make or buy the best components, put them together expertly, and inspect them carefully.
> **Focus_** The business focuses on one or more narrow market segments rather than going after a large market. The firm gets to know the needs of these segments and pursues either cost leadership or a form of differentiation within the target markets.

These 3 generic types of strategies can be combined (see Figure 15).

A company should evaluate its current and future product portfolio with both models.

3.4.10 Risk and strategy selection

Companies will face conflicting goals trying to maximizing economic success while reducing risk. Only a small percentage of product innovation projects actually end-up in the market. The more the projects differentiate, the higher the risk (see Figure 14). The risk of failure can be minimized if:

> Innovation is based upon mid- and long-term objectives and strategies;
> Innovations are appropriate for company size and resources;
> Information systems exist to integrate new and changing needs;
> Innovation is initiated by the market and not by technological developments;
> Innovation concentrates on the linkages within the value chain (they are more difficult to copy); or
> Innovation helps to differentiate a company from its competitors.

At the end of this stage, the company should be able to select a product innovation strategy that fits best to its internal and external environment and vision.

3.5 Idea generation

The idea generation phase often refers to the creative component of the product development process in which solutions are put forward, built upon, and used to spawn new solutions.

Idea generation can involve many different techniques and people prefer different kinds of techniques. Typical methods include generating 'search fields' and creativity sessions. Idea management is important at this stage due to the large number of ideas that are generated and need to be selected and their diversity. Based upon a combination of the most promising ideas, product concepts are proposed.

3.5.1 Search fields

The first step of the idea generation process is to develop 'search fields'. For developing these search fields, the internal 'strategic' strengths of a company are the best place to start, for example, company strengths like its financial situation, knowledge on specific technologies or its export know-how. By combining the strengths of the company with the indicated opportunities and trends in the SWOT analysis, search fields for new product ideas can be generated (see Figure 16).

In order to use the results from a SWOT Matrix, it has to be adjusted to the search field matrix (see Figure 17). On the horizontal axis (cells A to F), the opportunities identified early in the SWOT analysis are written down.

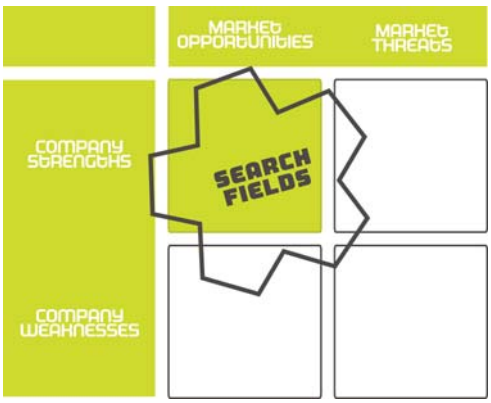


FIGURE 16 ___ SEARCH FIELDS THAT COMBINE THE IDENTIFIED STRENGTHS AND OPPORTUNITIES OF A SWOT MATRIX (BUIJS AND VALKENBURG, 2000).

Next, the internal strengths are put in the cells 1 to 8 on the horizontal axis. By combining the internal strengths with the external opportunities new product ideas can be generated.

As a result, the company might come up with several promising search fields. To facilitate the evaluation and selection of the best search field, it is useful to work them out in more detail. After selecting the most promising search fields, product ideas can be generated within them.

3.5.2 CREATIVITY SESSIONS

Creativity sessions enable the production of a lot of ideas for new products. All ideas - no matter how ludicrous or extreme they may sound - should be gathered. Depending upon the search fields, the product development team can apply different kinds of creativity techniques to generate product ideas.

Chapter 9 presents different creative techniques in more detail with examples.

3.5.3 CONCEPT DEVELOPMENT

The concept development builds upon the creative ideas generated, merging them and developing more fleshed out concrete options for evaluation. A concept is a clearly written and possibly visual description of the new product idea, including primary features, consumer benefits, and an outline of technology needed. Concept generation can involve:

> Definition of target market and customers;
> Identification of the competition and formulation of a competitive strategy;
> Development of preliminary technical product and testing scheduling;
> Estimation of required resources for product development; and
> Creation of a preliminary business plan.

After the selection of the best concept, it is worked out in detail.

		External opportunities					
		A	B	C	D	E	F
Internal strategic strengths		Increase pizza consuption	More catering	University longer open	Increasing interest for healthy food	...	...
	1	High quality white bread	*Pizza bread*		*Open kiosk at campus*	*Healthy sandwiches*		
	2	Big production space		*Home delivery*				
	3	Good contacts with auction						
	4	Greengrocer's shop around the corner				*Vegetable burger*		
	5	...						
	6	...						
	7	...						
	8							

FIGURE 17 ___ SEARCH FIELD MATRIX OF A FOOD COMPANY.

3.6 REALIZATION

Product development is not a stand-alone process. Parallel to the product development process the production development and marketing planning takes place (see Figure 18).

The production planning is directly linked to design and visa versa. Equipment availability and investment needs should be considered during the design phase. Production management will need to plan how to introduce any production changes that result from design changes.

It is essential to market a new product targeting the needs and wishes of the customer. Therefore, information on market analysis, consumer behaviour, trends and future scenarios, government policies, environmental concerns, new technologies and materials can be useful. Company policies and needs should also be taken into account. The plan will provide guidance to design and marketing decisions.

Once the design has been set, it is essential to decide how best to communicate the product's strengths, price, and distribution. Strategies need to be developed for these aspects.

3.7 PRODUCT DEVELOPMENT IN DEVELOPING ECONOMIES

Traditionally, product development activities were focused in developed countries. However, these activities are increasingly important for international competitiveness and developing economies are beginning to focus on building this expertise.

Up until the 1970s, developing economies had industrialization policies that subsidized locally produced products acted as barriers to imported products**.** In addition, high levels of state involvement in manufacturing and (partially) state run enterprises had a tendency to be more production- than market-driven. Closed markets economies created low incentives for companies to innovate.

Nevertheless, developing economies are increasingly concerned with design promotion and practice, especially in the light of globalisation of markets. For example, in South East Asia, formal product design activities have been established parallel to the industrial development policies. A successful example is South Korea. Due to the role played by foreign markets and multinational companies, South Korea began to differentiate products by incorporating product innovation into its economic policies. As a result, South Korea has developed from a country competing on low technologies, imitation and cost leadership in the 1960s towards a nation competing on user-centered design and pioneering approaches (see Figure 19).

In developing economies the bulk of product development activities are of an adaptive rather than innovative type, with minor changes in products. Product developers are often still seen more as "stylists" instead of "product innovators".

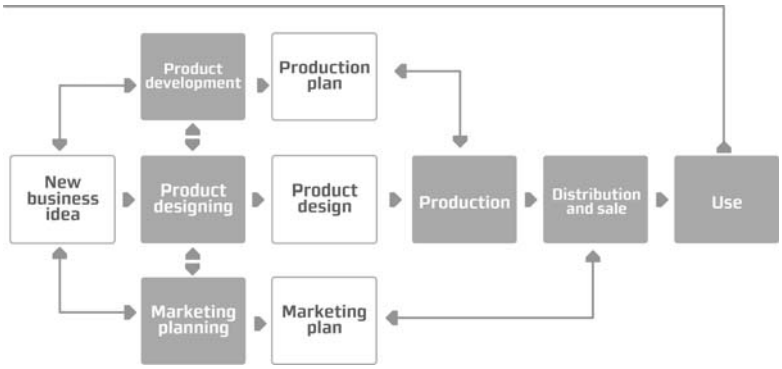


FIGURE 18 ___ PARALLEL ACTIVITIES: PRODUCT DEVELOPMENT, PRODUCTION DEVELOPMENT AND MARKETING PLANNING.

Research shows that SMEs in developing economies have different attitudes towards product design compared to SMEs in developed economies. Some of the observed differences are:

> A tendency to design incremental improvements for existing products;

> Concern with product appearance over product function;

> An approach to design based on a tradition of technology import rather than a tradition of invention or innovation:

> A tendency not to design solutions that have no precedence in the market place (international and local);

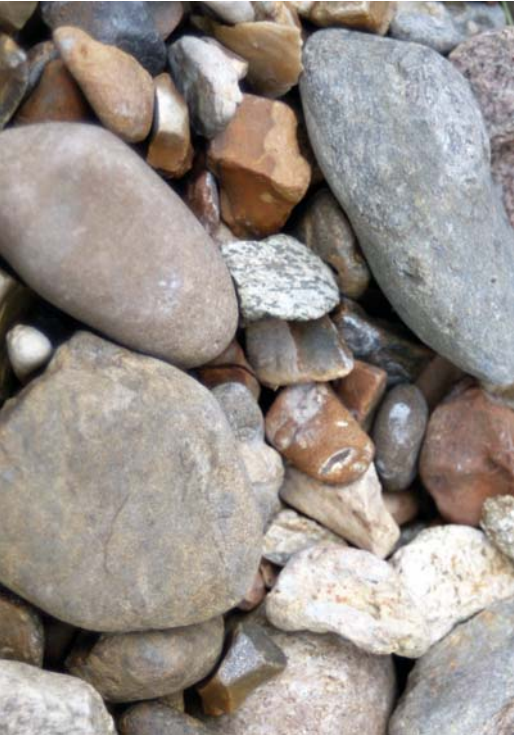
> Lack of tools and experience to compare and evaluate alternative approaches to design problems; and a

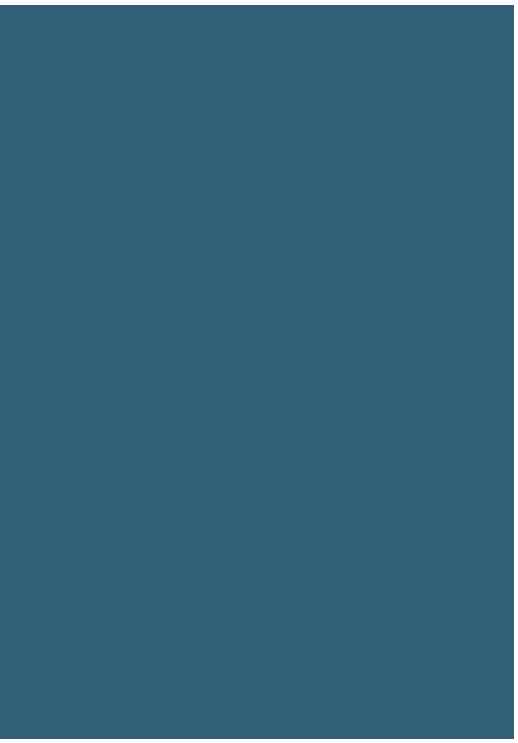
> Difficulty in developing clear project briefs.

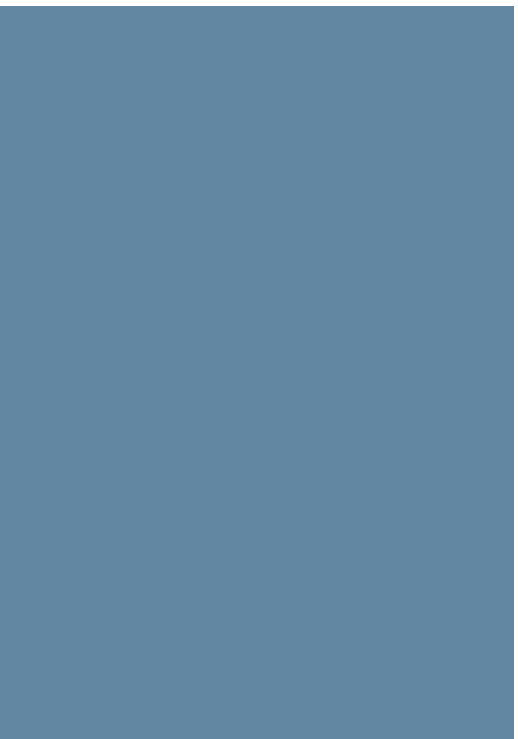
These aspects highlight the need to build capacity in product development. The next chapters provide step-by-step instructions on how to identify and carry out 2 different kinds of D4S efforts.

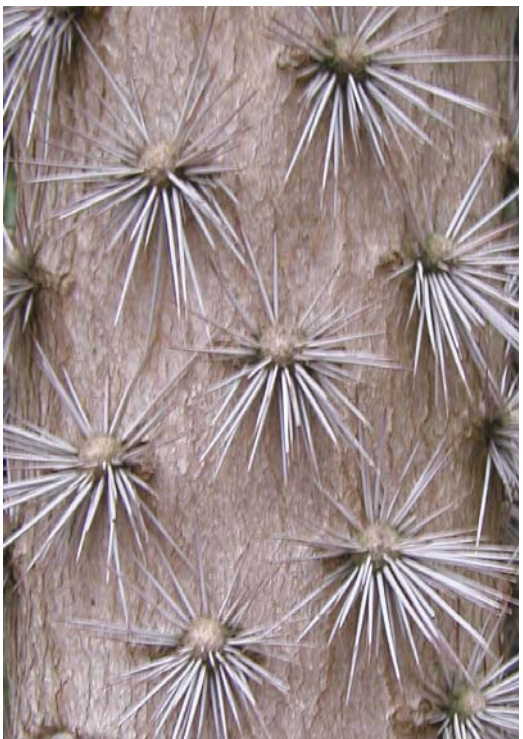
YEAR	GNP	LEVEL OF TECHNOLOGY	PATTERN OF MANUFACTURING	INDUSTRY STRATEGY	DESIGN STRATEGY
1960s	$80	Low Technology	Original Equipment Manufacture (OEM)	Overall Cost Leadership	Design to Cost Imitator
1990s	$5,000	Medium Technology	Mass Production	Differentiation	Image Design Improver/ Modifier
2000s	$10,000	High Technology	Mass Costumization	Focus	User-Centered Design Pioneer

FIGURE 19 ___ DEVELOPMENT OF SOUTH KOREA FROM COST LEADERSHIP TO DESIGN LEADERSHIP (CHUNG, 2004).









PLANET

PART II

HOW TO DO D4S IN PRACTICE

004 D4S NEEDS ASSESSMENT

The D4S Needs Assessment is a step-by-step approach to prioritize industry sectors to effectively target D4S demonstration projects. Successful D4S projects require good insight and understanding of the characteristics and needs of the national economy and local industries. A D4S project action plan can be divided into 4 stages: identifying the characteristics and needs of the project, the national economy, the industry sectors and specific companies.

An understanding of the national economic situation will: contribute to the objectives of a D4S project; serve as a starting point to identify suitable companies for demonstration projects; and assist in the development of appropriate D4S training materials. D4S in-company (in-house) demonstration projects should be relevant to the overall D4S project expectations.

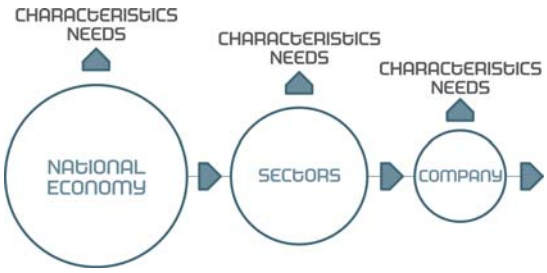


FIGURE 20 ___ CHARACTERISTICS AND NEEDS OF THE NATIONAL ECONOMY, SECTORS AND COMPANIES.

Following the 4 sets of questions will result in a D4S project action plan which targets industry sectors and carries out a needs assessment for D4S training materials (see Figure 20). The four levels and underlying basic considerations are:

Level 1 > The project

> What are the objectives of the project?
> Who are the main beneficiaries?
> What is the goal of the knowledge transfer for each of these target groups?

_ **Clear objectives and preliminary target groups**

Level 2 > The national economic situation (Macro)

> What is the national income?
> What is the human development index?
> How is the competitive position of the country and its industries?
> How significant are their exports and what is their composition?
> What is the contribution of the agricultural, industrial and service sectors to the national economy?
> At which stage is the industrial development of the country?
> What is the role and impact of SMEs and large industries in the national economy?
> What is the role and impact of the informal sector in the national economy?
> What are the sustainability issues related to production and consumption?

_ **Selection of relevant sectors and company size**

Level 3 > Sector level (Meso)

> How does the sector perform?
> What are current (product) innovation strategies of the sector?
> What is the absorptive capacity for innovation of the companies within the sector?
> What are the relevant sustainability issues within the sector?
> What are (potential) drivers for product innovation and D4S in the sector?
> Who are the relevant stakeholders within the sector?

_ **Selection of companies**

Level 4 > Company level (Micro)
> What are current (product) innovation strategies for the company?
> What is the absorptive capacity for innovation of the company?
> Are there local R&D institutions that can support the product innovation process?
> Are there local (industrial) design schools that can be involved?
_ Development of appropriate training materials (content as well as approach)

4.1 LEVEL 1: THE PROJECT

Why is a D4S project being initiated? Is it being supported by a transnational company within the context of improving the sustainability of its supply chain? Is the project supported by an international organization? For example, UNEP supports capacity building in the centers in its UNIDO-UNEP National Cleaner Production Centres Programme. Each project has its own goals and objectives. In project A, for example, the focus could be on *creating awareness* of D4S within a broad target group, while project B could attempt to *demonstrate D4S* environmental and economical benefits for the industry by executing demonstration projects in local companies. Finally, project C could have an objective to *build capacity* by providing intensive training. There is a wide range of possible objectives and approaches for D4S projects and each will require a specific type of knowledge transfer and training. Hence, understanding the overall project motivation is key.

> *What are the objectives of the project?*
> ***Worksheet N1***

A project often has different target groups. Will the target groups need the same kind of D4S knowledge and training? Government representatives might be interested in different aspects of D4S knowledge compared to people from industry. Company managers have different needs than designers in the product development department. Information needs should be considered for each target group. Do they have to understand the general concept (know-what)? Or should they also understand why it is important (know-why)? Will they need to be able to apply it (know-how)? (see Figure 21).

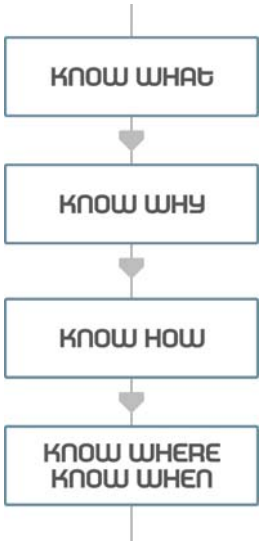


FIGURE 21 ___ HOW DEEP AN UNDERSTANDING IS NEEDED?

> *Who are the main beneficiaries?* > ***Worksheet N1***
> *How deep an understanding is needed for each target group? Know-what? Know-why? Know-how?* > ***Worksheet N1***

4.2 LEVEL 2: THE NATIONAL ECONOMIC SITUATION

As a next step, the national economic situation and level of industrial development of the target country will be explored. To support this, it is useful to collect some relevant economic and industry-related statistics of the country. To get a better understanding of the information, it is useful to collect data for 3 other countries for the sake of comparison (see Table 4). These could be neighboring countries or best practice (successful) countries in the region or elsewhere in the world.

4.2.1 COLLECTING DATA

Data can be collected easy through on-line public databases such as those listed below.

	TARGET COUNTRY	COUNTRY B	COUNTRY C	COUNTRY C
GDP IN $				
GDP PPP IN $				
HDI				
ETC.				

TABLE 4 ___ EXAMPLE OF SOME OF THE COUNTRY STATISTICS FROM A WORKSHEET.

United Nations Development Program (UNDP) 'Human Development Report'
> http://hdr.undp.org/statistics/data/

The World Bank 'Key Development and Statistics Data'
> http://www.worldbank.org/data/countrydata/countrydata.html

The World Bank 'Knowledge Assessment Method'
> http://info.worldbank.org/etools/kam2005/home.asp

CIA World Fact Book
> http://www.cia.gov/cia/publications/factbook/

World Economic Forum (WEF) 'Global Competitiveness Report'
> http://www.weforum.org/gcr

World Resource Institute (WRI) 'Earth Trends'
> http://earthtrends.wri.org/

United Nations International Children's Emergency Fund (UNICEF) 'The State of the World's Children'
> http://www.unicef.org/infobycountry/index.html

> *Collect the economic and social data for the countries.* > ***Worksheet N2***

In the next steps the economic and social data will be reviewed and analyzed in more detail. As can be seen, the indicators are collected by a variety of organizations for different purposes. They use similar though not consistent terminology. These indicators can be helpful in selecting industry sectors and companies and illustrate the current ways in which data is collected and monitored.

4.2.2 GROSS DOMESTIC PRODUCT (GDP)

Economic and other development indicators of a country can provide useful insights to the product innovation level and business climate in a country. The development level of a country is often based on a set of criteria that include income, quality of life and economic vulnerability of the country.

Income is often expressed in Gross Domestic Product (GDP) per capita. Quality of life is expressed by the Human Development Index (HDI) of the United Nations Development Program (UNDP). Many other characteristics can be found within these indicators such as the education level and industry composition.

National income can be indicated in several ways, but is usually expressed in GDP and GDP Purchasing Power Parity (PPP) per capita. GDP stands for the total market value of all goods and services that are produced within a country during a given period and includes the profits from all foreign-owned corporations and foreign individuals working in that country. The PPP is a theoretical exchange rate derived from the perceived parity of purchasing power of a currency in relation to another currency. In contrast to the "real" exchange rate used for currencies in the official market (as opposed to the black market), the PPP exchange rate is calculated from the relative value of a currency based on the amount of a "basket" of goods the currency will buy. Typically, the

prices of many goods will be considered, and weighted according to their importance in the economy. The PPP exchange rate is perceived to be a better comparison of standard of living.

The United Nations Development Program (UNDP) classifies countries into High, Middle and Low income. Below, Figure 22 illustrates the average GDP and GDP PPP for the three country national income groups. As can be seen, the differences between the High income and the Middle/Low income countries are great.

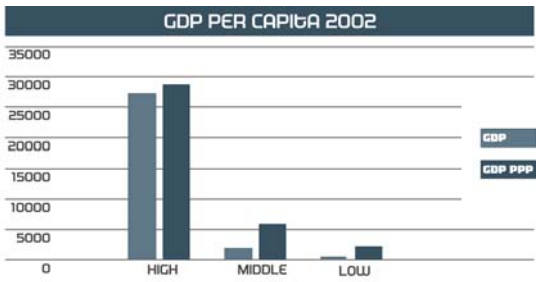


FIGURE 22 ___ GDP AND GDP PPP FOR THE THREE NATIONAL INCOME GROUPS (UNDP, 2005).

The World Bank classifies countries into four income groups according to Gross National Income (GNI) per capita (2004):

High income countries	$10066 >
Upper-middle income countries	$3226 - $10065
Lower-middle income countries	$826 - $3255
Low income countries	< $825

The World Bank country classifications can be found at www.worldbank.org/data/countryclass/.

The income category in which the country fits often provides a first indication of the major industry sectors and their composition. In low income countries, for example, the agricultural sector provides the main contribution to GDP and small and micro-enterprises are dominant. While studies have found a link between income and other indicators, it is easy to show that the link is far from linear and universal. For example, in large countries like India and China, huge differences in development levels occur in different regions within one country. In India, there are high-tech ICT firms in the Bangalore region and meanwhile labour-intensive low-tech jute industry can be found in West Bengal.

The development stage of a country often relates to the economic development, but it is also closely associated to the social development in terms of education, healthcare, and life expectancy. Based upon the development stage countries can be classified into the following four groups:

> LDC: Least Developed Countries_ The 50 poorest countries in the world (most in Sub-Sahara Africa) as defined by the United Nations.

> DC: Developing Countries_

> NIC: Newly Industrialising Countries_ Countries switching from an agricultural to an industrial-based economy, especially the manufacturing sector. Current examples are Turkey, Thailand, Malaysia, Mexico and South Africa.

> IC: Industrialised or Developed Countries_ Most countries in Europe, North America, Japan and Australia.

The term LDC is sometimes confused with LLDC: Land Locked Developing Countries. The economic performance of landlocked developing countries reflects the direct and indirect impact of geographical situation on key economic variables. Landlocked developing countries are generally among the poorest of the developing countries, with the weakest growth rates, and are typically heavily dependent on a very limited number of commodities for their export earnings. Moreover, of 30 landlocked developing countries 16 are classified as least developed. The term developing economies used in this publication encompasses Least Developed Countries, Developing and Newly Industrializing Countries. The D4S concepts of Benchmarking and Redesign are also applicable in Industrialised or Developed Countries, but due to higher level of awareness and experience in product-related efforts, additional approaches should also be considered in project development.

> What are the GDP and GDP PPP for the selected countries? ***> Worksheet N3***

> Into which income categories do the countries fit? ***> Worksheet N3***

4.2.3 HUMAN DEVELOPMENT INDEX (HDI)

Several stakeholders from society argue that just GDP per capita is an incomplete measure of a country's development progress. The UNDP's Human Development

Index (HDI) is a later attempt to quantify a multidimensional view of development progress. The Human Development Index (HDI) is a composite index that measures the average achievements in a country in three basic dimensions of human development: a long and healthy life, as measured by life expectancy at birth; knowledge, as measured by the adult literacy rate and the combined gross enrollment ratio for primary, secondary and tertiary schools; and a decent standard of living, as measured by GDP per capita in purchasing power parity (PPP) in US dollars. The index is constructed using indicators that are available globally, and a methodology that is simple and transparent. While the concept of human development is much broader than any single composite index can measure, the HDI offers a powerful alternative to income as a summary measure of human well-being. It provides a useful entry point into the use of information contained in the subsequent indicator tables on different aspects of human development.

> *What are the current HDI ranks of the countries?* > ***Worksheet N3***

4.2.4 COMPETITIVE GROWTH INDEX (CGI)

The process of economic growth is complex and many factors come into play as a country develops. The World Economic Forum tried to capture this complexity when it started estimating the Growth Competitiveness Index (GCI). The Growth Competivity Index (GCI) aims to gauge the ability of the world's economies to achieve sustained economic growth over the medium- to long-term. It assesses the impact of those factors that economic theory and the accumulated experience of policymakers in a broad range of countries have shown to be critical for growth.

The CGI is composed of three "pillars", all of which are widely accepted as being critical to economic growth: the quality of the macroeconomic environment, the state of the country's public institutions, and, given the increasing importance of technology in the development process, a country's technical readiness. The CGI highlights the strengths and weaknesses of national economics. In this way it offers a tool to get a sense of the business environment of country. If, for example, a country has a low ranking it might indicate that new investments in enterprises might be risky and that the national capacity to support technological change in the enterprises will be minimal.

> *What is the CGI ranking of the countries? Have they been improved during the last year(s)?*
> ***Worksheet N3***

4.2.5 IMPORT AND EXPORT

It is valuable to take a look at the import and export levels a country. Their size (as a percentage of the GDP) is of interest as well as the type of product (primary or manufactured products) is involved.

The size of the country's exports provides an indication of how important it is for the local economy. If exports are important (or if the national policy is to stimulate export) it makes sense to select (potential) exporting companies. From a D4S point of view, it is critical to know to which countries the exported products are going because of the relevant environmental legislation or a potential sustainability market.

To export manufactured products instead of primary products has a sustainability component. Export of manufactured products requires the local industry to be involved in processing and implies creating local 'added-value'. The strategy for a D4S project could be to stimulate the processing of primary materials in the local context before export in order to stimulate the generation of local income. This would have poverty alleviation implications.

> *How big are the import and export levels (as a % of the GDP) in the country?* > ***Worksheet N3***
> *Does the export market mainly consist of primary or manufactured goods?* > ***Worksheet N3***
> *What are the export countries (neighboring or international) and relevant sustainability considerations?* > ***Worksheet N3***

4.2.6 AGRICULTURAL, INDUSTRIAL AND SERVICE SECTOR

Economic activities in a country can be divided into agricultural, industrial and service sectors and they are often directly linked to economic development. For

example, the economic activities in some developing economies have a strong emphasis on agriculture activities, which affects the industrial sector, as activities focus on processing agricultural outputs.

In developed economies high levels of GDP are generated by the service sector. Figure 23 illustrates the contribution of the three sectors to the GDP in the different income groups of countries.

The importance of the service sector is growing continuously in all income groups as can be observed in Figure 24.

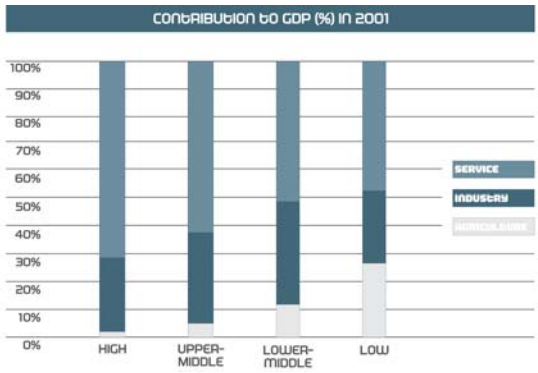


FIGURE 23 ___ CONTRIBUTION OF THE SECTORS TO THE GDP (UNDP, 2005).

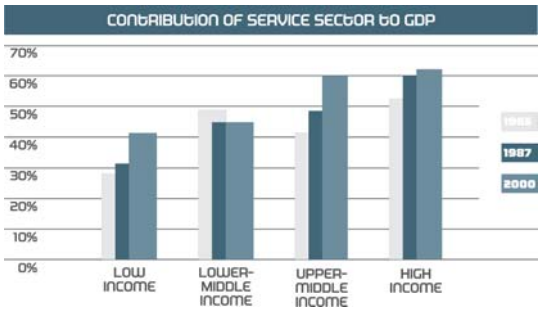


FIGURE 24 ___ THE INCREASING CONTRIBUTION OF THE SERVICE SECTOR TO GDP (UNDP, 2005).

The project team can decide to focus on the sector that is currently important or that is expected to experience growth in the future.

> *What are the main sectors in the country?*
> ***Worksheet N3***
> *Which sector(s) are attractive for a D4S project?* > ***Worksheet N3***

4.2.7 INDUSTRIAL DEVELOPMENT OF THE COUNTRY

There is a direct link between the economic development of a country and its industrial activities. Developing economies are characterized by industries that are low-skill and labour intensive. In developed economies industries tend to have medium- and high-skilled labour, to be technology driven and capital intensive. This is illustrated by Figure 25.

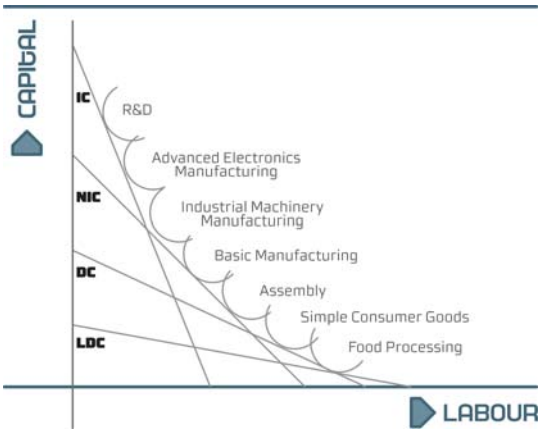


FIGURE 25 ___ EXPECTED ECONOMICAL ACTIVITIES BASED ON DEVELOPMENT OF COUNTRIES (KOGUT, 2003). IC= INDUSTRIALIZED, NIC= NEWLY INDUSTRIALIZED, DC=DEVELOPING AND LDC= LEAST DEVELOPING COUNTRIES.

As Figure 25 illustrates, in developing economies (DC and LDC), food processing and simple basic consumer goods (like furniture) dominate the local industrial activities. In Newly Industrialising Countries (NIC) industrial activity focuses on assembly, basic manufacturing and on the production of more complex technical products. Developed economies tend to concentrate industrial activities on capital- and knowledge-based R&D and on advanced electronics manufacturing. These classifications can help provide an initial understanding of the industrial activity in an economy. However, large countries may have a mixture, such as in India and China.

Traditionally, countries strive to move up the 'curve' or 'ladder' of economical and industrial development (or value chain), from labour-intensive to more capital and knowledge-intensive economic activities and from producing simpler products to more complex products.

To climb the value chain and compete in new markets, improvements are necessary in quality, marketing, organizational structure, and logistics. Innovation is one way to make these improvements. Hence, a D4S project may use the information gathered above to develop a strategy ultimately aimed as moving the country's economy up the value chain.

> *What is the level of the country?* > ***Worksheet N3***
> *What are the characteristics of the local industry? Labour, material, capital or knowledge intensive?* > ***Worksheet N3***

4.2.8 LARGE INDUSTRIES AND SMES

The enterprise sector can be divided by size into micro, SMEs and large enterprises. Different-sized enterprises have different characteristics, ways of operating and innovation capabilities.

The term SMEs covers a heterogeneous group of businesses ranging from a single artisan working in a small shop making handicrafts for a village market, to a sophisticated engineering firm selling in overseas markets. Several criteria can be used to define company size such as the number of employees, the sales value and production equipment value. Each of these can be useful.

The World Bank defines medium-sized enterprises as those smaller than 250 employees and small enterprises as those with less than 50 employees. At the lower end of the SME sector, micro enterprises consist of companies made of self-employed firms and those with less than 10 employees. Irrespective of the level of development, a significant proportion of the micro, and sometimes, small enterprises are found in the informal sector or shadow economy of a country. Informal enterprises are those that operate outside of the regulatory and legal environment. They are not formally registered and do not pay taxes. They represent the large majority of the SMEs in developing countries (see Figure 26).

Studies show that SMEs contribute to over 55% of GDP and to 65% of total employment in high-income countries (see Figure 27). SMEs and informal enterprises account over 60% of GDP and up to 70% of total employment in developing economies and they contribute to over 95% of total employment and about 70% of GDP in middle-income countries.

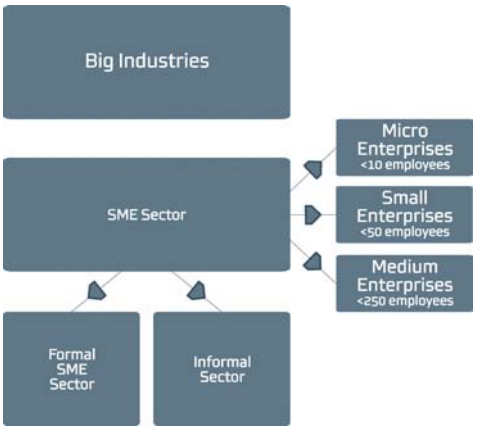


FIGURE 26 ___ CLASSIFICATION OF COMPANIES.

In developing economies, the contribution of SMEs to employment and GDP is less than that of the informal sector. The informal sector in these countries is believed to account for over half of GDP and is made up of micro enterprises. Many projects focus on SMEs because of these characteristics.

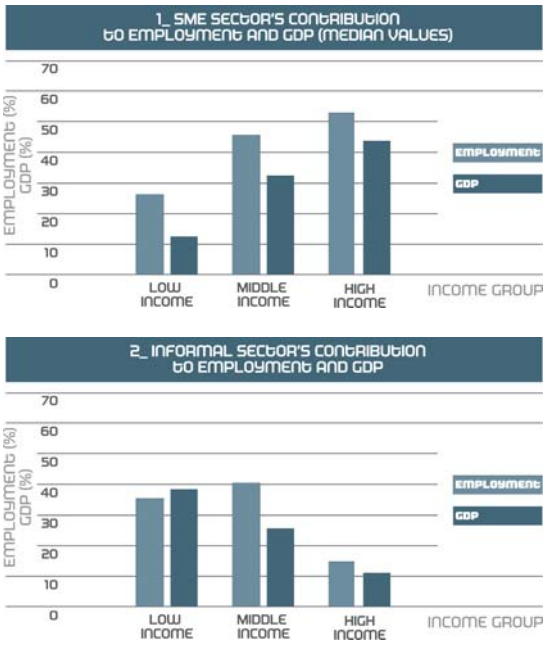


FIGURE 27 ___ THE CONTRIBUTION OF SME AND INFORMAL SECTOR TO EMPLOYMENT AND GDP (OECD, 2004).

4.2.9 THE ROLE OF SMES

Innovative SMEs are the backbone of the private sector and have a significant role to play in economic development in general. They share a number of characteristics that make them attractive for targeting innovation projects. They are able to react quickly and efficiently to market changes. Studies of small firms confirm that they can function as a powerful engine for economic growth and performance.

However, because the sector is extremely heterogeneous, volatile, and differs greatly in developed and developing economies, actions must be targeted efficiently. SMEs need to be effectively connected with global markets, to find buyers for their products and suppliers for their inputs. This requires developing skills, technology, information and research, all of which can benefit from partnerships, be they amongst SMEs themselves or between SMEs and large enterprises. Innovation can act as a bridge to these kinds of projects.

In developing economies, SMEs often offer the only realistic prospects for employment increase and adding value. In short, SMEs can contribute to sustainability for the following reasons:

> SMEs tend to lead to a *more equitable distribution* of income than larger enterprises. In addition, they are less concentrated in urban areas than the larger companies and thus create employment in rural areas;

> SMEs contribute to a *more efficient allocation of resources* in developing economies. They often adopt labour intensive production methods and thus reflect the resource endowment in developing economies where labour is plentiful and capital is scarce;

> SMEs *support the building of productive capacities*. They help to absorb productive resources at all levels of the economy and contribute to the establishment of dynamic and resilient economic systems in which small and large firms are interlinked.

SMEs in developing economies suffer from problems such as the lack of: capital, access to markets, finance, qualified personnel, training, and technological and marketing capabilities. Due to globalization, liberalization of markets, rapid advances in information, communication and production technologies, the new production dynamics have created stiff competition. Local SMEs face the competition of international competitors entering into local markets.

4.2.10 THE ROLE OF THE INFORMAL SECTOR

The informal sector covers a wide range of market activities that combine two groups of different natures. On the one hand, the informal sector is formed by the coping behavior of individuals and families in economic environment where earning opportunities are scarce. On the other hand, the informal sector is a product of rational behavior of entrepreneurs that desire to escape regulation.

The informal sector plays an important and controversial role. It provides jobs and reduces unemployment and underemployment, but in many cases the jobs are low paid and job security is poor. It bolsters entrepreneurial activity, but to the detriment of regulation compliance - particularly tax and labor regulations. The size of the informal labor market varies from the estimated 4-6% in the high-income countries to over 50% in the low-income countries. Its size and role increases during economic downturns and periods of economic adjustments and transition.

The informal sector can be characterized by:

> The use of family and unpaid labour (apprentices) and reliance on manual labour rather than on sophisticated machinery and equipment;

> Flexibility, allowing people to enter and exit economic activities in response to market demand;

> Simple and sometimes precarious facilities;

> The ability to improvise products from scrap materials;

> A willingness to operate businesses at times and locations convenient to customers; and

> A tendency to locate smaller markets, out of reach of the larger firms.

> *What are the roles of SMEs and the informal sector in the national economy? What are their share in the GDP and employment?*
> ***Worksheet N3***
> *What kind of companies will be targeted for the project?* > ***Worksheet N3***

4.2.11 D4S ASPECTS ON NATIONAL LEVEL

The last step on the national level is to identify the overall D4S goals for the country in relation to production and consumption levels. The D4S drivers as described in Chapter 2 can be used to develop the national D4S drivers.

> *What are the main sustainability issues related to production and consumption in the country?*
> ***Worksheet N3***

4.2.12 SELECTION OF SECTORS

Based upon the objectives of the project and the analysis of national economic and social context, the project team can define criteria in order to select the most appropriate sectors.

> WITHIN THE 'D4S IN CENTRAL AMERICA' PROJECT, THE FOLLOWING CRITERIA FOR SELECTING PRIORITY SECTORS WERE USED:
> 1> Representative and important sector for the country;
> 2> Large share of small- and medium-sized companies in the sector;
> 3> Relevant environmental impact; and
> 4> Proven potential for D4S in the sector.

TEXT BOX 3 ___ EXAMPLE OF CRITERIA FOR SELECTING COUNTRIES.

> *Define the criteria for the sector selection.*
> ***Worksheet N4***
> *Select sectors based on the criteria.*
> ***Worksheet N4***

4.3 LEVEL 3: SECTOR

After selecting one or more sectors as target group within the project, it is time to explore and characterize them in more details. The following can contribute:
> Carrying out a SWOT analysis for the sector(s) (see Chapter 3);
> Discussing the general product innovation approach within the sector(s) by using the growth matrix and competitive strategies matrix (see Chapter 3);
> Determining the D4S drivers for the sector(s) (see Chapter 2).

> *Execute a SWOT analysis on the sector, discuss the innovation strategies and determine the D4S drivers for the sector.* > ***Worksheet N5***

In addition, it is useful to contact trade associations and other business contacts to gain better insight regarding the characteristics of the sector. Based upon these insights the team can define criteria for selecting suitable companies within the sector.

> WITHIN THE 'D4S IN CENTRAL AMERICA' PROJECT THE FOLLOWING CRITERIA WERE USED FOR SELECTING COMPANIES:
> General
> 1> Small- or medium-sized company;
> 2> Representative company for the sector;
> 3> National or regional owned company;
> 4> Interest and/or willingness to participate in a D4S project;
> 5> Existing product development function in the company; and
> 6> Necessity and opportunity for D4S improvement of the product.
> Specific
> 7> Capability to execute a D4S project;
> 8> Potential business opportunities for D4S Redesigned products; and
> 9> An organized and structured production process.

TEXT BOX 4 ___ EXAMPLE OF CRITERIA FOR SELECTING COMPANIES.

> *Define the criteria for company selection.*
> ***Worksheet N6***
> *Select companies based upon criteria.*
> ***Worksheet N6***

4.4 LEVEL 4: COMPANY

After the sectors and companies have been selected, it is time to survey the characteristics and needs of the companies themselves.

4.4.1 ABSORPTIVE CAPACITY FOR THE COMPANY

Most of the knowledge that companies use in innovation comes from outside. Since most innovations result from borrowing rather than invention, the ability to exploit external knowledge is a critical component of innovative capabilities. So absorptive capacity – the ability of a firm to recognize the value of new, external information, assimilate it and apply it to a commercial end - is key to performance.

Building this capacity in a firm consists of two phases. First, efforts to enhance the firm's ability to access external knowledge requires a knowledge sharing culture. The second phase consists of efforts to enhance the firm's ability to use external knowledge — to transform and implement it within the firm.

Understanding the current (technological) capabilities and the knowledge absorption capacity of a company helps to define the appropriate knowledge and innovation strategy. According to the World Bank (see Figure 28),

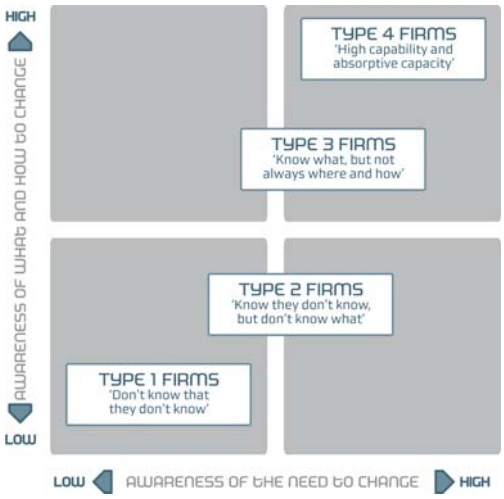


FIGURE 28 ___ GROUPING OF FIRMS ACCORDING TO THEIR TECHNOLOGICAL CAPABILITY AND KNOWLEDGE ABSORPTIVE CAPACITY.

firms can be placed in four categories based on (1) the degree to which a firm is aware of the overall need to change and (2) the degree to which management is aware of what to change and how to go about changing it.

At the lowest level are firms that have no capacity for innovative activities or change. Depending on the stage of a company, different support can be provided to ease their movement from the bottom left to the upper right quadrant (from Type 1 to Type 4).

A more educated labor force finds it easier to adopt foreign technology and to more rapidly develop its own. The creation and role of 'mid-level' craft and technician skills are crucial to the absorption and use of production technologies and to informal R&D innovative activity.

> *What is the firm category (1, 2, 3 or 4)?*
> ***Worksheet N7***

4.4.2 IDENTIFYING THE RIGHT D4S INNOVATION STRATEGY FOR A COMPANY

Innovation should be integrated in a gradual manner, building upon resources and capabilities available in a company. Depending on the absorptive capacity and the technological skills of a company, the following approaches are available:

1> Low technology SMEs and micro enterprises
Business_ To stabilize business and build competitive capabilities.
Innovation_ To build awareness of the potential of innovation.
2> Minimal technology SMEs
Business_ To develop competitiveness.
Innovation_ To introduce basic skills, to encourage adoption and application of new ideas.
3> Technology competent enterprises
Business_ To support market development, internationalization of business.
Innovation_ To build in-house innovation capabilities.
4> R&D rich enterprises
Business_ To develop international markets, entry to global supply chain.
Innovation_ To encourage R&D engagement with international innovation networks, technology transfer and diffusion.

> *Which of the categories fit the company best?*
> ***Worksheet N7***

A step-by-step approach is often necessary, especially among SMEs, which may have difficulty accessing capital for large investments. SMEs can make simple, low-cost and quick pay-off adjustments. These eco-efficiency/cleaner production changes in production processes, which because of the lower costs per unit of production, can show immediate profit implications. With profit benefits companies may have an easier job acquiring capital for more fundamental and costly changes (such as product design and development). Hence, a D4S pro-ject may begin with a cleaner production element to build credibility and support needed for the larger effort.

4.4.3 PRODUCT OR CAPACITY COMPANY

A product company is one that develops, brands and (partly) produces its own products. A capacity company mainly offers it production capacity to other companies and customers and does not bring its own products into the market. An example would be a company that galvanizes components for other companies. Some differences in characteristics are:

	PRODUCT COMPANY	CAPACITY COMPANY
Design	Own design	Design by customer
Design Department	Yes	No
Focus	Product design	Product technology
Brand	Own brand	Customers brand
Production	Systematic, planned	Flexible, improvisation
Staff	Generalist & specialists	Specialists
Time focus project	Mid-long-term	Short-term
Customer	Anonymous	Known

TABLE 5 ___ THE CHARACTERISTICS OF PRODUCT VERSUS CAPACITY COMPANIES (BUIJS AND VALKENBURG, 2000).

Product companies have more experience in developing new products and are more prepared for new (more radical) innovation activities. A capacity company that wants to (partly) transform into a product company will have limited in-house capacity and experience with identifying end-user markets, developing products and branding. They should be more incremental in the innovation approach. Additionally capacity companies will need more support to increase their in-house product development capacity.

> *What is the product development capacity and experience of the company? Are they a product company or a capacity company, or a mixture?*
> ***Worksheet N7***

4.5 D4S NEEDS ASSESSMENT ACTION PLAN

After going through the stages of the D4S Needs Assessment, the team should have clear insights into the potential of the D4S project and should be able to make a D4S action plan for the project.

4.5.1 MIND MAPS

Mind maps offer an efficient way to summarize collected information and to elaborate on it. They are useful for:
> Summarizing information;
> Consolidating information from different sources;
> Thinking through complex problems; and
> Presenting information.

To create a mind map, start by writing the topic of the map in the middle and draw a circle around it (see Figure 29). For major sub-headings, draw lines out from this circle. If there is another level of information

FIGURE 29 ___ AN INITIAL MIND MAP OF A D4S PROJECT.

belonging to the same sub-headings above, draw these and link them to the sub-heading lines. See the example below.

Useful starting points for the mind map can be question like: Who will be involved? Why? What kinds of knowledge transfer activities are possible? What will be the tangible deliverables? What is the proposed time frame? Figure 30 shows the outcome of national D4S action plan made by two NCPC staff members during a workshop.

FIGURE 30 ___ EXAMPLE OF D4S COUNTRY PROJECT MIND MAP CREATED DURING A D4S WORKSHOP.

005 A 10 STEP APPROACH FOR D4S REDESIGN

D4S Redesign, as the name implies, aims at redesigning an existing product made by a company (or by a competitor) from a sustainability point of view. D4S Redesign is of particular interest for developing economies because this incremental type of product innovation involves smaller risks and investment, follows a structured and predictable process and is known to be economically and commercially as important as more radical approaches (see also Chapter 3). Because the focus of D4S Redesign is an existing product, the market and manufacturing conditions specific to the product are already known. Its improvement potential can be determined from easily accessed information – such as feedback from the sales department, user experiences and testing and market investigations. In addition, the existing production facilities are usually suitable for manufacturing the redesigned product and, hence, investments costs would likely remain within reasonable boundaries. The risks connected with the redesign effort are lower compared to more radical D4S innovation approaches.

The D4S Redesign approach has 10 steps. Each step reflects a part of the product development process as illustrated in the figure below. In the following sections, each step is explained, and a reference is made to the connected worksheets that can be found on the accompanying CD-ROM (see also Figure 31).

STEP 1: CREATING THE TEAM AND PLANNING THE PROJECT

The D4S Redesign team will be responsible for introducing and implementing D4S Redesign procedures at the organizational and technical levels. Therefore the team needs to identify those people inside and outside the company that will be involved in the project and determine how each one should be used best.

The D4S Redesign team members should be recruited from different areas. The goal is to involve product developers, environmental experts, employees in the sales and marketing departments and senior management. If appropriate, finance and quality departments also can be involved. The marketing department is critical in D4S Redesign activities. Experience shows that the marketing department is key in sharing knowledge on consumer needs and wants and in marketing the ultimate product.

The team needs the full support of senior management and product managers because they decide on budgets and product strategies. Other key stakeholders outside the company (knowledge institutes/universities, dedicated consultancies, sector organizations or partners from local or regional clusters) can be asked to join the project team or monitoring committee. See Chapter 4 Needs Assessment for how to identify relevant stakeholders.

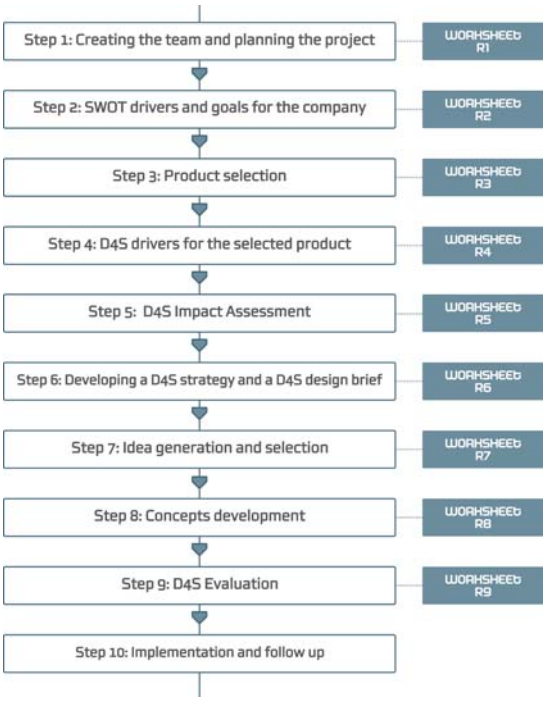


FIGURE 31 ___ D4S REDESIGN STEP-BY-STEP.

In addition to networking and collaboration, external expertise in the project team might be needed when specific experience or knowledge is not available inside the company. Advice can be provided by an external design or innovation consultant. This advice might be limited to targeted needs within specific phases of the project. Collaboration with local industrial design schools can be helpful to support the D4S projects with interns or graduate students.

The D4S Redesign team should not be too big (preferably not more than 6 people) and should try to have the following characteristics:

> Creative to be able to generate new improvement options;
> Decision-making capacity;
> Communication skills within the team and the organization;
> Multi-disciplinary; and
> Well organized and operational.

The role of each team member should be clarified at the beginning of the project along with the specific tasks and responsibilities to optimize the process.

EXAMPLE_

D4S Redesign team was organized at Fabrica Venus (Guatemala) with the people involved in product development and others that usefully contributed to the pro-ject. See Chapter 7.1.

> *Which departments and staff members will be involved in the D4S Redesign team? What will be his or her specific role in the team?* > ***Worksheet R1***

An essential prerequisite for the successful introduction of D4S Redesign – as in all implementation processes – is to motivate those involved in the project. There are three basic ways of convincing people about the relevance of D4S Redesign: 1) highlight business benefits, 2) provide good examples of D4S Redesign products and resultant benefits, and 3) listing convincing sustainability arguments. In addition, successful D4S Redesign projects can motivate company employees and help to integrate D4S Redesign into the company after the demonstration project is completed.

The first activity for the D4S Redesign team is to develop a clear action plan and to determine expected deliverables. Most D4S Redesign projects take from three months to a year to complete, depending on the product innovation capacity of the company and the complexity of the product that is redesigned.

> *Discuss the timeframe of the project: What will be carried out? How often the team will meet and how they will communicate with the rest of the organization?* > ***Worksheet R1***

STEP 2: SWOT DRIVERS AND GOALS FOR THE COMPANY

The process of D4S Redesign is essentially the same as for a conventional product development process. However, its goal is to integrate sustainability aspects. As a result, the D4S Redesign process is interwoven with the normal product development and businesses processes within the company. (Note the parallels with the processes outlined in Chapter 3). Therefore, the company's objective and its current situation should be taken into consideration in the project.

In order for a D4S Redesign project to be successful, it is important to have clear goals and expectations in the beginning. What are the goals of the company and the team? The team should ensure that project goals are aligned with the company's policies, business plans, and other strategic issues.

Based upon a SWOT analysis, which outlines the current product innovation capacity within the company and an overview of the D4S drivers, the team can define the D4S Redesign project goals and the level of ambition and innovation within the company.

SWOT ANALYSIS

It is useful to first get a picture of the competitive situation of the company. The SWOT matrix is a useful tool to facilitate this process. It analyzes the internal strengths and weaknesses as well as the external oppor-

tunities and threats of the company. For more information on SWOT analysis see Chapter 3.

EXAMPLE_
A SWOT analysis was made at Talleres REA (Guatemala) to define clear goals for the project.
See Chapter 7.2.

> *Identify the internal and external conditions of the company and fill in the SWOT Matrix.*
> ***Worksheet R2***

The product innovation capacity within the company is based on earlier product innovation experience and staff competence. This capacity assists in the identification of the appropriate D4S innovation ambition of the company.

> *What is the main activity of the company? Developing and producing products (product-company) or does it use production capacity for producing products for other companies (capacity-company)?* > ***Worksheet R2***

> *On the average, how many redesigned products and how many totally new products are launched into the market annually?*
> ***Worksheet R2***

> *Does the company have a product development department or do they normally contract out design services for product development?*
> ***Worksheet R2***

D4S REDESIGN DRIVERS

Why does the company want to carry out D4S initiatives? What are the D4S drivers for the company? Sometimes a company might be forced by external drivers like legislation or supply chain requirements. However, often the project will be driven by demands from inside the company, such as cost reduction or corporate responsibility. Generally there are one or two major drivers. Even if the drivers are obvious, they should be verified during the initial project stage to check whether other drivers are also relevant (see Chapter 2 for an overview of D4S drivers that can help to identify the critical drivers for the company).

> *Identify which internal and external D4S drivers are relevant for the company and prioritize them.* > ***Worksheet R2***

The selected internal and external D4S drivers are related to the three different pillars of sustainability: people, planet and profit. In some projects the objective is to find a 'perfect balance' amongst them.

EXAMPLE_
The Ragbag line consists of new products made from plastic waste in India. In addition to the environmental aspects, the social aspect of income generation is very important.
See Chapter 7.5.

Other projects may have a specific focus on the environmental aspects (planet) or on the social aspects (people).

EXAMPLE_
The social aspect was crucial in the development of building products from mining waste in South Africa. Social improvements proved much more important then environmental gains. See Chapter 7.4

> *Discuss if people, planet or profit should be balanced for the project or if one or two should be prioritized.* > ***Worksheet R2***

GOAL OF THE PROJECT

After carrying out a SWOT analysis which provides a better understanding of the competitive position of the company and identifies the D4S internal and external drivers, the team can address the following questions:

> What **must** the company do?

Because of environmental law requirements or customer demands.

> What does the company **want** to do?

Because of cost reduction, improved market position or assumed corporate responsibility.

> What **can** the company do?

Depending on available financial and human resources and product innovation capacity.

Specific D4S project goals are defined based upon these inputs. The goal(s) of a D4S Redesign project can vary depending on the results of this step. Examples of possible goals are given below.

POSSIBLE GOALS FOR D4S REDESIGN PROJECTS:

> To show that the sustainability of a product can be improved;
> To gain insight into the sustainability impacts of a product life cycle;
> To communicate sustainability aspects of a product to the market;
> To demonstrate that D4S can contribute to the economic performance (cost reduction) of a company;
> To prepare a company and its product portfolio to meet upcoming legislation requirements;
> To enter sustainability niche markets with sustainable products; and
> To bring down the end-of-life cost of a product.

Experience shows that for a first project, it is advisable to set up project goals which can be achieved in a relatively short time. This builds a foundation of support and skills for future projects.

> *What is the goal of the D4S demonstration project?* > ***Worksheet R2***

STEP 3: PRODUCT SELECTION

The selection of which product to develop is often made intuitively in a company. However such an approach may not result in the selection of the most appropriate product and may reduce the chances of project success. Therefore, product selection criteria should be derived from Step 2. The product should be one that is affected by identified D4S Redesign drivers and in line with the D4S project goals resulting from Step 2.

> *Based on Step 2, what are the product selection criteria?* > ***Worksheet R3***

If possible, the product should:
> Have sufficient potential for change;
> Be relatively simple (in order to achieve fast results and to avoid extensive research); and
> Be affected by the identified D4S drivers for the company.

> *Select a product out of the company portfolio that fits defined D4S product selection criteria.* > ***Worksheet R3***

STEP 4: D4S DRIVERS FOR THE SELECTED PRODUCT

Companies often are developing, producing and selling different products at the same time. The drivers identified in Step 2 might apply to the entire product portfolio but might not be relevant to the selected product. For example, the selected product might be affected by environmental legislation or be sold in a specific niche market that has demanding customers. Therefore it is good to go through the D4S drivers section (Chapter 2) again to validate the drivers for the selected product.

> *Determine which internal and external drivers are relevant for the selected product and prioritize them.* > ***Worksheet R4***

STEP 5: D4S IMPACT ASSESSMENT

A successful D4S Redesign project is based on understanding the sustainability impacts of the target product during its lifetime. The product life cycle can be assessed on the three sustainability pillars of planet, people and profit.

There are various methods, qualitative and quantitative, for assessing the sustainability profile of the product. The analysis can be very detailed and time consuming, as in the case of a life cycle assessment (LCA). The more quantitative assessment methods (often supported by LCA software) can provide quantified estimates of impacts. (See the list of references in Further Reading at the end of this publication).

Within the scope of D4S Redesign projects that target SMEs in developing economies, the use of more simple and qualitative sustainability assessment methods is more appropriate. Comparatively, SMEs have relatively few staff, expertise, data and available finances. In addition, the social aspects can usually be assessed on a qualitative base.

The main goals of a D4S Impact Assessment are:

> To understand the major sustainability aspects of the product life cycle; and

> To identify sustainability priorities of the product life cycle.

A D4S Impact Assessment consists of 5 steps:

1> Creating the life cycle process tree;

2> Defining the user scenario and functional unit;

3> Identifying D4S impact criteria;

4> Filling in the D4S Impact Matrix; and

5> Prioritizing the D4S impacts.

1> Creating the life cycle process tree

The project team should first decide on the exact area of study – known as the functional unit - and the boundaries of the assessment. A process tree can be used to identify the key stages in the product life cycle and the boundaries of the system. This can be done by noting the major upstream stages, such as raw material extraction and processing, and the major downstream stages, such as packaging, distribution and transport, sales, use, disposal and recycling. The life cycle process tree is important because it documents all the stages of the product's life cycle that need to taken into account. It can help to identify life cycle stages that might otherwise be overlooked. It also helps the team see which areas have bigger impacts and should be considered as priority impacts, hence, identifying the project's boundaries. Prioritising areas for study will depend on a number of factors, such as whether or not the company can influence the stage and availability of information.

It is useful to visualize the process tree. This can be done by using flowchart software or by sketching it by hand. It is recommended to note the physical location of each of the life cycle stages (see Figure 32).

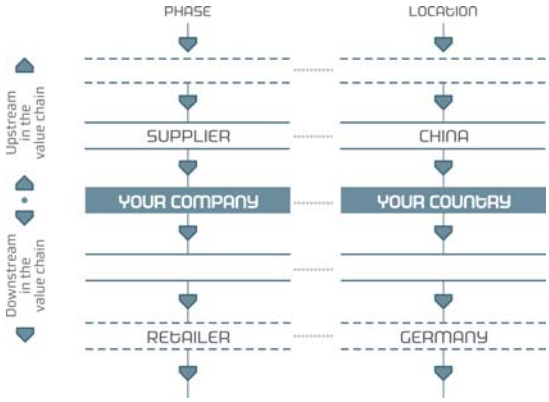


FIGURE 32 ___ EXAMPLE OF PART OF A LIFE CYCLE PROCESS TREE.

EXAMPLE_

A value chain project was executed on milk cream production at Hacienda El Jobo (El Salvador). It took into account the agricultural, production, and the retail phases of the product. See Chapter 7.3

> *Outline the stages of the life cycle process tree and indicate the physical location.* > ***Worksheet R5***

2> Defining a user scenario and functional unit

The product function and how the consumer uses it – known as the user scenario – can assist in defining the functional unit. The way the product is used, such as frequency and lifespan can have significant impacts on the outcomes of the sustainability assessment, especially if the product consumes energy or materials during the use phase. It is important to take into account where the product will be used since the local circumstances, such as different ways of generating electricity (coal, nuclear or renewable), can influence environmental impacts. The user scenario would include the location and time-related elements of the product. For example '*the product will be used by an average Ugandan family in 2005 in an Ugandan city for an average of 1 hour per day for 10 years.*'

> *Define the user scenario and the functional unit of the product.* > ***Worksheet R5***

3> Identify D4S impact criteria

The product life cycle, (as discussed in Chapter 2), includes raw material acquisition, manufacturing, distribution and transportation, use and end-of-life considerations. Each stage of the product's life cycle consumes materials and energy (inputs) and releases wastes and emissions (outputs) into the environment (see Figure 33). In addition, each stage in the product life cycle has social impacts (people) and involves economic (profit) flows.

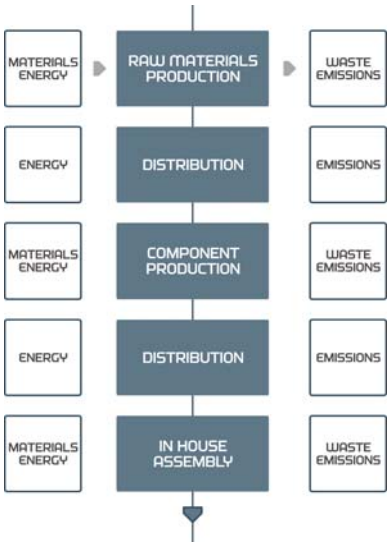


FIGURE 33 ___ INPUT-OUTPUT MODEL OF THE PRODUCT LIFE CYCLE.

The D4S Impact Matrix is a qualitative or semi-qualitative method that provides an overview of the environmental inputs and outputs and social aspects at each stage of the product life cycle. It also provides an idea of where additional information is needed. It can help the team make a quick qualitative assessment of the life cycle. The matrix is made up of 7 columns and several rows. The columns correspond to the different product life cycle stages and the rows concentrate on the relevant D4S criteria.

Rows_ Environmental criteria usually include: material use, energy consumption, solid waste, and toxic emissions. Social criteria usually include social responsibility, local or regional economic development and in-house social and workplace aspects related to human resource management. More issues can be considered by adding rows. Examples include issues such as specific local problems or sustainability issues like water consumption, biodiversity, CO2 emissions, cost, and cultural heritage. In addition, rows can be added and linked to the relevant D4S drivers (Steps 2 or 4).

Columns_ Depending on the *life cycle process tree* of the product, the stages can be named in different ways and the number of columns can be increased. In Figure 34, the life cycle has 6 stages. Depending on the real situation, the team can decide to add or leave out stages. For example, if a retailer is interested in the D4S impact of the products, the team might decide to add a column 'retailer' in between the distribution and use phases. In this way the contribution of the retailer (e.g. cooling of the products in the supermarket) can be made more explicit in the D4S Impact Assessment. In the case that a product leasing company is involved in the project, where the product remains the property of the leasing company, a stage 'service and maintenance' might be added.

Always try to keep the matrix clear and transparent. Do not add more columns and rows than needed!

> *Identify D4S criteria factors (rows) and life cycle stages (columns) to be included. Complete the first row and first column of the D4S Impact*

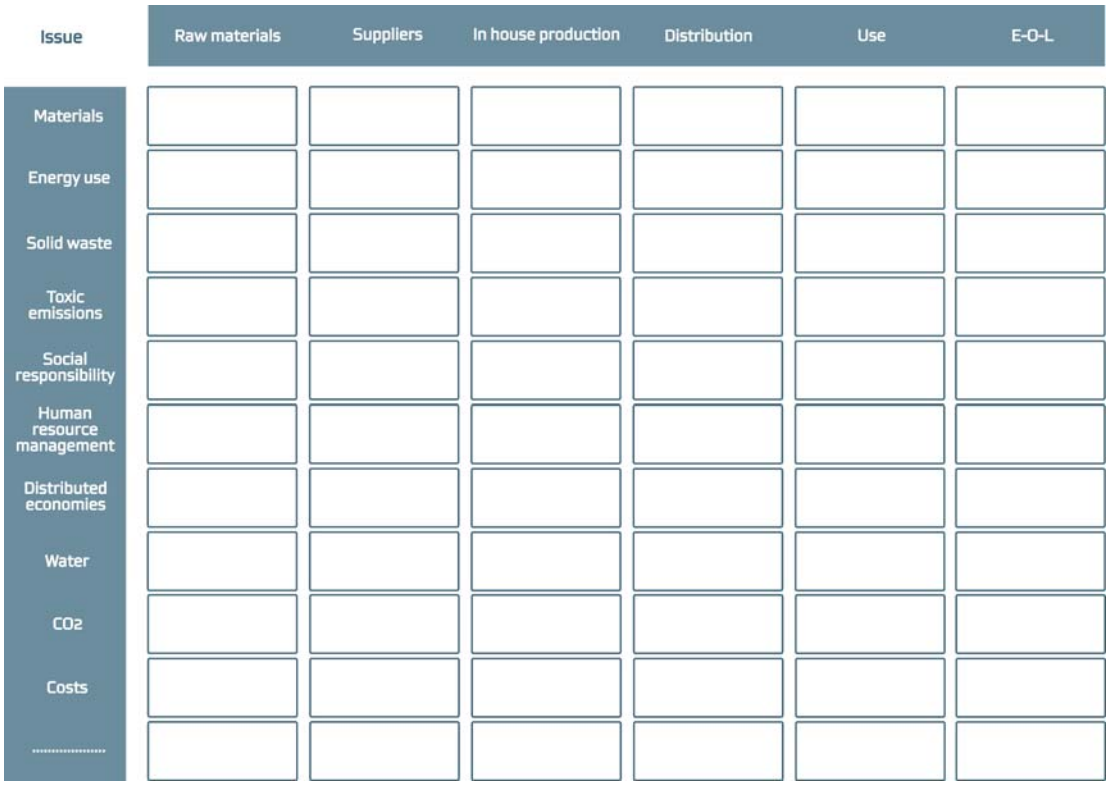


FIGURE 34 ___ D4S IMPACT ASSESSMENT MATRIX.

Matrix. > ***Worksheet R4***

4> Fill in the D4S Impact Matrix

The next step is to discuss and fill in the resultant D4S Impact Matrix. Often existing knowledge within the team is sufficient. The idea is to sit together and to discuss the D4S aspects of the different steps of the life cycle. In some cases, it might be useful to invite a D4S expert. For example, discussions of the environmental aspects might benefit from an energy expert joining the session.

There are different ways to fill in the matrix. The team can decide to it more qualitatively (for example 'plastic (fossil fuels)') or more quantitatively (for example 'gasoline 200 liter'). The challenge is not to write down all the materials and processes, but to record those that are relevant.

Some suggestions for filling in the D4S Impact Matrix:

Material row_ This row is intended for notes on environmental problems concerning the input and output of materials. This row should include information and data about the use of materials and components that are: non-renewable, being depleted, creating emissions during production (such as copper, lead and zinc), incompatible and/or inefficiently used in all stages of the product life cycle. Some relevant questions for the team include:

> What kind and quantity of materials are used?
> Which type and quantity of surface treatment is used?
> Are they renewable or non-renewable?
> Are materials incompatible (for recycling)?
> Other?

Energy consumption row_ This row lists energy consumption during all stages of the life cycle. It could include energy consumption for the production of the

product itself, transport, operating and use or maintenance and recovery. Material inputs with high energy content are listed in the first cells of the column. Exhaust gasses produced as a result of energy uses are included in this row. Some relevant questions for the team include:
> How much energy is consumed during manufacture?
> What feedstock is used (coal, gas, oil etc.)?
> How is the product transported, how far and by what mode?
> Have energy intensive materials like primary aluminum been used?
> Other?

Human resource management (HRM) row_ This row lists the activities needed to improve the HRM at the company. Some relevant issues include:
> How safe and clean is the work place?
> Is healthcare being provided for employees and their families?
> Are there policies to address issues like freedom of association?
> Are there corporate policies to abolish child labour?
> Are there corporate policies to abolish discrimination?
> Are there training and development opportunities in place for employees?
> Other?

The same applies for the other sustainability issues in the first column of the D4S Impact Matrix.

EXAMPLE_
In the project of Talleres REA (Guatemala) a generic D4S Impact Matrix was filled in to show the various impacts. See Chapter 7.2.

> *Fill in the D4S Impact Matrix.* > ***Worksheet R5***

5> Prioritizing the main D4S impacts

After filling in the matrix, examine the cells and highlight those that have major 'sustainability' impacts. The next step is to prioritize the impacts which will become the focus for developing improvement options.
> *Highlight those cells or activities in the D4S Impact Matrix that have high sustainability impacts.* > ***Worksheet R5***

During the development of the matrix, improvement options may become obvious.

> *Collect obvious improvement options to use in the later phase of idea generation.* > ***Worksheet R7***

STEP 6: DEVELOPING A D4S STRATEGY AND A D4S DESIGN BRIEF

The insights gained in the analysis phase (Steps 2, 4, and 5) are the starting point for Step 6. The D4S strategy wheel illustrates 7 general D4S strategies that cover a wide range of improvement directions and parallel the stages of the product life cycle:
1> Selection of low-impact materials;
2> Reduction of materials usage;
3> Optimization of production techniques;
4> Optimization of distribution system;
5> Reduction of impact during use;
6> Optimization of initial lifetime; and
7> Optimization of end-of-life system.

Next to the 7 strategies described above, figure 35 also shows the '0' strategy of complete new product design – an important strategy in light of innovation

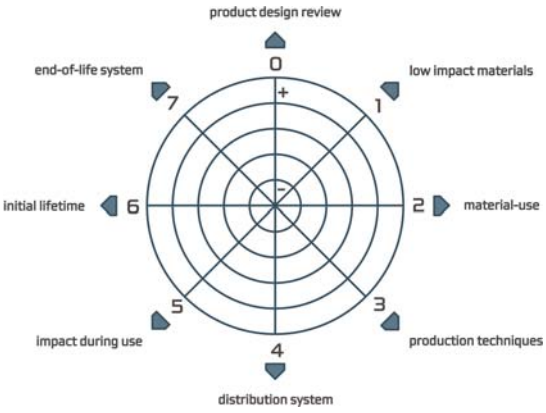


FIGURE 35 ___ D4S STRATEGY WHEEL.

potential. In this strategy, consumer needs define the development of a mix of products and/or services that can best meet these needs in the most sustainable manner. This publication, which focuses on D4S Redesign and D4S Benchmarking, does not refer to this more radical innovation strategy. The broader UNEP Design for Sustainability: A Global Guide (2006) has more information on this topic.

The D4S Strategy Wheel can be used to define which of the 7 design strategies are best suited for the selected product. The results of the analysis phase are linked to potential D4S improvement strategies. However, the results from Steps 2, 4, and 5 might not lead to only one improvement strategy or, conversely, may suggest an unambiguous direction. The results might lead to a different improvement direction than

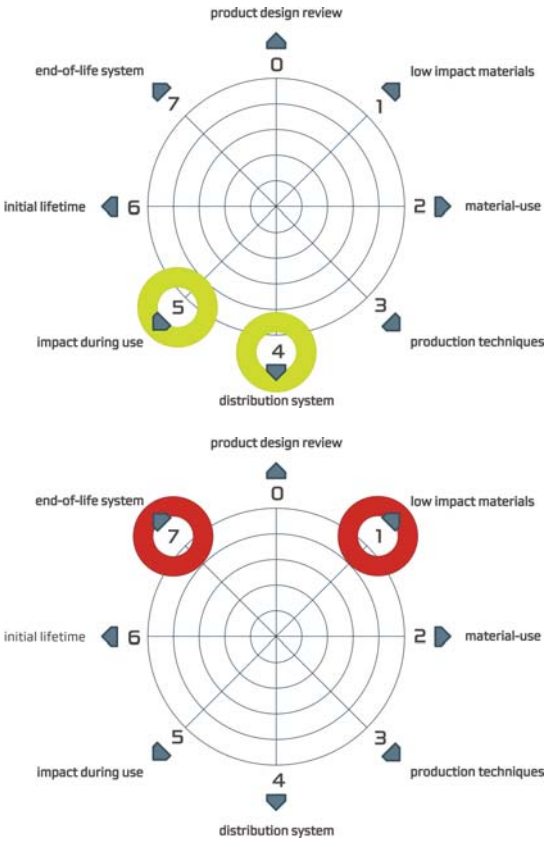


FIGURE 36 ___ EXAMPLE OF SELECTION OF D4S STRATEGIES BASED UPON 1) PRIORITIES BASED UPON D4S IMPACT ASSESSMENT (TOP), 2) PRIORITIES BASED UPON D4S DRIVES (BOTTOM).

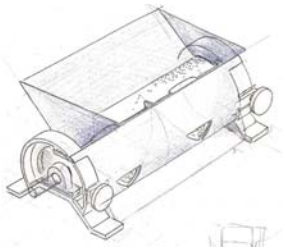
the direction derived from the outcomes of prioritized D4S drivers (the business perspective).

For example, in the case of an electronic product being developed by a company in Vietnam for the European market, the outcome of the D4S Impact Assessment might highlight energy consumption and worldwide distribution to have the greatest environmental impact. As a result, the design team could focus on D4S strategy 5 "Reduction of impact during use" and strategy 4 'Optimization of distribution system'. On the other hand, the outcome from the assessment of the D4S drivers might conclude that environmental legislation regarding 'take-back' legislation and hazardous substances is essential. This outcome could lead to the decision to focus on strategy 1 'Selection of low impact materials' and strategy 7 'Optimization of the end-of-life 'system'. (See Figure 36.)

This can lead to complex decision-making to select the D4S design strategy and evaluation of the trade-offs between the results of different assessments. To facilitate the decision-making process, the team can select two strategies based on the D4S Impact Assessment and two based on the D4S drivers.

> *Based upon the results of the D4S Impact Matrix, what are the 'top two' D4S strategies for improvement options?* > ***Worksheet R6***

EXAMPLE_



In the project at Talleres REA (Guatemala) different strategies were chosen, two were developed based on the impact matrix and two were based on the drivers. See Chapter 7.2.

After defining project goals and selecting 4 priority D4S strategies, the team can make a final evaluation and select the product strategies for the D4S Redesign.

> *What D4S strategies with the company and project team focus on in the next stages of idea generation and concept development?*
> ***Worksheet R6***

When the guiding D4S strategies have been determined, the team can draw up a more detailed design brief. The design brief should include as a minimum:
> The reason(s) for selecting the product;
> An indication of the social (people), environmental (planet) and financial (profit) goals;
> The selected D4S strategies;
> The way the project will be managed;
> The final composition of the project team;
> A plan and time scale for the project; and
> The project budget (staff and money) and activity breakdown.

> *Work out the D4S design brief.* > ***Worksheet R6***

STEP 7: IDEA GENERATION AND SELECTION

This step generates ideas for improving the sustainability of the product. Once generated, the team prioritises them and then generates, selects and details a new product concept. (See Figure 37.)

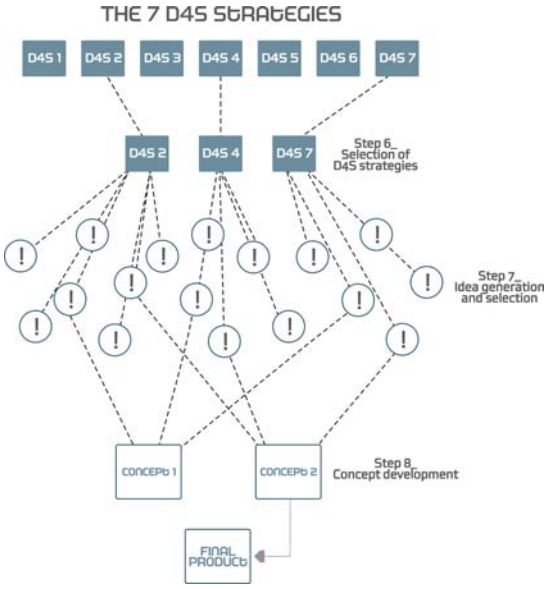


FIGURE 37 ___ THE D4S PRODUCT DEVELOPMENT PROCESS.

The D4S design brief and selected D4S strategies are the starting points for generating ideas for improvement options. Different techniques can be used to generate ideas:
1> Using obvious ideas collected during the D4S Impact Assessment and D4S driver evaluation;
2> Using the D4S Strategy Wheel for brainstorming;
3> Using the D4S rules of thumb; and/or
4> Other creativity techniques.

1> Ideas from the D4S Impact Assessment and D4S drivers

During the analysis of the D4S Impact Matrix and the D4S drivers, obvious improvement options have been collected on Worksheet R7.

EXAMPLE_
Recycled plastics were used to create a new product (strategy 1) by Ragbag (India). See Chapter 7.5.

2> Brainstorming with the D4S strategy wheel

The D4S Strategy Wheel can be used for identifying suitable design strategy directions as well as provoking new ideas. With this in mind, the 7 D4S strategies have been extended with sub-strategies:

1> Selection of low-impact materials that are;
a_ Cleaner
b_ Renewable
c_ Have lower energy content
d_ Recycled
e_ Recyclable
f_ Have a positive social impact, (e.g., generate local income)

2> Reduction of materials use:
a_ Weight
b_ Volume (transport)

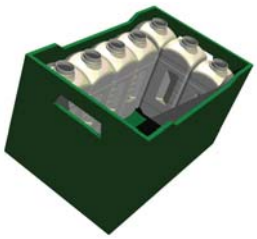
EXAMPLES_
Reduction of materials (strategy 2) was used in many of the case studies. See the Microplast bottle (Costa Rica), Chapter 7.6; and for export packaging (Uganda), see Chapter 7.7.

3> Optimization of production techniques:
a_ Alternative techniques
b_ Fewer steps
c_ Lower/cleaner energy
d_ Less waste
e_ Fewer/cleaner materials used to support the production
f_ Safety and cleanliness of workplace

EXAMPLE_
Optimization of production techniques (strategy 3) was used in dairy production at Hacienda El Jobo (El Salvador). The example took into account water use reduction in the production phase. See Chapter 7.3.

4> Optimization of distribution system:
a_ Less/cleaner/reusable packaging
b_ Energy efficient transport mode
c_ Energy efficient logistics
d_ Involve local suppliers

EXAMPLE_
Optimization of distribution system (strategy 4) included changing the Microplast bottle form and size for the delivery crate. See Chapter 7.6.



5> Reduction of impact during use:
a_ Lower energy consumption
b_ Cleaner energy source
c_ Fewer consumables needed
d_ Cleaner consumables
e_ Health supporting and/or added social added value

EXAMPLE_
Lower energy consumption (strategy 5) was applied in the design of a PV powered solar lamp in Cambodia. See Chapter 7.8.

6> Optimization of product lifetime:
a_ Reliability and durability
b_ Easier maintenance and repair
c_ Modular product structure
d_ Classic design
e_ Strong product-user relation
f_ Involve local maintenance and service systems

EXAMPLE_
Easier maintenance and repair (strategy 6) was applied to the new depulper of Talleres REA (Guatemala). See Chapter 7.2.

7> Optimization of end-of-life system:
a_ Re-use of product
b_ Remanufacturing/refurbishing
c_ Recycling of materials
d_ Safer incineration
e_ Taking into consideration local (informal) collection/recycling systems

> Organize a brainstorming session and come up with options to improve product sustainability using selected D4S strategies. **> *Worksheet 6***

3> The rules of thumb for D4S strategies

For each of the 7 strategies, 'rules of thumb' have been formulated. The overview of these rules can be found in Chapter 8.

> *Check the D4S rules of thumb to see if they stimulate other improvement options.*
> ***Worksheet R7***

4> Apply other creativity techniques

Next to the improvements derived from the previous steps, it also makes sense to apply other creativity techniques to generate improvement options.

'Creativity thinking' is an expression used to describe different ways of thinking that can lead to new ideas. Rational as well as irrational ideas can lead to useful concepts. Creativity techniques can inspire a team to generate even the most 'crazy' ideas. Chapter 9 provides several techniques.

> *Organize a creativity session and generate improvement options.* > ***Worksheet R7***

Selection of promising ideas

After generating a lot of ideas, it is useful to cluster them according to the 7 D4S strategies.

> *Cluster all the generated improvement options according to the D4S strategies.* > ***Worksheet R7***

A qualitative process of selection is then applied to prioritise the ideas. The improvement options are subsequently assessed for environmental, social and economical impact/benefits as well as technical and organizational feasibility. In addition to the criteria below, each company may define additional ones or weigh them differently according to individual circumstances. Possible criteria could be:
> Expected environmental (planet) benefit;
> Expected social (people) benefit;
> Expected economical (profit) benefit;
> Technical feasibility (given available resources of the company);
> Organizational feasibility;
> Perceived added value of the customer; and
> Market potential.

> *Which criteria should be used to select and prioritise improvement options?* > ***Worksheet R7***

The improvement options can be evaluated and provided with 'values' against each criteria.

++	2	Very positive score/ very feasible
+	1	Positive score/ feasible
0	0	Neutral score
-	-1	Negative score/ almost feasible
--	-2	Very negative score/ completely infeasible

Option feasibility is often time-related: some improvement options and redesigns can be carried out immediately (short-term) and others require more time (mid- or long-term).

> *List the options and rate each one based on the time implications (short or long-term).*
> ***Worksheet R7***

A final choice can usually be made only after the ideas have been fleshed out in greater detail in what is known as a 'product concept'.

STEP 8: CONCEPTS DEVELOPMENT

In this step, the selected product ideas are developed into concepts and then into a more detailed design. In essence, the ideas generated previously are combined into holistic concepts. (See Figure 37.)

At this stage there will be uncertainty about the feasibility of the various ideas. In practice, several concepts will be developed at the same time. It may be possible to combine several ideas in one design. A technique called the Morphological box (See Chapter 9 Creativity Techniques) is valuable when the team wants to combine several ideas in one product concept in a systematic way. (See Figure 38.)

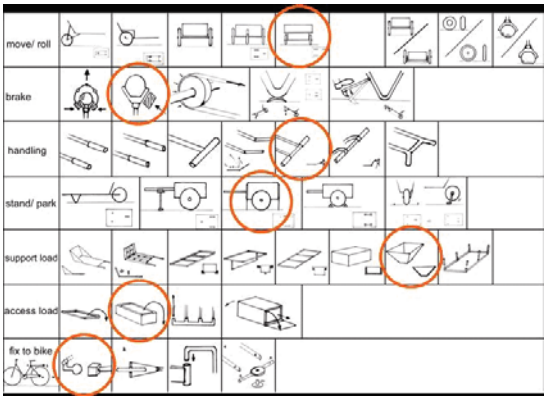


FIGURE 38 ___ MORPHOLOGICAL BOX FOR A FOOD TRAILER IN GHANA.

EXAMPLE_ F

The morphological box was used for the development of a food trailer in Ghana. See Chapter 7.9

The team can use test models, prototypes and computer simulations to estimate technological feasibility. These tools provide insights into technological feasibility and allow the design to be optimized.

Attention must also be given to the financial feasibility of the new concepts. The project team will have to ascertain whether the financial benefits of the options will counterbalance the costs involved.

The next effort is to evaluate and select the best concept before it is further detailed. Not all concepts that are developed are equally useful. The possibility of combining the best characteristics of each concept might be considered.

A selection table is a good way to evaluate concepts. The team uses the information on the product specification from earlier steps (like the D4S Design Brief). The team assigns different qualitative values such as good, fair, poor, or numerical scores from 1 to 10. With these values, an overall estimate can be made of each of the concepts. This process may be similar to the one applied in the idea generation and selection stage (Step 7).

In addition to product design, the production plan and marketing plan will now be developed as in traditional product innovation projects (see Chapter 3).

STEP 9: D4S EVALUATION

Comparing the product profile of the new design with that of the previous product enables an estimate of the sustainability merits of the new product.

> *Evaluate the benefits of the D4S drivers and goals as defined in Step 2.* > ***Worksheet R9***

STEP 10: IMPLEMENTATION AND FOLLOW-UP

This step involves prototype production, testing, planning of large-scale manufacturing and test marketing. For D4S redesigned products, the sustainability elements are integrated into these activities. During prototyping and testing the actual sustainability performance of the product can be evaluated for the first time. In the test marketing, consumer reactions to the sustainability qualities of the products can be assessed along side standard criteria. With these insights, final alterations can be made before large-scale market introduction.

In parallel, the company needs to prepare a communication strategy. The company can decide to present the sustainability benefits of the product explicitly in its advertisements or not. Both strategies have advantages and disadvantages. Explicit marketing can be worthwhile if the consumer group is interested in sustainability issues, or when the marketing contributes to a brand or corporate image. The disadvantage can be that the company may be required to substantiate sustainability claims. In addition, sustainability generally is an abstract idea for consumers that will significantly strengthen the marketing message.

After the product launch, the company can monitor the product's sustainability performance. Feedback and criticism, as well as inputs derived from active evaluation can be fed back into the planning process for further product revision.

06 D4S BENCHMARKING

In most developing economies, copying (or imitating) is the prevalent method to develop new products. SMEs often base product ideas on existing products of local or international competitors. The D4S Benchmarking approach adopts a similar kind of philosophy: learning from competitors' improvement solutions. The D4S Benchmarking approach is especially suitable for companies that develop new products based upon imitating existing products.

6.1 INTRODUCTION TO D4S BENCHMARKING

In most markets, companies - regardless of their size - need to be aware of their peers' activities to maintain and/or to improve their competitive advantage. This is true for most business activities that have a direct or an indirect link to business and consumer markets. This is also relevant for environmental and sustainability issues. Companies need to determine how competitors are performing, where they stand themselves, and what are the industry best practice levels. For such needs, benchmarking has proven to be an effective tool. Benchmarking is the process of improving the performance of an existing product by continuously identifying, understanding, and adapting outstanding practices and processes found both within and outside of the organisation.

Traditionally, benchmarking is applied to processes and strategies rather than to products and services. *Environmental* benchmarking of strategies and processes is more common than environmental benchmarking of products and services. Environmental benchmarking can take place on many levels, and can focus on products/services as well as processes/strategies, both internal and external to a company (see Table 6).

Within this publication 'D4S Benchmarking' refers to activities that focus on products and services (the right column) in combination with a focus on environmental aspects. The D4S Benchmark approach has a strong focus on the profit and planet part of the D4S concept and less on the people part.

	PROCESSES/ STRATEGIES	PRODUCTS/ SERVICES
Internal	Benchmarking a company's processes/strategies against internal targets/goals in order to set/revise goals and rate internal improvements.	Benchmarking products /services against previous models/generations in order to check targets/goals and rate improvements.
External	Benchmarking a company's processes/strategies against those of competitors in order to determine and assess possible future strategies.	Benchmarking products /services against those of the competition in order to generate improvement options and gain competitive advantages.

TABLE 6 ___ TYPES OF ENVIRONMENTAL BENCHMARKING.

D4S Benchmarking is a structured approach to compare the environmental performance of a company's products against competitors' products and to generate improvement options. Since individual competitors often use different solutions to resolve the same design problems – like a different product architecture, components or technology – D4S Benchmarking offers a reflective approach and advises learning from others' products. Experience shows that, in practice, no single product scores high on all criteria and against all other products. This means that benchmarking improvement options can always be generated.

An important element of benchmarking is the concept of best practice: *'those practices that please the customer most'*. The goals of a benchmarking study should be based on customer needs, whether the customers

are internal (departments within an organisation, higher management levels, or employees) or external (consumers, citizens, regulators, legislators, local and national environmental groups or investors).

6.2 BENEFITS OF D4S BENCHMARKING

The goal of D4S Benchmarking is to learn from the best practice of others. It is an incremental improvement tool. Some of the potential benefits include:

> Helping the company understand and develop a critical attitude to its own business processes. Benchmarking helps to overcome complacency ('it is OK the way it is') and convince the 'non-believers'. It also creates awareness about environmental issues inside and outside a company.

> Promoting an active process of learning in the company and motivates change and improvement. Benchmarking can break down ingrained reluctance to change and create momentum — employees become more receptive to new ideas. It also stimulates environmental thinking.

> Finding new sources for improvement and ways of doing things without having to 'reinvent the wheel.' It provides a creative basis to find environmental improvement solutions.

> Establishing reference points for measuring performance and providing early warning for lagging cost structures, customer satisfaction, technology infrastructure and for business processes (see Text Box 5). It can also correct inaccurate perceptions about competitor strengths, weaknesses and strategies. It helps focus more on specific environmental areas for improvement and ensures that environmental activities are embedded in the business.

6.3 D4S BENCHMARKING IN PRACTICE

D4S Benchmarking in *large industries*

Several large companies have used D4S Benchmarking as a means to ensure that environmental thinking is not limited to individual products, which may be labeled as 'green' projects, but more introduced the concept more thoroughly. Philips Consumer Electronics, for example, used D4S Benchmarking as an important element in their EcoVision programme. It provided management with the proper yardsticks on which to base decisions, which was crucial for embedding D4S in existing business processes. The basic idea is that environmental performance information gains value when it is compared amongst products.

CASE EXAMPLE_SONY TV'S_

Sony learned the importance of external benchmarking because of an experience in the mid-1990s. At that time one of Sony's colour TVs in the European market received a 'reasonable buy' rating from a Dutch consumer magazine, in part because its environmental performance fell short of that of competing models. Subsequent to publication of the magazine report, the market share for the Sony model dropped 11.5% in the Netherlands. At the same time, the two competing models that had received 'best buy' ratings garnered share gains of 57% and 100%. This experience spurred Sony Europe to redesign its TVs to be more environmentally sound. Sony's new Eco TV received positive ratings in the consumer test magazines by reducing the use of materials and plastics, decreasing needed disassembly time and by increasing product recyclability.

TEXT BOX 5 ___ EXAMPLE OF SONY TV'S

D4S Benchmarking in *SMEs in developing economies*

In most developing economies, copying (or imitating) is the prevalent method to develop new products. SMEs often base product ideas on existing products of local or international competitors. Companies typically do not have R&D facilities. Products from (foreign) competitors are analysed, adapted and copied. Various studies confirm that 'replication' of new and increasingly complex products is the primary means through which new technological knowledge is assimilated in firms. Replication becomes a systematic activity and copying is

done from prototypes as well as from blueprints. This process of copying or imitating competitors is in line with the idea of benchmarking - learning from others in order to improve strategies, processes and products.

There are three strategies for 'imitators' to enter the market successfully: offer low prices, make a better product ('imitate and improve'), and use market power against a weaker pioneer. Small companies in developing economies often lack the capacity to improve products, resulting in inferior products from a quality and environmental point of view. The D4S Benchmark approach can be an appropriate response to addressing both of these issues and improving products in the context of developing economies.

6.4 HOW TO CARRY OUT A D4S BENCHMARKING PROJECT?

Light and extended version of D4S Benchmarking

The characteristics and goals of a D4S Benchmark exercise might be different each time it is carried out, depending on the context and capabilities of the company, the goals of the exercise and the targeted industrial sector. For example, SMEs often have limited resources like labour, R&D and finances. As a consequence, they normally carry out a benchmark effort in a simplified 'low-cost' way compared to larger industries. International companies might have the budget to purchase and analyse a competitor's product. SMEs often have to base a benchmark analysis on pictures of the products taken from catalogues and magazines, from internet information (like consumer tests) or by visiting fairs and shops. For example, an IKEA brochure has been used by companies in Asia to 'benchmark' or inspire design to develop furniture products for the export to European markets.

This section presents a standard D4S Benchmarking method for assessing products, irrespective of product category or industry. The method is based on 10 steps which will be explained in more detail below. Depending on the context and needs, the method can be adjusted in two ways:

> **Light** versus **Extended version_** A set of worksheets is available to use for documentation when going through the steps. When a company has experience in carrying out an D4S Benchmark, or when thorough analysis is not possible or desired, the "all-in-one" Worksheet, which provides a "*light version*" of the 10-step D4S Benchmarking method, is appropriate. If more time, staff and budget is available the "*extended version"* could be chosen. In this case, each step is supported by one worksheet (10 in total).

> **Physical** versus **Information_** The D4S Benchmark method can be carried out on *physical* products that are purchased, tested, dismantled and measured especially for the exercise. In case this is not possible, the D4S Benchmark can also be based on *information* collected rather than buying the product (see Step 6 for more information).

	BASED UPON INFORMATION OF PRODUCTS OF COMPETITORS	BASED UPON PHYSICAL PRODUCTS OF COMPETITORS
Light version (All-in-one worksheet)	A	B
Extended version (10 worksheets)	C	D

TABLE 7 ___ TYPES OF D4S BENCHMARKING.

This leads to four different versions of D4S Benchmarking (see Table 7). The light version based on collected information (version A) is more in line with the capabilities of SMEs. The extended/physical version (D) might be more interesting for larger companies. Before planning a D4S Benchmark, the most appropriate approach (A, B, C or D) for the company or project should be evaluated and determined.

6.5 STEP-BY-STEP D4S BENCHMARKING

Each step has a specific goal, question to be answered and worksheet. It is recommended to first print out the worksheet before starting. Figure 39 provides an overview of the 10 steps.

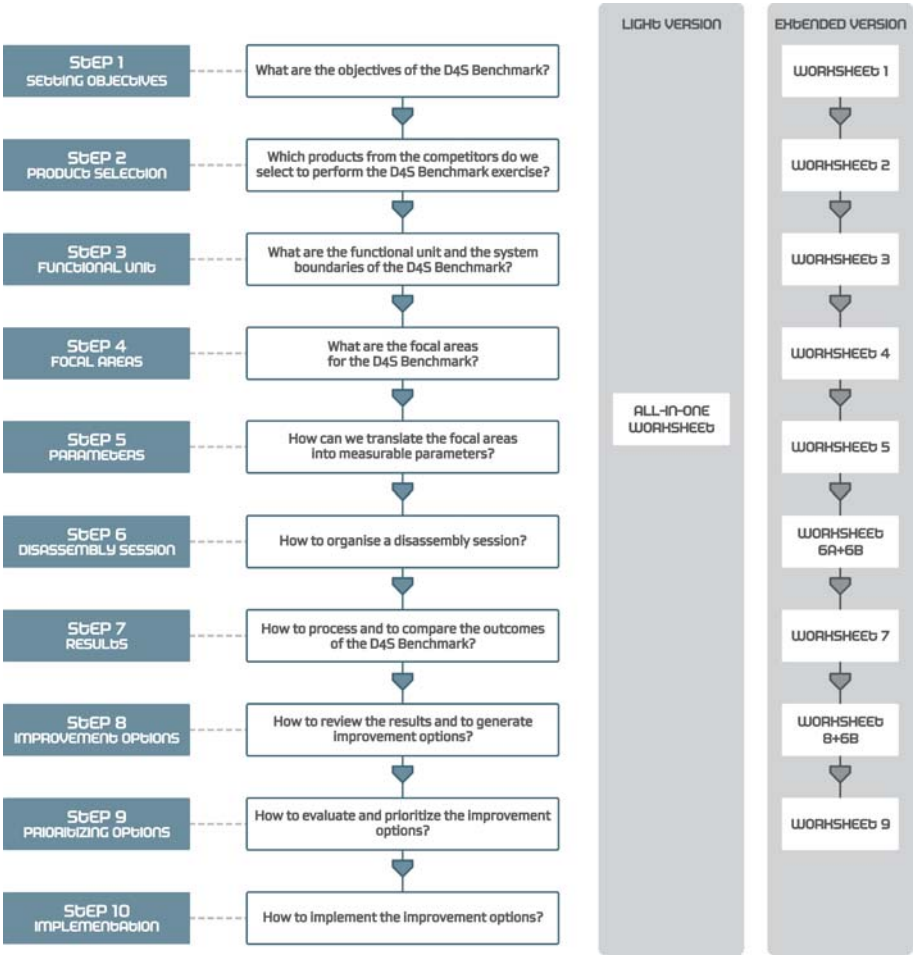


FIGURE 39 ___ OVERVIEW OF THE 10 STEPS OF THE D4S BENCHMARKING METHOD.

Step 1_ What are the objectives of the D4S Benchmark?

There are many reasons to initiate a D4S Benchmark. In the beginning it is essential to discuss the project goals objectives with the team. What will be analysed? What should be achieved? These questions will have an impact on the project design and assist in identifying the products to be studied and the parameters used to make comparisons.

Possible objectives of a D4S Benchmark project could include:

> To *learn from worldwide competition* in order to enter an international market;

> To know how the *product scores* in comparison *to local competitors*;

> To get *inspiration for environmental improvements*;

> To know *where the product stands in relation to specific (upcoming) legislation* like packaging or take-back obligations. What can be derived from competitors in the field?

> To monitor *improvements over time;* and there may be

> Other reasons important to the company.

> *Specify the product to be benchmarked and define the main objectives for carrying out the project.* > ***Worksheet B1***

> *Determine the appropriate type of D4S Benchmark for the company. Light version versus extended version - information versus physical version* > ***Worksheet B1***

Step 2_ How to select products for the D4S Benchmark?

The second step of the benchmark procedure is to select the products to be used. They can be selected from competitors at the international, national or local level. Sometimes much can be learned from the worst performing products in the sector.

1> Identify the *leading products* in the sector (local, regional or international);

2> Select products in the *same specific market* (target group, price/quality etc.); and

3> Identify products that illustrate '*best practice*' in the field.

A more structured approach could involve establishing selection criteria. Be sure to take into account the objectives determined in Step 1. For example, if the objective is:

> To *learn from competition worldwide* make sure to include 2-3 products from global competitors, preferably from top multinational brands.

> To know how the product *scores in comparison to local competitors* make sure to include 2-3 products from local competitors, preferably those that have the largest market shares.

> To get *inspiration for environmental improvements* make sure to include 2-3 products from competitors that have good environmental performance, image, and/or that operate in an environmental niche market.

> To know *where the product stands in relation to (specific) upcoming legislation* make sure to choose products from brands that will be affected by the same legislation and/or products from brands that are operating in markets that already have similar legislation.

> To see *performance improvements over time* within product groups of the company make sure to choose products from the previous generation of the company's own brand. Using several products of the company's main competitor to benchmark rate of improvement can also be useful.

> *Based on objectives, choose the product brands that will be compared in the D4S Benchmark exercise.* > ***Worksheet B2***

The next step is to identify the most appropriate products. It is useful to use identification and selection criteria that are in line with the company's own product. The following criteria can help:

> **Functionality_** Describe the major and specific features of the product. Make sure that the benchmark product does not differ too much from the company's product. If the products are similar in functionality, the results are more appropriate to compare.

> **Manufacturing year_** Verify that the products come from the same product generation. Have they been developed and launched into the market in the same period? It does not make sense to compare the newest model with an old model of a competitor.

> **Retail price_** Check if the products have similar retail prices.

> **Availability_** Make sure that there is not too much difference in commercial availability. Ideally all products should be equally accessible to customers.

The project products will be identified at the end of Step 2.

> *Choose the products and describe their features following the selection criteria.*
> ***Worksheet B2***

Step 3_ What is the functional unit and system boundary of the D4S Benchmark?

The context in which a product will be used influences the results of the benchmark. For example, the intensity of use of a product will have a serious impact on the level of the product's energy consumption during a certain period. To make a clear comparison of products, it is essential to describe the function, the context, user scenario and system boundaries. This is usually referred to as the 'functional unit' and enables a 'fair' comparison. Addressing the following can be useful:

> Identify the perceived function(s) of the product according to the user;

> Describe the average user within his or her context;

> Identify the location where the product will be used and;
> Determine a user scenario describing elements such as the intensity of product use.

> *Determine the functional unit of the product.*
> ***Worksheet B3***

Step 4_ What are the focal areas for the D4S Benchmark?

To determine the main product variables to be benchmarked, it is necessary to identify what issues or focal areas are of 'environmental' relevance. This should be done from a broad perspective. Answers to the questions 'what is environmentally sound?' or 'what is green?' depend on the perceptions of different stakeholders. In practice, this requires at least three perspectives - from scientific, consumer and government points of view.

> The scientific perspective of environment_
From the scientific perspective, the goal is to identify the key environmental impacts of a product during its life cycle. This is usually done by applying some form of a life cycle assessment (LCA) depending on the data availability. For many products, LCAs are publicly available on the Internet. However, it should be noted that much of the data is based on developed country databases and methods, which may not accurately reflect the situation of a product life cycle in another part of the world. In the case that good LCA data are not available, a D4S Impact Matrix (see Chapter 5) can be a practical alternative. Based on these assessments, it is possible to identify which stages of the life cycle are important in terms of environmental impact.

> The government perspective of environment_
From the government perspective, it is important to identify the relevant legal systems for the product(s), as this might highlight additional environmental issues. This will determine the priority items on the government agenda and may not always reflect the same priorities as the scientific perspective (see also Chapter 2).

> The customer perspective of environment_
From the customer perspective, yet another number of relevant environmental issues might arise. These are likely to go beyond the narrow definition of environment and could encompass sustainability in a broader sense. Perceptions of the general public are strongly linked to emotions. Environmental issues related to health and safety (and therefore potential toxicity) score high. Whereas concerns about resources are considered a more long-term issue and thus score low. Concerns about emissions generally score medium (see also Part I).

How to choose focal areas for environmental improvement?

A number of environmental issues will be generated after evaluating the scientific, government and consumer perceptions. The next step is to prioritize these issues. To keep the process short and manageable, a maximum of 5-6 main environmental issues should be chosen. This can be done based on the size of environmental impacts, financial aspects, and/or customer perceptions. Although combining these criteria into a weighted score can be difficult, in practice, the main focal areas will become clear fairly easily, usually targeting energy consumption, material application and distribution.

FIGURE 40 ___ THE FIVE GREEN FOCAL AREAS OF PHILIPS.

As an example, Philips Consumer Electronics decided in the mid-1990s that product development, marketing and sales would focus on five green focal areas: weight and materials application, potentially hazardous substances, energy consumption, recycling and disposal, and packaging. This was internally and externally communicated by using the focal areas as shown in Figure 40.

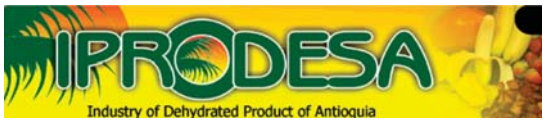


FIGURE 41 ___ IPRODESA, PRODUCER OF DRIED FRUITS IN COLOMBIA.

IPRODESA, a medium sized food processing company in Colombia, carried out a D4S Benchmark to explore the possibilities to enter the European market of dried fruits. Five international competitors on the European market were selected and used to benchmark the products of IPRODESA. The following five focal areas were the main focus for the D4S Benchmark:

a_ Environmental aspects of the food and packaging;
b_ Protection of the food;
c_ Distribution and retail;
d_ Communication; and
e_ Perception by consumers.

Specific worksheets for food products can be found on the CD-ROM.

> *Determine the focal areas for the benchmark process.* > ***Worksheet B4***

Step 5_ How to translate the focal areas into measurable parameters?

With the focal areas identified, the next step is to translate them into measurable variables. The challenge is to translate these 'qualitative' focal areas into quantifiable variables. Energy is expressed in kWh and materials in grams, etc. In many cases, it might be necessary to use more than one variable to describe one focal area.

> *Describe measurable parameters for the focal areas.* > ***Worksheet B5***

Step 6_ How to organize a disassembly session?

In a 'physical' D4S Benchmark, the next step is to organize a disassembly session to flesh out and collect information on the focal areas. To get the best results out of a disassembly session it is worthwhile to plan well and structure it methodically. Do not forget to weigh and measure the whole product before taking it apart! Tools including a weight balance, a stopwatch, a multometer (to measure energy consumption) and a camera will help obtain and record measurements.

During the disassembly session, other steps of the benchmark will present themselves. For example the 'smart solutions' employed by competitors and 'silly solutions' in the company product will become obvious. It is useful to write these observations down!

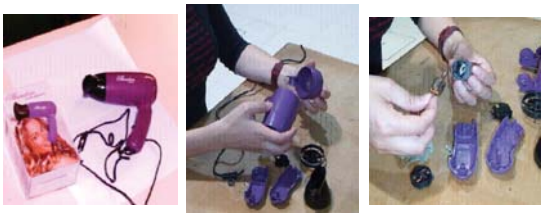


FIGURE 42 ___ EXAMPLE OF DISASSEMBLY SESSION OF AN ELECTRONIC PRODUCT

Where no physical products are available for disassembly (known as an 'information' D4S Benchmark, see Table 6), other information sources are needed to gain an understanding of how competition is solving design issues for the focal areas in the reference product. Often most of the required information can be collected through the internet. There are also more traditional ways of studying the products of local competitors like visiting fairs, observing products in the shop and interviewing customers.

> *Organise a disassembly session following a plan, note all findings and issues that are obvious (like smart and silly solutions).*
> ***Worksheets B6 A and B***

Step 7_ How to process and compare the outcomes of the D4S Benchmark?

After the collection of all relevant information for the D4S Benchmark focal areas, the next step is to process the data. It is advisable to prepare fact sheets for each focal area summarizing the compiled information. From these fact sheets all the measurements for the benchmarked products can be seen at a glance, which makes the information more easily interpretable.

> *Summarize all benchmark findings.*
> ***Worksheet B7***

Step 8_ How to review the results and to generate improvement options?

There are several ways to come up with D4S improvement options. In addition to solutions that the D4S Redesign chapter of this publication might yield, it may be useful to consider:
1> Using worksheet B 6B (Issues that are obvious) to identify smart solutions from competitor's products that can be applied to the company products;
2> Using the same worksheet to identify silly solutions in the company's products that need improvement in comparison to competitor's products. The competitor illustrates that the solutions are feasible, so they are likely to be feasible in the company product as well; and
3> Trying to look for alternatives that have not been considered.

> *Review all results and identify improvement options.* > ***Worksheet B8***

Step 9_ How to evaluate and prioritize the improvement options?

Apart from environmental considerations, a multitude of issues need to be taken into account in evaluation and prioritization of the improvement options that are generated. For each option, the following aspects should be considered:
> *Environmental benefits_* an assessment of whether the improvement option reduces environment impacts along the product life cycle.
> *Consumer benefits_* an assessment of whether the consumer is likely to accept the option as a benefit.
> *Societal benefits_* an assessment of to what extent society will benefit from the proposed improvement.
> *Company feasibility*
  > *Technical feasibility_* an assessment of whether the improvement options are technically feasible (and timely).
  > *Financial feasibility_* an assessment of the financial viability each of the improvement options.

For each criterion it is possible to assign a 'score'. Depending on the weighting factors, an overall score can be derived and the improvement options can be ranked. After improvement options have been generated, ranked and validated, the options need to be implemented and integrated into the company.

> *Select the best improvement options by evaluating them against the potential benefits and feasibility.* > ***Worksheet B9***

Step 10_ How to implement the improvement options?

The previous steps will result in a number of options for product improvement. Behind each improvement option will also be an understanding of why the option is good, beneficial to most or all stakeholders and financially and technically feasible. Connected to the options, are some examples from competing companies that are already applying these solutions and some measure of the potential results from implementing them. The product development and decision making processes are different in each company. However, this information should be very helpful in motivating decision makers to apply or at least consider the improvement options.

6.6 D4S Benchmark for specific product groups

As mentioned in the beginning of this chapter, the characteristics of a D4S Benchmark might be different each time. In some cases not all the steps are needed or the needed steps can be simplified. For example, in the case of a D4S Benchmark for food products, Step 3 (definition of the functional unit) and Step 6 (disassembly session) are unnecessary. In other words, one must always determine if all steps are needed. The format of the D4S Benchmark has to be adjusted for the specific industrial sector in which it will be used.

The CD-Rom has worksheets for an extended version of the D4S Benchmark for durable products like electronics and an adjusted version for the food sector.

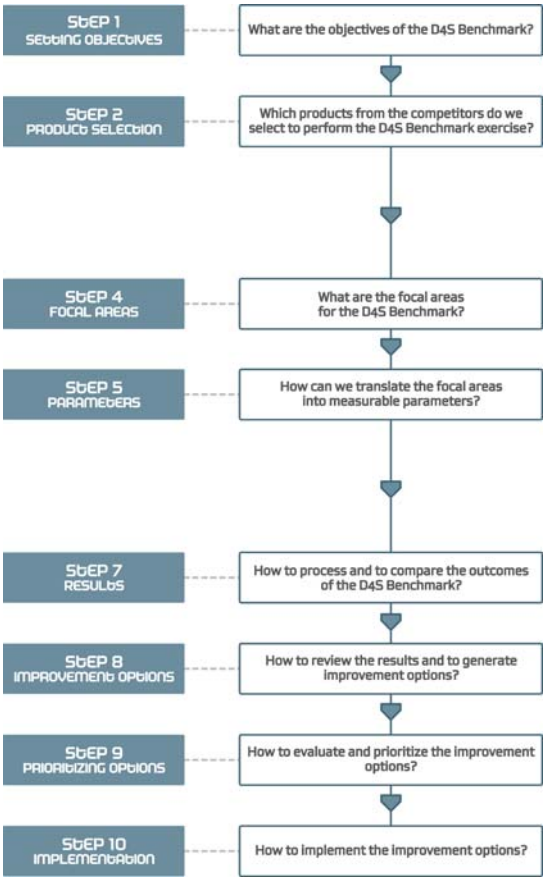
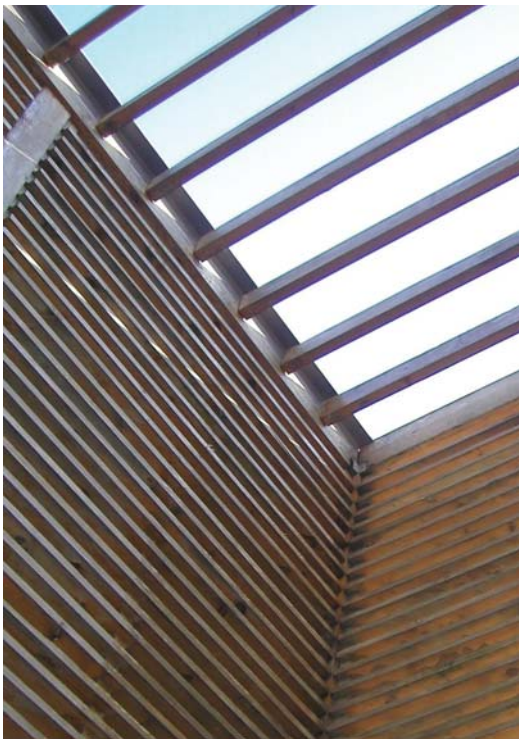


FIGURE 43 ___ EXAMPLE OF RELEVANT STEPS FOR A D4S BENCHMARK FOR THE FOOD SECTOR.

BENCHMARKING EXAMPLES > See case studies section_

7.10> Industrias Waiman Costa Rica: Refrigerator
7.11> Intermech Cassave Grater, Tanzania
7.12> Philips Taiwan Monitor



PROFIT

PART III

REFERENCE INFORMATION ON D4S

007 D4S CASE STUDIES IN DEVELOPING ECONOMIES

In this section, a number of case studies from developing economies are presented. Reference to these case studies has already been made in the earlier chapters where they serve as examples for specific phases and strategies for D4S Redesign and D4S Benchmarking.

7.1 BUILDING THE D4S TEAM AT FABRICA VENUS, GUATEMALA

The company

Venus is a medium-sized Guatemalan company located in Guatemala City that produces 150 different kinds of candies in the factory. They sell most of their products on the Central and Latin American market and sell a smaller amount in the USA and South America. The case study is a good example of a medium-sized company that does not have a design department and where product development is a team effort.

Motivation for D4S

The project was undertaken as part of a Regional Ecodesign Project supported by CEGESTI, a Costa Rican Research Institute, the United States Environmental Protection Agency and Agency for International Development and the Delft Technical University, The Netherlands. The project sponsored ecodesign projects throughout Central America. Venus wants to sell products in new markets and especially in the European market. Because of the different kind of requirements on the European market, for instance packaging, some product changes were needed and Venus decided to use a D4S approach for this innovation process.

The project

This D4S example is interesting because of the key role played by the design team throughout the project. The company does not have a separate product development department. People from several departments handle product development as part of their regular jobs. Normally, the development process of a new product takes between 3 and 6 months. When bigger changes in the production process are needed, the process can take up to one year.

For this project, executed in 1999, Venus organized a team of people usually involved in product development and others that could usefully contribute. The team consisted of:

> Commercial director;
> Production director;
> Head of quality control;
> Technical advisor of the company; and the
> Marketing director.

The team had monthly meetings during the project and ideas for new products came from each of the team members and were discussed. Analysis of the ideas was executed by different members of the team, depending on their expertise. The work on the selected product was divided amongst team members, each with specific goals and time schedules. Testing was done both for the production process and for marketing. The president of

the company made the final decisions on production and market issues and was informed regularly by the team.

Improvement options

Hard-boiled candies were selected as the project product because of the great variety and it is the best selling and cheapest product to produce (accounting for 80% of the turnover). To reduce environmental impacts, options were generated to address the use of packaging material - more environmentally sound materials were sought and the printed area on the wrapper was reduced to be less work for the machines to print.

Pillow pack wrapping for the candies was chosen as a packaging solution, since a pillow pack saves more than 40% of raw materials compared to the original single and double twist wrapper design. In addition, the machine to make the pillow pack was much faster than the previous wrapper machines and produced less material waste.

Cast PP material was selected for the bags instead of laminate BOPP (which poses problems for recycling and needs glues) for the packaging. In Central America it is possible to recycle PE. Therefore, it was suggested that the company collect the PE used in transport and have it taken to a recycler by the trucks on the return trip. The company could earn money from selling the PE bags to the recycler.

Results

The outcome of the project was the development of two new products for the European market and two new, smaller bags that were implemented in production for the local market. The new pillow pack with more than 40% material reduction was released into the market. The company implemented some of the other improvement options related to the distribution system which resulted in interesting cost savings.

FIGURE 44 ___ THE SMALLER PACKAGING ON THE LEFT IS THE NEW PACKAGING FOR VENUS PRODUCTS.

For more information: see CEGESTI (1999), Augustijn and Uijttewaal (1998) and Crul (2003).

7.2 SWOT, IMPACT ANALYSIS AND D4S STRATEGIES AT TALLERES REA, GUATEMALA

The company

Talleres REA (Guatemala City) is a family company of 35 employees with 50 years of experience in producing machinery for coffee processing. REA produces all the products necessary for converting red coffee berries into the brown beans that end up in coffee all over the world. The company has a workshop with traditional machines for working with metals.

Motivation for D4S

The project was part of the regional Ecodesign Programme. The Guatemalan government released new legislation dealing with the massive use of water in the wet-processing of coffee during the project period (1999-2000). In addition, there was growing awareness on ecological issues related to coffee producing, both in Guatemala and the countries that import the coffee. Ecologically grown and processed coffee receives a higher price, providing a strong motivation for REA clients to move in that direction.

The project

A SWOT analysis for the company was made by the project team (see Table 8). The most important findings were as follows:

The selected product to be redesigned was a depulper which is central to coffee processing. The depulper of

STRENGTHS	▶ Years of experience ▶ Quality ▶ Durability ▶ Flexibility ▶ Good ethics, serious and honest ▶ Stable employees (experienced) ▶ Easy maintnance ▶ Good service in maintenance and technical assistance
WEAKNESSES	▶ No stoks ▶ Consistency and standardization of products ▶ "Up to date"/innovation in technology ▶ High costs of production > primary material > work done manually ▶ Delivery time ▶ Capacity of installation ▶ Marketing ▶ Lack of information ▶ Structure and sequence of process ▶ Little experience with changes/development in the products
OPPORTUNITIES	▶ Prices in dollars ▶ New markets > export ▶ Diversification > new products ▶ D4s project ▶ Introduction of solar energy ▶ Integrated service > reasonable price as external competence
THREATS	▶ Environmantal legislation ▶ Changes in dollar exchange rate ▶ Economic regulations ▶ National and international competition ▶ Globalization ▶ Price/availability of electric energy

TABLE 8 ___ SWOT FOR TALLERES REA.

Issue	Raw Materials	Suppliers	In House production	Distribuition	Use	E-O-L
Materials	Metals Paint additives bearings	Metals packaging	Connections (screws etc) Surface treatment	Packaging: card board, metal, plastics	Changing of parts every 1-5 years; concrete for base	Recycling of parts, recycling as metal
Energy use	Input energy for metal production	Metal products production	Gas for welding electricity, Fuel	Fuel for transport	Fuel	Fuel for transport
Solid waste	Mine waste	Metals scrap	Metals scrap	Packaging waste		Obsolete parts disposal of metals, bearings
Toxic emissions	Toxic Mine waste, NOx	Chemicals, NOx, dust	Chemicals, NOx, dust	NOx, dust	NOx, dust	NOx, dust
Social responsability	Health in mining communities		Health, income in local community			
Human resource management		Working conditions	Working conditions		Clean drinking water	
Distributed economies		Local employment	Local employment	Local employment		
Water	Water use for mining	Water use for metal production	Water use for pulpero production		600.000 l /day Waste water (high BOD)	
Climate change	CO2	CO2	CO2	CO2	CO2	CO2
Costs	High			High (installation)	High (maintenance)	
.....						

TABLE 9 ___ D4S IMPACT ANALYSIS FOR TALLERES REA.

REA functioned, but relied on old technology and traditional materials.

A generalised D4S Impact Analysis for the depulper of REA resulted in the following (see Table 9):

Improvement options

The improvement areas identified by the SWOT/Drivers Impact Analysis were:

> D4S Strategy 3_ *Production techniques*. Decreasing the number and size of components could result in better production techniques and less waste.
> D4S Strategy 5_ *Impact during use*. Reduction of water during use phase (responding to legislation) was an important improvement direction. Also, a design addressing the entire system offered possibilities for sharing power amongst several machines.

From the Impact Analysis the following additional strategies were prioritised:

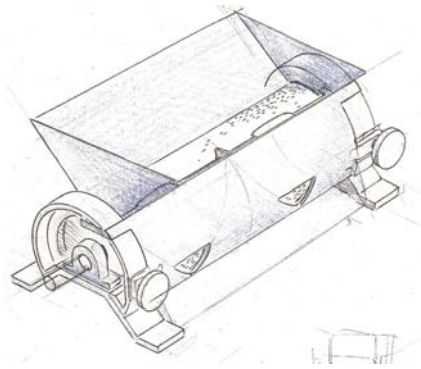


FIGURE 45 ___ CONCEPT AND THE NEW DEPULPER OF REA.

> D4S Strategy 1_ *Low impact materials*. Changing copper parts to stainless steel could be better for the environment because the steel would last longer (4-5 years) before needing to be replaced.
> D4S Strategy 2_ *Reduction of material use*. By executing a functional analysis of the different parts, it was possible to identify where cast-iron was needed and which parts could be changed or eliminated.

Results

All four strategies were pursued. Talleres Rea produced a prototype of the new concept which resulted in a 70% reduction in weight, a 50% savings in production time, less energy and a 50% reduction in costs. The product is now sold on the market. Talleres Rea executed a second D4S project as a follow-up because of the success of the first.

For more information: see Garvik (1999), Cegesti (1999) and Crul (2003)

7.3 PRODUCTION CHAIN PROJECT AT HACIENDA EL JOBO, EL SALVADOR

The company

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. Other products are cheese, cream and meat. The cooperative has its own milk production plant with 20 employees.

Motivation for D4S

The company needed new product/market combinations to stay competitive in the market. Sustainability aspects were seen as very important in the development of these new products. The project was undertaken as part of a Regional Ecodesign Project supported by CEGESTI, a Costa Rican Research Institute, the United States Environmental Protection Agency and Agency for International Development and the Delft Technical University, The Netherlands.

The project

From the beginning in 2001, the project took into account all aspects of the production chain, from cow to final product. The company was assisted by CEGESTI, in Costa Rica and by Landivar University in Guatemala. It was a challenging project for the company, aimed at developing completely new products (low-fat milk cream) and new markets. There was a strong emphasis, in addition to the product orientation, to reviewing the elements at the beginning of the supply chain such as manure and energy use and cleaner production issues. The cream product was redesigned and improvements in the production process were realized. In addition, biogas generated from the manure at the hacienda and interactive working relationships with the packaging supplier were initiated.

Improvement options

The development of a low-fat cream could lead to a direct increase in income, since the bulk of the costs for making milk products is linear to fat content. This relation is decoupled in the selling price of low-fat cream. In addition, cleaner production options in the milk factory were identified.

FIGURE 46 ___ HACIENDA EL JOBO (TOP) AND THE CREAM PRODUCTS (BOTTOM).

Results

The practical results were as follows:
> Water use reduction by 30% at 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; and a
> Reduction in ink used in the packaging.
It was expected that the product diversification would lead to bigger overall market share for the company and to increased production. The project also led to a better insight into the environmental situation of the company, and renewed efforts to enter new markets.

For more information: see Sagone (2001) and Crul (2003).

7.4 SOCIAL ASPECTS OF SUSTAINABILITY: CONSTRUCTION PRODUCTS FROM MINING WASTE IN SOUTH AFRICA

The company

This case study was done in 2003 in cooperation with the United Nations Industrial Development Organization, Anglo Corporation, Delft Technical University and other representatives from South African mining industries.

Motivation for D4S

The project partners joined efforts to find a way to improve sustainability within the context of the mining industry. Mining is a major industry in South Africa and has a number of negative aspects connected to it:

> Poor safety and workers health conditions in many companies;
> HIV/AIDS issues in several countries;
> Inappropriate use and management of land, including land of indigenous people and protected (ecological) areas;
> Abuse and mistrust amongst local communities;
> Negative environmental impacts connected to current and past mining and mineral processing operations (including tailings dumps, post-closure issues, and loss of biodiversity);
> Inefficiency of mineral use worldwide and the low levels of recycling and closed cycles of many minerals; and
> Increased small scale mining by migrating poor people on marginal minerals deposits, under dangerous working conditions with considerable environmental impact.

One identified partial solution was to find uses for mining waste in road and building construction materials. Limitations to these materials include the presence and leaching of heavy metals and other substances, corrosive or abrasive characteristics, and radiation.

In addition, even in the improbable case that 100% of the products needed for road and housing construction were made from these wastes, it would only represent 1-2 % of the actual *annual increase* of total mining waste, and is virtually insignificant. Making (new) products from mining waste is not a long-term solution to reduce, eliminate the environmental problems of the waste.

Product development from mining waste should take into account the need to reduce use of virgin materials for building and road construction, to evaluate the availability of cheap local materials and to improve local economic development including business and employment development. For the mining corporations it implies that this type of activity is not significant from an environmental point of view and only marginally important from an economic viewpoint. However, it can be highly relevant from a social sustainability and corporate social responsibility perspective.

Improvement options

The most common products made from mining wastes are products for building construction such as standard building bricks.

Common bricks can be considered a 'low value' product. If mining waste materials become available for a low price in addition to needed low-level technology and equipment, this could lead to a large number of entrants into the market. A lower selling price, falling economic returns even at higher production levels could result in a downward cycle.

To avoid this, projects should also aim to produce higher value 'smart' products next to common bricks. As a first step, better brick design could lower brick weight for the same strength and improve brick appearance (in the case of facade bricks), thus widening the range of uses. The fact that lighter bricks use less material (thus less waste material is used) should not be taken as a negative point, since even maximum use of mining wastes for construction needs would not solve mining waste issues.

Other improved design approaches could include:
> interlocking bricks that do not require mortar during construction, thus reducing the use of expensive mortar products; and
> hollow bricks (lighter) allowing insertion of certain fixtures or conduits without additional work.

FIGURE 47 ___BRICK PRESS AND BRICKS FROM MINING WASTE.

Other products of higher economic value, such as lintels, tiles, panning and products used in the public space like street curbs, posts, roadblocks etc. could also be developed.

From a sustainability point of view, the fact that building products can provide shelter is of key importance. The lack of good quality, cheap housing in developing economies is a constant problem. Mainstream materials and technologies are far from being a solution for the poorest sectors of society. Mining waste, abundantly available at the right location and for a low price, can offer part of the solution.

For more information: see UNIDO (2003)

7.5 NEW PRODUCTS AND REUSE: RAGBAG IN INDIA AND THE NETHERLANDS

The Company

Ragbag is the brand name of a line of fashionable products made from recycled plastic bags collected by 'rag pickers' in the slums of New Delhi, India, providing income for the deprived. The production is done by a cooperative of women who wash and clean the bags and make them into new products designed by young European and Indian designers, who initiated the project.

Motivation for D4S

The collection of plastic bags in New Delhi by the rag pickers generates direct income for the poor in the slums of New Delhi and was a key motivation for the project. The use of plastic for a completely new and fashionable product means reuse of the material and a reduction of the need for virgin materials.

FIGURE 48 ___ RAG PICKERS IN DELHI.

The project

In this case study a completely new line of products was developed. Plastic rags were collected, washed, dried and separated by colour. The plastic bags then go into a machine which presses them into thicker and more durable sheets. No dyes or inks are required. It takes about 60 plastic bags to make one sheet. The sheets are then cut, lined with cloth and stitched or molded into the various products.

FIGURE 49 ___ COLLECTION CENTRE IN DELHI.

Results

The project created jobs for 50 rag pickers, people at collection centers and fabricators (mainly women) in New Delhi, providing them and their families with income and access to more opportunities.

FIGURE 50 ___ RAGBAG PRODUCTS: SHOULDER BAG (TOP) AND ORGANISER (BOTTOM).

The Ragbag collection currently (2006) consists of fashionable shoulder bags, backpacks, shopping sacks and wallets,

For more information: see www.ragbag.nl

7.6 PRODUCT REDESIGN: A PLASTIC BOTTLE AT MICROPLAST, COSTA RICA

The company

Microplast is a plastic products company in Costa Rica with 70 employees, founded in 1981. The company uses 25 tonnes of plastic per month to make different bottles for pharmaceutical, cosmetic and food products.

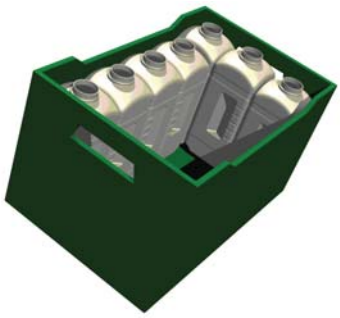
Motivation for D4S

The project was undertaken by the company CEGESTI, a Costa Rican Research Institute, the UNIDO UNEP National Cleaner Production Centre (NCPC) of Costa Rica and Delft University of Technology, The Netherlands. The product redesigned was a 1.8 litre HDPE bottle. In 2005, Microplast produced, on a small scale, a bottle of this size for milk and juices. The market for this type of bottle was increasing and the old bottle which had a lot of improvement potential, made it an interesting product for this project.

The project

The redesign of the 1.8 litre HDPE bottle of Microplast was carried out in cooperation with a large Costa Rican food company. This company used 300,000 1.8 litre HDPE bottles per month. As a starting point for the redesign effort, the bottle from MicroPlast was compared to two bottles used by the leading competing company. The average weight of a bottle without a top was between 60 and 70 grams. The bottles were distributed in standard HDPE boxes. The boxes were also used for other types of packaging such as Tetra Pack and Tetra Brik. The company was able to put 12 bottles in one box.

FIGURE 51 ___THE OLD MICROPLAST BOTTLE AND THE MICROPLAST FACTORY.



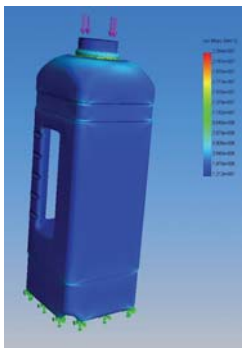


FIGURE 52 ___ NEW CRATE AND MECHANICAL CHARACTERISTICS OF NEW BOTTLE.

Improvement options

The main environmentally focus areas were:
> Reduction of used material per bottle (D4S Strategy 2)
> Reduction of impact of packaging material per litre content (D4S Strategy 1 and 2)
> Reduction of waste material during production (D4S Strategy 3)
> Higher efficiency in distribution (D4S Strategy 5)

Next to the environmental focus areas, the following areas were also taken into account:
> Improve the ergonomic characteristics of the bottle
> Improve the aesthetics of the bottle

The wall thickness of the old bottle was approximately 0.6 mm. Benchmarking in The Netherlands proved that it was possible to reduce the thickness to 0.2 mm. This is only possible when the blow-molding machinery is equipped with a Parison Control system. With such a system, a wall thickness for the new bottle of 0.3 mm was a feasible goal. New machinery and Parison Control would also reduce the amount of waste material during production.

To determine the dimensions of the new bottle, the dimensions of the distribution box were taken into account. With the dimension of the new bottle, it was possible to put 15 instead of 12 bottles in the distribution box resulting in an increase of 25%.

With the computer program COSMOS, the mechanical characteristics of the bottle were examined. These stress analyses resulted in new positioning and number of rims. To improve the ergonomic aspects of the bottle, it was important to change the grip. The new grip was positioned in the middle of the bottle to avoid pain in the wrist during use. When the bottle is full (1.8 kilo), it is important that the momentum of the user is as small as possible.

To avoid pain to the hand, the grip was positioned in such way that the user could grasp the grip with all fingers and thumb. The ergonomic data used for the redesign of the grip was obtained via the Dynamic Anthropometrics Department of the Delft University of Technology.

Results:

> Material use reduction of 45-50%
> Better distribution efficiency of 25%
> Environmental impact reduction of 43%
> Better ergonomics
> Less reprocessing during production
> More attractive design

What does this mean in practice? On a scale of 300,000 bottles per month, this would mean a reduction of 9000 kilos of HDPE per month and thus a savings of 108 tons of HDPE per year. Furthermore, it was possible that the plastic packaging industry in Costa Rica would respond to the new thinner bottle of MicroPlast by developing new and better products. This could have a positive influence in the plastic packaging industry in Costa Rica.

FIGURE 53 ___ THE NEW BOTTLE.

The two following examples illustrate the potential benefits in distribution. The first example was in the potential to reduce the cooling area. After the bottles are filled with juice or milk the bottles are stored in a cooled area to keep the quality of the content guaranteed. The higher distribution efficiency means a reduction of 202.5 m³ cooled storage area per month (based on 300 000 bottles per month). The second example was in the potential to reduce storage area in the cooled distribution trucks. A truckload contains 15 pallets. With 25% higher distribution efficiency, this means that 12 cooled truck journeys could be saved per month or 144 cooled truck trips per year. The economic and environmental benefits also include less gasoline consumption, maintenance costs and less labor costs.

For more information: see CEGESTI via www.cegesti.org

7.7 PRODUCT REDESIGN: MAKSS PACKAGING INDUSTRIES LTD. IN KAMPALA, UGANDA

The company

MAKSS Packaging Industries Ltd. has 135 employees, was established in 1994 and produces 2,500,000 kg corrugated cardboard boxes per year. It was one of the first companies to get in touch with the Uganda Cleaner Production Centre (UCPC) in 2002 when the UCPC launched a D4S Redesign project.

Motivation for D4S

UCPC found that MAKSS had significant potential to improve their production process of corrugated cardboard boxes and to innovate its products. The design of the fruit box, for example, was traditional and had not changed in 20 years. It consisted of two pieces of cardboard which required a separate production process for each. The traditional boxes were formed by using metal staples or tape. Transportation was done first via trucks on rough roads and later via air, mainly to Europe. Corrugated cardboard boxes need to be very robust and lightweight at the same time. Light weight engineering could improve both aspects: reducing the material input for the sake of environmental considerations and reducing costs due to expensive air transportation.

The project

UCPC invited MAKSS to become the pilot company for the first D4S training course in August 2002. Initial ideas were generated during this workshop, such as reducing the thickness of the corrugated cardboard from 5 layers to 3 layers and strengthening the boxes with stiff edges and stiffeners at the same time. Furthermore, the idea of integrating the lid into the box design, which could help reduce the total mass of the box, was found.

In the next phase, MAKSS Packaging Industries Ltd. started its own project. Intensive discussions took place with the different customers (flower producers, fruit and vegetable exporters etc.) to find out their requirements and adapt the design of the boxes accordingly. MAKSS Packaging Industries Ltd. then redesigned the boxes, reduced costs and the environmental impacts at the same time.

Results and benefits

As a first result MAKSS launched two redesigned products on the Uganda market in November 2002 - the 5 kg fruit box and the flower box for export. Both were redesigned according to D4S criteria.

The redesigned box for flower export has the following advantages:

> Resource efficiency_ A 167 gram reduction in weight equal to 12% of the original design.

> Improved production process_ The production of the box involves one production step less since the bottom is 3 ply instead of 5. The box is self-locking and does not require any tape or staples.

> Cost reduction_ The box is sold at a cheaper price to the customer, air cargo charges (approximately 1.5 U$/kg to Europe) are less since it is lighter.

> Functionality and customer satisfaction_ This design offers better ventilation for the flowers, so the product can be better protected and the flowers are in better shape and consequently have higher value.

The D4S redesigned box for fruit has the following advantages:

> Resource efficiency_ A 60 gram reduction in weight equal to 10.7%

> Improved production process_ The production of the box involves one production process less since the MAKSS D4S redesign box is a one-piece box. Off-cuts are utilized to make pads for other boxes.

> Cost reduction_ The box is sold at a cheaper price to the customer, air cargo charges (approximately 1.5 U$/kg to Europe) are less since it is lighter.

> Functionality and costumer satisfaction_ Stability and ventilation are excellent. The easy locking system saves time. A one-piece box is easier to handle and less space is needed for packing. Furthermore, there is no problem with imbalance in stocks between tops and bottoms.

For more information: contact the Uganda Cleaner Production Centre at www.ucpc.co.ug

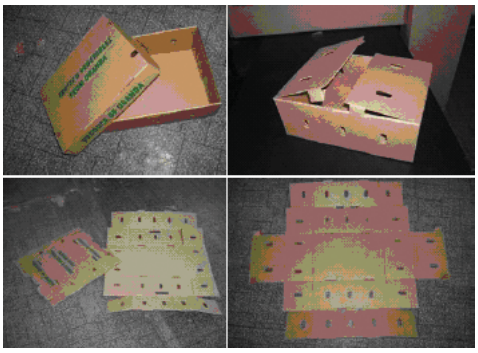


FIGURE 54 ___ OLD AND NEW MAKSS FRUIT BOX.

7.8 PRODUCT INNOVATION: A SOLAR LANTERN FOR THE CAMBODIAN MARKET

The company

Kamworks is a startup solar company in Cambodia founded by the Dutch charity foundation Pico Sol in 2006. A Technical University of Delft graduation project was carried out with Ecofys, a Dutch consultancy firm that specializes in sustainable energy solutions. The project covered the total design phase of a product from market analysis to the prototype of the final product.

Motivation for D4S

About 90% of Cambodian households have no access to a secure electricity infrastructure for reliable lighting. Many people live below the poverty line of less than 1$ per day. Providing these people with modern electric lighting is a small but important step. In Cambodia wages are low and 60% of the population is 20 years old or younger. Creating jobs is a major economic challenge.

Cambodia also has opportunities. The country receives over 5 full solar hours a day, with a balanced distribution over the year, making it one of the sunniest countries in the world.

Kamworks considers Cambodia's problems and solar resources as opportunities for local production of solar lighting products that fit the purchasing power of rural households. After an initial analysis and development of an adjusted solar lantern, Kamworks contacted the Delft faculty of Industrial Design Engineering to develop a solar lighting product.

The project

About 55% of the households in Cambodia use car batteries for electricity storage to power television and lighting. People spend between $40 and $70 per year on charging these car batteries. Batteries are charged in a sub-optimal way, resulting in a reduction of product lifespan by more than 50%.

Most of the people use a fuel lamp to meet lighting needs. They use it as a mobile light for several purposes in and outside the house and in rainy or windy situations, it cannot be used. The light is not very bright and uses expensive kerosene. Most of the people spend at least $2 monthly of the lamps.

FIGURE 55 ___ SOLANTERN WITH PV PANEL, BACKGROUND: ANKOR WAT TEMPLE.

FIGURE 56 ___ SOLANTERN: DISPERSED LIGHT AND FOCUSED LIGHT BY USE OF REFLECTOR.

For the project, a specific user group was identified of fishermen and frog hunters. They use a small lamp on their head connected to a battery of 2 to 4 kilograms, which is on their shoulder. The headlight uses incandescent light bulbs that break several times per night. Some fishermen spend even over $100 per year on charging the battery and replacing the bulbs. This headlight is also used for general in-house lighting. On the basis of these data, a series of possible new designs for lamps was developed.

Result

The final product was a vacuum-formed quality lantern, charged by a 45 Wp PV panel. The product has the working title SOLantern. The design appeals to Cambodia's national symbol, the temples of Angkor Wat. Cambodian people are proud of the temples because they dates from a historic period when Cambodia played a dominant role in the South Asian region.

Vacuum forming is an appropriate technology for a startup company like Kamworks. It combines the advantages of low investment costs and ease of application. The technology is applicable for relatively low production volumes (up to 10,000 per year). The moulds can be produced locally and are cheap in comparison with injection molding.

The SOLantern is well designed electronically. It has quality components that all are replaceable. The product conforms to an international standard ("PV-GAP") to encourage quality solar products for the world market. The final result of the project was a working prototype that was used for a thorough market evaluation of the product in Cambodia.

In May 2006, Kamworks won a 175.000 USD prize in the Worldbanks' Development Marketplace Competition for educating young Cambodian orphans in entrepreneurial skills that can help sell SOLanterns.

For more information: see www.kamworks.com

7.9 PRODUCT REDESIGN: TRAILER FOR RURAL TRANSPORT OF CROPS IN GHANA

The company

REAL ('Rural Enterprise for Agro Logistics') is an enterprise working for, and partly owned, by farmers and agro-managers in Ghana.

Motivation for D4S

The project was carried out in 2003 and had the aim to design a means of rural transport for crops that would reduce post harvest loss, thus increasing crop market value and improving labor conditions for farmers (men and women) in Ghana. This sustainable transport system was designed with locally available materials and production methods suitable for Ghana. The design took into consideration the influences of local culture and social habits.

The project

The concept development phase began with the generation of concepts from a functional point of view. The concepts were made out of combinations of the several functions and were clustered into three design directions. After

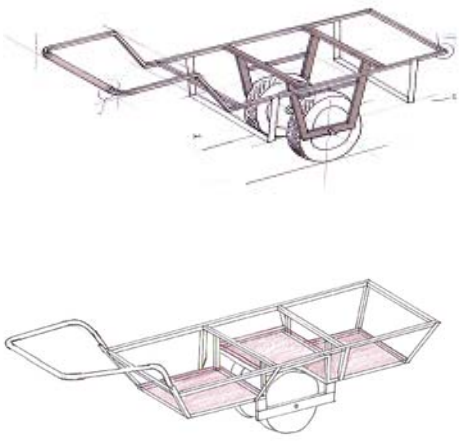


FIGURE 57 ___ CRATE TRAILER AND MULTI TRAILER.

identifying the available materials, further constraints were encountered and considerations were made.

Three design directions resulted in three concepts, the Plain trailer, the Combi trailer, and the Crate trailer. The Plain trailer concept consisted of one loading space, created with wire mesh. The Combi trailer could carry almost any kind of container and had the possibility to create one space, from wire mesh as well. The Crate trailer could only fit plastic crates from an industrial containers producer in Tema. After taking several steps in development a fourth concept, the Multi trailer was generated out of the Combi and Crate trailers. The Multi trailer concept offered the opportunity to use almost any kind of container to transport the crops. It was especially designed for current use as well as future use anticipating the introduction of a complete logistic system based on crates by REAL.

After comparing the four concepts on design guidelines, the Crate trailer and the Multi trailer proved to be the two most feasible concepts. Both concepts were constructed in a Ghanaian workshop. Before going into production, models were constructed. This required locating a workshop, a welder, buying the materials, and finding specific components for the construction of details of the trailers.

As soon as the models were finished, they were tested in the two regions in the south. After observation and evaluation of the models in use, small changes were made to improve performance. The last test in the north was performed and evaluated as well. It appeared that at least twice the amount of head load could be transported in the same time or even faster. The users of the trailer appreciated the ease of use and maneuvering, the increased amount of products that could be loaded and the width of the total trailer which could be used on small paths.

After testing both the Crate trailer and the Multi trailer on the design guidelines, it was evident that the Multi trailer needed to be further defined. The dimensions of the Multi trailer were further optimized in Solidworks, a 3D modeler, in the Netherlands. This model contains the basic construction and some details.

FIGURE 58 ___ CRATE TRAILER (T) AND MULTI TRAILER (B).

FIGURE 59 ___ TESTING OF THE TRAILER.

Results

Multi trailer potential results include:
> Transportability was improved. The trailer was suitable for single path roads, double track grass roads, feeder roads and asphalt roads, except for Abor where it is only suitable for single and double track roads.
> Efficiency was increased. Twice the amount of crops could be transported in the same time or faster.
> Ergonomics of handling crops was improved. The burden on the farmers (men and women) was lightened.
> The trailer could be produced locally. It could be produced with production methods available in Ghana and made from locally available materials.

Recommendations for further dissemination of the REAL trailer were:
> The construction of the trailer could be optimised for weight and weld type and production could be simplified.
> Promote the use of trailers amongst women, as well as in the transport of the crops.

In summary, the Multi trailer reduced the post harvest losses thereby increasing the farmers' income. Labour conditions have improved due to the lighter burden.

For more information: see Steinbusch (2003)

7.10 BENCHMARK FOR REFRIGERATOR OF WAIMAN INDUSTRIES, COSTA RICA

The company

Industrias Waiman is located in San Jose, Costa Rica and produces metal products, especially appliances that heat, cool and prepare food and beverages. The company consists of a manager, who is the owner of the company, and eighteen employees.

Motivation for D4S

The company operates in markets where environmental performance, especially the energy use of the products, is of key importance. The main goal of the project was to develop a product that offered opportunities to improve business with less environmental impact compared to the reference product. The project was part of the regional Ecodesign Programme.

The project

In 1998 the project identified a product to benchmark. It was a vertical commercial refrigerator which is sold to small shops and restaurants to cool and display their products and to larger 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 to design from an environmental point of view. The priorities for the redesign were to:
> improve the cooling quality;
> reduce energy use during life-time; and to
> increase ease of maintenance.

Improvement options

Improvement options were generated with an 'information benchmark' approach. One element of the benchmark was the evaluation of products from direct competitors. A lot of small Cost Rican competitors and a few international brands are on the market. Information

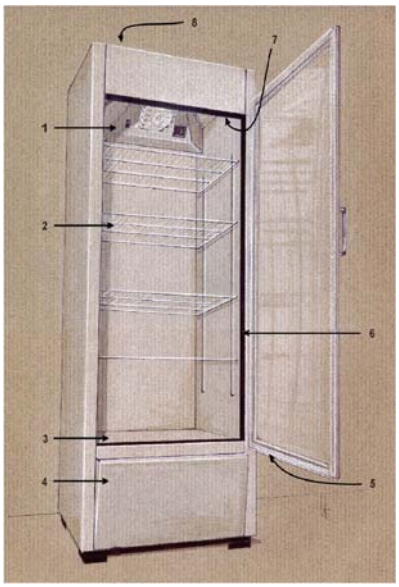


FIGURE 60 ___ WAIMAN REFRIGERATOR.

was gathered from brochures and the internet on the size of the companies, price of the comparable products, and on the market share and technical specifications of the products.

A second element of the benchmark was a detailed analysis of the refrigeration market, with an emphasis on food and beverage companies, supermarkets and governmental organizations. Coca Cola in this region has refrigerator suppliers from Guatemala and Mexico and uses a standardized set of performance criteria such as initial pull-down time, electrical performance, condensation standards, energy consumption, use of CFC free refrigerant and safety.

Results

On the basis of this information benchmark, the design brief for the redesign of the product was formulated and development was started. The concept with the best results was applied in the final prototype. The improvements included:

> less pull-down time needed to lower the temperature;

> better distribution of the cooled air by repositioning of the ventilator; and

> 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 was developed. The resistance was used to heat the outside window in order to avoid condensation on one side of the window. Another adjustment to increase energy efficiency was to reposition the TL inside the refrigerator. This adjustment was applied successfully. Small improvements on the maintenance were applied directly and achieved by benchmarking during the external analysis. These improvements resulted in an improvement in the ease of cleaning and repairing. The product improvements were implemented in the production directly and during the development phase.

For more information: see Hoornstra (1998)

7.11 BENCHMARK: INTERMECH CASSAVA GRATER, TANZANIA

The company

Intermech Engineering Limited is a small-sized company situated in Morogoro, Tanzania, that offers a wide range of services such as engineering design, manufacturing, machinery installation and plant commissioning. The main focus is on the manufacturing of agro- and food processing machinery and equipment. There are 10 workers in the metal workshop.

The project

Cassava is an upcoming and promising crop in Tanzania which can be processed into starch for food purposes and used as an input for the local textile industry. Intermech decided to develop a range of products based on processing the harvested cassava into high

FIGURE 61 ___INTERMECH METAL WORKSHOP IN MOROGORO, TANZANIA.

quality starch. As a first step, a new cassava grater was developed in 2003. In order to develop the first model, several other existing models were benchmarked through observation of illustrations, the internet and competitors' products found at fairs. Based upon this benchmark, a version with a wooden drum with needles was developed (see Figure 62).

FIGURE 62 ___ THE ORIGINAL WOODEN DRUM WITH SPIKES AND THE NEW METAL DRUM.

In a next step, staff from the Faculty of Engineering of the local University of Dar es Salaam (UDSM) redesigned, together with Intermech, the first version of the new cassava grater. More than 20 relevant improvement options were introduced to reduce environmental impacts, to increase product quality and to decrease the costs. The improvement options focused on the center of the product, the wooden drum. The production of the wooden version with metal pins was very labor and cost intensive. Secondly, humidity problems led to low quality processing of cassava and a shortened lifespan of the drum itself, which resulted in high maintenance costs.

Results

One of the outcomes from the redesign project was the replacement of the wooden drum with one produced from cast aluminum and perforated sheet. The new metal drum:

> Had fewer parts and production operations, resulting in lower production costs;
> Used locally available materials;
> Increased efficiency while processing cassava;
> Had a longer expected lifespan; and
> Improved ergonomics and safety for the user.

After the successful benchmarking and redesign of the cassava grater, Intermech continued with development of the next product in the cassava processing line: the starch extractor.

FIGURE 63 ___ REDESIGNED CASSAVA GRATER.

For more information: see Msoro (2004)

7.12 BENCHMARK: PHILIPS COMPUTER MONITOR

The company:

Philips Consumer Electronics is one division of Royal Philips Electronics, one of the biggest electronics companies in the world.

Motivation for D4S

The monitor division of Philips Consumer Electronics faced particular challenges at the end of the 1990's. The business was strong and expanding, and highly successful in terms of revenue, market share and profit. However, product designs were gradually lagging and management was looking to strengthen the product line. In view of this, a D4S Benchmark was executed. The goal was to drastically improve a 17 inch monitor, from both an ecological and economic perspective.

The project

D4S Benchmarking was introduced during a collaborative project between the Philips Consumer Electronics – Environmental Competence Center and the Delft University of Technology. Based upon green focal areas, a Philips monitor was compared with several of its commercial competitors, and the results improved the next generation of products.

For the benchmark monitors with similar technical specifications were chosen: the Philips product to be improved, 2 products from Japan one was selling very well in the market and one originating from Korea. The monitors were benchmarked on 27 aspects related to energy consumptionmaterial application, packaging, chemical content, recyclability and life cycle performance.

Results

The competitors were better than Philips in several areas.

The results of the benchmark were communicated to the organization and worked as a stimulant. It was decided not to wait for next generation of monitors but to make an adapted product based upon the present concept. Based upon the benchmark and creative sessions, the team came up with number of improvement options. Due to lack of time, not all suggested improvement options were implemented. However, the results of the implemented improvement were impressive.

Since then (1997), the D4S Benchmark methodology has been implemented at all product divisions, and benchmark reports are now inside Philips available for products ranging from portable CD players, lighting bal-

ITEM	PHILIPS	COMP. 1	COMP. 2	COMP. 3
Weight of plastics (g)	4597	3283	**3123**	3592
Costs of plastics applied ($)	16	6	**5,5**	8
Weight of iron (g)	2301	840	**452**	757
Weight of aluminum (g)	**348**	606	404	1698
Presence of flame retardants	**No**	Yes	Yes	Yes
Length of cable/wiring (cm)	4000	2200	2800	**2070**
Disassembly time (s)	750	**470**	580	480

TABLE 10 ___ OUTCOMES OF THE D4S BENCHMARK OF MONITORS.

Item	Philips old	Philips adapted
Plastic materials cost ($)	16	10
Metal environmental impact (mPt)	54	32
Number of printing wiring boards	6	3
Length of cable/wiring (cm)	4000	2270
Disassembly time (s)	750	570

TABLE 11 ___ PRODUCT CHARACTERISTICS OF PHILIPS MONITOR BEFORE AND AFTER THE BENCHMARK.

lasts, and shavers, to complete medical systems. Since the first project more than 100 D4S Benchmarks have taken place within Philips.

For more information: see Caluwe (2004) and Eenhoorn and Stevels (2000)

7.13 AN EXAMPLE OF AN INTERNATIONALLY SUPPORTED D4S PROGRAMME: INWENT

The Company

InWEnt – Internationale Weiterbildung und Entwicklung GmbH (Capacity Building International, Germany) is an organisation for international human resources development, advanced training and dialogue. It was established through the merger of Carl Duisberg Gesellschaft (CDG) and the Deutsche Stiftung für Internationale Entwicklung (German Foundation for International Development, DSE) and draws upon decades of experience in development cooperation.

The vocational training projects of InWEnt are characterised by an emphasis on a sustainable development approach. Engineers and designers from Latin America, Africa and Asia work together on preliminary designs for more sustainable products within the context of a one-year training programme carried out in Germany. There was a phase of support provided specifically to sustainable products. This kind of programme has good potential to build technical capacities in countries at the implementation level.

One example is the preliminary development of a freight bicycle for Peru and Indonesia, by engineer Lulus Ketriyanto (Indonesia) and designer Ricardo Geldres Piumatti (Peru).

Motivation for D4S

Personal bicycles, rickshaws and cargo bicycles are muscle powered. Cities with active bicycle and cargo bicycle traffic have less pollution than those with the usual traffic of cars, taxis, buses and lorries. The emission and noise pollution in cities caused by motor traffic decreases with the introduction of muscle-powered modes of transport. The development, manufacturing and use of cargo bicycles can also create jobs.

The project

Indonesia has a strong bicycle industry that manufactures various cargo bicycles for the country. In Peru this form of cargo transport is also popular and there is a market for it. The origin of the cargo bicycle is in Asia, usually rickshaws used for transporting people. Cargo bicycles require smooth, flat terrain and streets. Recently there have been attempts to use rickshaws for tourism in Europe. The rickshaws used for this are imported from Asia.

The preliminary development for the cargo bicycle was developed by an Indonesian engineer in cooperation with a Peruvian product designer within the context of a training programme carried out by InWEnt in Germany. No prototype of the design was produced, since the project was performed for educational purposes only.

A simple design was chosen deliberately for the cargo bicycle. The cargo is positioned in front of the handlebars although this can affect the vision of the driver. With this design the rear part of a normal bicycle can be used. Cargo bicycle hire, spare parts provision and repair services have the potential to create additional jobs.

For more information: see www.inwent.org, or contact winfried.kalhoefer@inwent.org.
Also see the accompanying CD for more examples from this vocational programme.

008 D4S RULES OF THUMB

Here are some basic suggestions to take into account when brainstorming product improvement options. They can be used as a checklist or as a source of inspiration. These 'rules of thumb' are organized according to the D4S strategies outlined in Chapter 5.

1> SELECTION OF LOW-IMPACT MATERIALS_

a> Cleaner materials

1_ Do not use materials or additives which are prohibited due to their toxicity. These include PCBs (polychlorinated biphenyls), PCTs (polychlorinated terphenyls), lead (in PVC, electronics, dyes and batteries), cadmium (in dyes and batteries) and mercury (in thermometers, switches, fluorescent tubes).

2_ Avoid materials and additives that deplete the ozone layer such as chlorine, fluorine, bromine, methyl bromide, halons and aerosols, foams, refrigerants and solvents that contain CFCs.

3_ Avoid the use of summer smog-causing hydrocarbons.

4_ Find alternatives for surface treatment techniques such as hot-dip galvanization, electrolytic zinc plating and electrolytic chromium plating.

5_ Find alternatives for non-ferrous metals such as copper, zinc, brass, chromium and nickel because of the harmful emissions that occur during their production.

b> Renewable materials

6_ Find alternatives for exhaustible materials.

c> Lower energy content materials

7_ Avoid energy-intensive materials such as aluminum in products with a short lifetime.

8_ Avoid raw materials produced from intensive agriculture.

d> Recycled materials

9_ Use recycled materials wherever possible, to increase the market demand for recycled materials.

10_ Use secondary metals such as secondary aluminum and copper instead of their virgin (primary) equivalents.

11_ Use recycled plastics for the inner parts of products which have only al supportive function and do not require a high mechanical, hygienic or tolerance quality.

12_ When hygiene is important (as in coffee cups and some packaging) a laminate can be applied, the centre of which is made from recycled plastic, covered with or surrounded by virgin plastic.

13_ Make use of the unique features (such as variations in colour and texture) of recycled materials in the design process.

e> Recyclable materials

14_ Select just one type of material for the product as a whole and for the various sub-assemblies.

15_ Where this is not possible, select mutually compatible materials.

16_ Avoid materials which are difficult to separate such as compound materials, laminates, fillers, fire retardants and fiberglass reinforcements.

17_ Preferably use recyclable materials for which a market already exists.

18_ Avoid the use of polluting elements such as stickers which interfere with recycling.

f> Materials with positive social impact, i.e., by generating local income

19_ Make use of materials supplied by local producers.
20_ Stimulate arrangements for recycling of materials by local companies which can substitute (part of) the raw materials of the company.

2> Reduction of materials usage_

a> Reduction in weight

21_ Aim for rigidity through construction techniques such as reinforcement ribs rather than 'overdimensioning' the product.
22_ Aim to express quality through good design rather than over dimensioning the product.

b> Reduction in (transport) volume

23_ Aim at reducing the amount of space required for transport and storage by decreasing the product's size and total volume.
24_ Make the product foldable and/or suitable for nesting.
25_ Consider transporting the product in loose components that can be nested, leaving the final assembly up to a third party or even the end user.

3> Optimization of production techniques_

a> Alternative production techniques

26_ Preferably choose clean production techniques that require fewer harmful auxiliary substances or additives (for example, replace CFCs in the degreasing process and chlorinated bleaching agents).
27_ Select production techniques which generate low emissions, such as bending instead of welding, joining instead of soldering.
28_ Choose processes which make the most efficient use of materials, such as powder coating instead of spray painting.

b> Fewer production steps

29_ Combine constituent functions in one component so that fewer production processes are required.
30_ Preferably use materials that do not require additional surface treatment.

c> Lower/cleaner energy production

31_ Motivate the production department and suppliers to make their production processes more energy efficient.
32_ Encourage them to make use of renewable energy sources such as wind energy, water power and solar energy. Where possible, reduce the use of fossil fuels and reduce environmental impact by, for example, choosing low-sulphur coal or natural gas.

d> Less production waste

33_ Design the product to minimize material waste, especially in processes such as sawing, turning, milling, pressing and punching.
34_ Motivate the production department and suppliers to reduce waste and the percentage of rejects during production.
35_ Recycle production residues within the company.

e> Fewer/cleaner production consumables

36_ Reduce the production consumables required – for example, by designing the product so that during cutting waste is restricted to specific areas and cleaning is reduced.
37_ Consult the production department and suppliers as to whether the efficiency with which operational materials are used during production can be increased – for example, by good housekeeping, closed production systems and in-house recycling.

f> Safety and cleanliness of the workplace

38_ Choose production technologies that require fewer harmful substances and generate less toxic emissions.
39_ Use production techniques that generate less wastes, and organize efficient in-company re-use and recycle systems for the remaining waste.
40_ Implement systems for in-company working conditions, health and safety like SA8000.

4> Optimization of distribution system_

a> Less/cleaner/reusable packaging

41_ If all or some of the packaging serves to give the product a certain appeal, use an attractive but lean design to achieve the same effect.
42_ For transport and bulk packaging give consideration to reusable packaging in combination with a monetary deposit or return system.
43_ Use appropriate materials for the kind of packaging – for example, avoid the use of PVC and aluminum in non-returnable packaging.
44_ Use minimum volumes and weights of packaging.
45_ Make sure the packaging is appropriate for the reduced volume, foldability and nesting of products – see strategy 2b.

b> Energy efficient transport mode

46_ Motivate the sales department to avoid environmentally-harmful forms of transport.
47_ Transport by container ship or train is preferable to transport by lorry.
48_ Transport by air should be prevented where possible.

c> Energy efficient logistics

49_ Motivate the sales department to work preferably with local suppliers in order to avoid long-distance transport.
50_ Motivate the sales department to introduce efficient forms of distribution – for example, the simultaneous distribution of larger amounts of different goods.
51_ Use standardized transport packaging and bulk packaging (Europallets and standard package module dimensions).

d > Involve local suppliers (distributed economies)

52_ Explore options for contracting more local transport/distribution.
53_ Form logistic consortia with fellow companies in the community to jointly outsource distribution and transport in an efficient way and by involving local distributors.

5> Reduction of impact during use_

a> Low energy consumption

54_ Use the lowest energy consuming components available on the market.
55_ Make use of a default power-down mode.
56_ Ensure that clocks, stand-by functions and similar devices can be switched off by the user.
57_ If energy is used to move the product, make the product as light as possible.
58_ If energy is used for heating substances, make sure the relevant component is well insulated.

b> Clean energy source

59_ Choose the least harmful source of energy.
60_ Do not encourage the use of non-rechargeable batteries – for example, a portable radio can be supplied with a battery charger, encouraging the use of rechargeable batteries;
61_ Encourage the use of clean energy such as low-sulphur energy sources (natural gas and lowsulphur coal), fermentation, wind energy, water power and solar energy. An example is a solar heater which does not require energy for heating water during the summer.

c> Fewer consumables needed

62_ Design the product to minimize the use of auxiliary materials – for example, use a permanent filter in coffee makers instead of paper filters, and use the correct shape of filter to ensure optimal use of coffee.
63_ Minimize leaks form machines which use high volumes of consumables by, for example, installing a leak detector.
64_ Study the feasibility of reusing consumables –reusing water in the case of a dishwasher.

d> Cleaner consumables

65_ Design the product to use the cleanest available consumables.
66_ Make sure that using the product does not result in hidden but harmful wastes – for example, by installing proper filters.

e> Reduce wastage of energy and other consumables

67_ Misuse of the product as a whole must be avoided by clear instructions and appropriate design.
68_ Design the product so that the user cannot waste auxiliary materials – for example, a filling inlet must be made large enough to avoid spillage.
69_ Use calibration marks on the product so that the user knows exactly how much auxiliary material, such as a washing powder, to use.
70_ Make the default state that which is the most desirable from an environmental point of view – for example, 'no cup provided by drinks dispenser' or 'double-sided copies'.

f> Health supporting, social added value

71_ Make sure the product has zero or minimal impact on the health of the user by avoiding use of toxic substances, low radiation levels etc.
72_ Design the product in accordance to the socio-economic needs and possibilities of the user groups.
73_ Assess the opportunities to design products for low-income groups.

6> Optimization of initial lifetime_

a> Reliability and durability

74_ Develop a sound design and avoid weak links. Special methods such as the Failure Mode and Effect Analysis have been developed for this purpose.

b> Easier maintenance and repair

75_ Design the product in such a way that it needs little maintenance.
76_ Indicate on the product how it should be opened for cleaning or repair – for example, where to apply leverage with a screwdriver to open snap connections.
77_ Indicate on the product itself which parts must be cleaned or maintained in a specific way – for example, by colour-coded lubricating points.
78_ Indicate on the product which parts or sub-assemblies are to be inspected often, due to rapid wear.
79_ Make the location of wear on the product detectable so that repair or replacement can take place on time.
80_ Locate the parts which wear relatively quickly close to one another and within easy reach so that replacements are easy to dismantle for repair or replacement.

c> Modular product structure

81_ Design the product in modules so that the product can be upgraded by adding new modules or functions at a later date for example, plugging in larger memory units in computers.
82_ Design the product in modules so that technically or aesthetically outdated modules can be renewed.
For example, make furniture with replaceable covers which can be removed, cleaned and eventually renewed.

d> Classic design

83_ Design the product's appearance so that it does not quickly become uninteresting, thus ensuring that the product's aesthetic life is not shorter than its technical life.

e> Strong product-user relation

84_ Design the product so that it more than meets the (possibly hidden) requirements of the user for a long time.
85_ Ensure that maintaining and repairing the product becomes a pleasure rather than a duty.
86_ Give the product an added value in terms of design and functionality so that the user will be reluctant to replace it.

f> Involve local maintenance and service systems

87_ Design the product with the possibilities of local service and maintenance companies in mind.
88_ Jointly develop new innovative service and repair centers in the region that can be involved both in servicing the new products an existing products.

7> Optimization of end-of-life system_

a> Re-use of product

89_ Give the product a classic design that makes it aesthetically pleasing and attractive to a second user.
90_ Make sure that the construction is sound so that it does not become prematurely obsolete in the technical sense.

b> Remanufacturing/refurbishing

91_ Design for dismantling (from product to sub-assemblies) to ensure easy accessibility of the product for inspection, cleaning, repair and replacement of vulnerable or innovation-sensitive sub-assemblies or parts.

92_ The product should have a hierarchical and modular design structure; the modules can then each be detached and remanufactured in the most suitable way.

93_ Use detachable joints such as snap, screw or bayonet joints instead of welded, glued or soldered connections.

94_ Use standardized joints so that the product can be dismantled with a few universal tools – for example, use one type and size of screw.

95_ Position joints so that the person responsible for dismantling the product does not need to turn it around or move it.

96_ Indicate on the product how it should be opened non-destructively – for example, indicate where and how to apply leverage with a screwdriver to open snap connections.

97_ Locate the parts that are relatively quickly worn out close to one another, so that they can be easily replaced.

98_ Indicate on the product which parts must be cleaned or maintained in a specific way – for example, by using colour-coded lubricating points.

c> Recycling of materials

99_ Give priority to primary recycling over secondary and tertiary recycling.

100_ Design for disassembly (from sub-assemblies to parts).

101_ Try to use recyclable materials for which a market already exists.

102_ If toxic materials have to be used in the product, they should be concentrated in adjacent areas so that they can easily be detached.

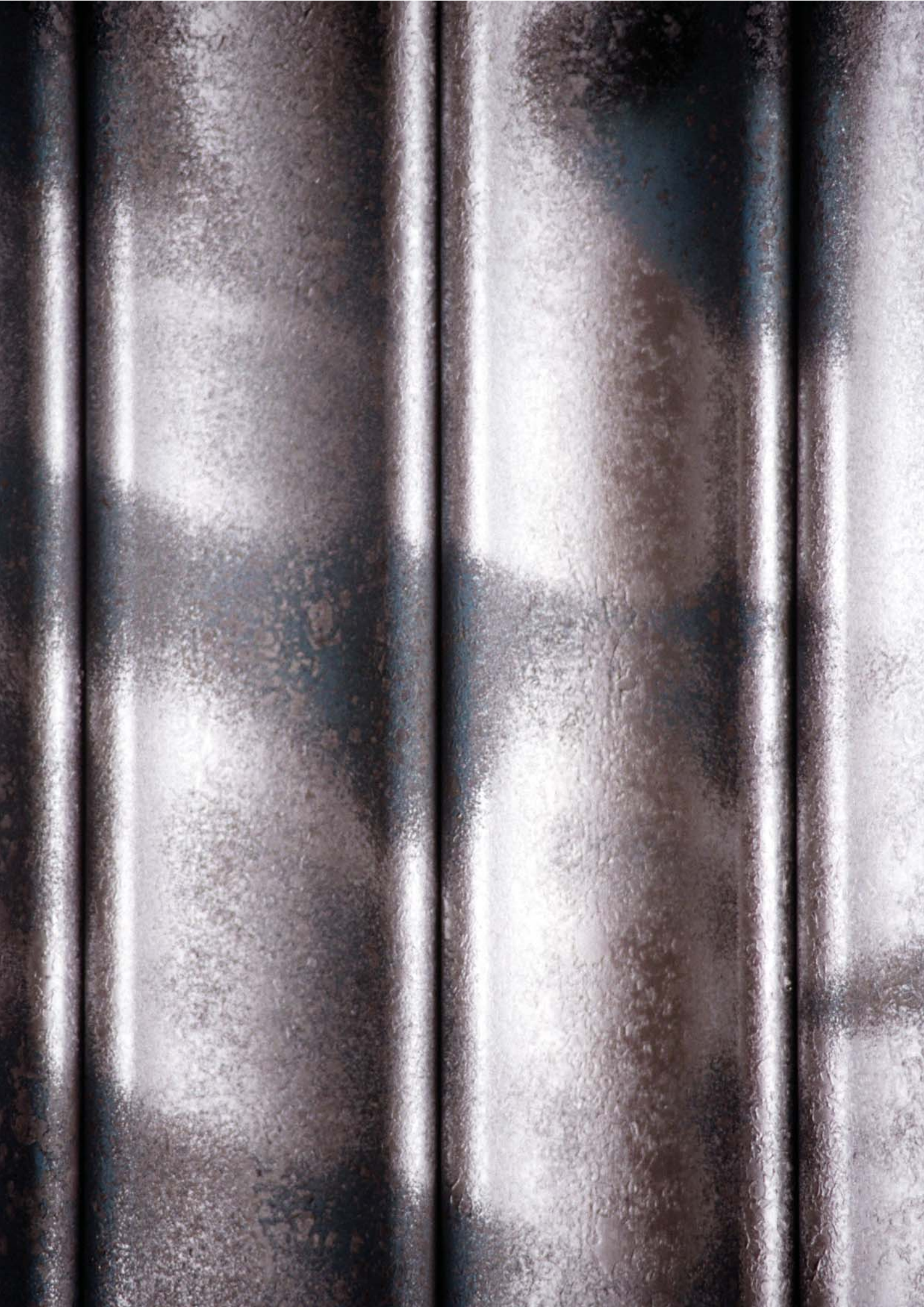
d> Safer incineration

103_ The more toxic materials there are in a product, the more the responsible party has to pay for its incineration. Toxic elements should therefore be concentrated and easily detachable so they can be removed, paid for and treated as a separate waste stream.

e> Taking in consideration local (informal) collection recycling systems

104_ Assess the possibilities of existing formal or informal recycling activities in the community to be involved in the take-back and recycling of the product.

105_ Jointly develop and/or support new and efficient collection and recycling systems in the region.



009 CREATIVITY TECHNIQUES

Creativity techniques can be used during the D4S Redesign (Chapter 5) and D4S Benchmarking (Chapter 6) processes. Creativity is a continuous part of the product development process and creativity techniques are useful throughout. Initially, it can be used on a conceptual level and at the end it can be applied to solve technical problems. The challenges encountered during the product development process need different creativity approaches - there is no 'one single' best technique. This chapter presents several techniques that cover a range of situations. It is recommended not to stick to one technique but to learn to use different techniques and develop experience.

What are creativity techniques?

Creativity can be defined as 'all the ways of thinking that lead to something new and useful for the thinker'. A creativity technique should help generate new ideas. Creativity tools can:

> Come up with new ideas;
> Break through fixed ways of thinking;
> 'Think out of the box' - thinking beyond current solutions;
> Build upon each others ideas; and
> Develop new inspiring and surprising ideas.

To understand how the techniques work and how they can contribute to the product development process it is necessary to put them into practice.

Group versus individual creativity techniques

In general, brainstorming in a group generates more ideas, but sometimes the group culture may hinder revolutionary ideas. Group techniques use the ideas of others for inspiration. Group members can use each other's information as input for further stimulation.

Individual brainstorming can lead to original ideas but there is a danger that the outcomes are predetermined or limited to the idea originator's way of thinking. In individual brainstorming, free association initially yields seemingly irrational outputs that later can be refined into more recognizable concepts.

Given the potential and limitations of these approaches it is recommended to apply both individual and group brainstorming in the same project.

Participants

Multidisciplinary teams are important to successful creativity sessions because it provides diversity in interactions and enables building novel associations. In group brainstorming, the free flow of ideas can be stimulated by including open-minded group members from different disciplines that are not afraid to ask 'stupid' questions. A group might, for example, select a range of different people: generalists and specialists, and creative people that are not experts in the field.

Mind-set

In using creativity techniques, one should be as open-minded as possible and try to avoid criticism of the ideas that are generated because this can cut off potentially useful ideas. A positive attitude is the strong foundation of a successful creativity session. The following rules can facilitate the creativity process:

> Group members should be able to express themselves freely and openly without censorship and should operate with appropriate respect towards others;
> There should be no judging of people and;
> It should be okay for members to 'lie'.

Session facilitator

Brainstorming can be greatly enhanced by appointing a facilitator to guide the session. The facilitator should guide the session and not let his or her own opinions interfere with the expression of other peoples' opinions.

The facilitator should keep track of time and allow everyone who wishes to express an opinion at both the individual and group level. It is very helpful if the facilitator has a good general knowledge of the subject.

The step-by-step process for a creativity session

Similar to the steps of product development process, each step of the creativity process has two main phases: a divergent phase and a convergent phase (see also Chapter 3). In other words, each phase starts with a 'problem' definition, followed by a divergent phase which includes the 'creation' or 'widening' of a field of possibilities which includes collecting and generating facts, problem statements, and ideas, without criticism. Then resultant solutions are clustered and categorized, followed by a convergent phase in which there is a narrowing of choices based on criteria of what is useful and relevant. (See Figure 64.):

1> Problem definition
2> Divergent phase
3> Clustering / categorizing
4> Convergent phase

The four stages of the creativity process each demand a different attitude from the participants.

Problem definition

The fomulation of the problem definition for the creativity session has a big impact on the outcomes of the creativity session. If the problem is not defined accurately, the created results might be irrelevant for the project. Guidelines for defining a problem include:

A_ Formulate the goal of the creativity session in one sentence.

Formulate from the project focus (the problem) in a concise and clear way. It forces the team to tackle the core of the problem. Often a problem consists of several sub-problems. It is recommended to tackle the sub-problems first, and then to bring the sub-solutions together.

B_ Keep a real and tangible focus.

If the problem defined is too abstract, the results will be general and will lead to sub-optimal solutions.

EXAMPLE_

"How can we generate a more positive attitude towards Photo Voltaic (PV)?" is a broad formulation. It becomes more specific if the statement focuses on children: "How can we inform children about PV so that they develop a more positive attitude towards it?" An example of an even more focused problem statement would be: "What can children play with that is made of PV?", or "How can we motivate children to play with outdoor play equipment made from PV?"

C_ Start with 'how' or 'invent'.

The pronouns 'who, what, where, when' and 'why' invite data collection. In order to stimulate solution generation, it is better to start with 'how' or 'invent'. The 'how'question focuses on the way or principle. The invent focus more on the end result.

Divergent phase

During the divergent phase of the creativity process, a large number of alternatives are identified.

At this stage the most important rule is: 'quality is quantity' to generate as many solutions and new ideas as possible. Free association plays an important role during this stage. In addition, the rule of not judging ideas is essential. When confronted with new ideas or concepts it is important that participants take a constructive stance.

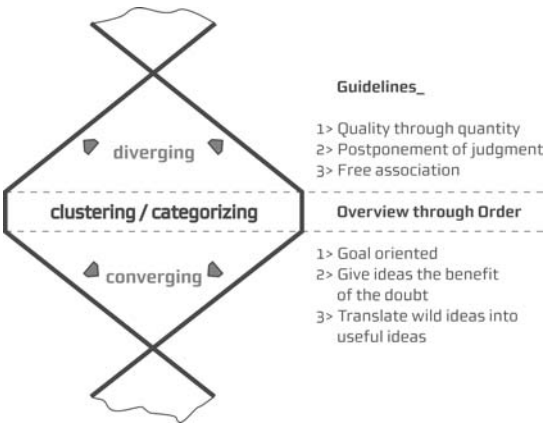


FIGURE 64 ___ THE CREATIVITY PROCESS.

Clustering phase

Done properly, many ideas and solutions will have been generated and collected during the divergent phase. The sheer number of new options will make it hard to come to select the best ones. For that purpose, an additional stage of 'cleaning up' and acquiring an overview of the options generated (over 200 ideas is not unusual!) is useful before moving on to evaluation and selection. In this phase ideas are grouped together based on commonalities. At this stage some ideas may be clarified and/or elaborated upon for clarification.

Converging phase

In the converging phase, all the ideas have the benefit of the doubt (the value of the idea may not be apparent at first), but one should also make decisions and work towards the stated objective. The alternatives chosen are then evaluated and selected.

FIGURE 65 ___ THE CREATIVITY PROCESS.

What kind of creativity techniques?

There are differences between textual and visual creativity techniques. General speaking, it is time (visual creativity techniques require more time than textual) and quantity (textual) versus detail (visual). Both kinds of techniques have advantages and disadvantages. Drawing may cover more of the original ideas because one does not have to reduce the idea into words but one has to be able to draw what one thinks. Textual is faster, but there can be problem with foreign languages and limitations because of the meaning of the words used. As a bottom line, creative techniques should be provocative and force thoughts out of the normal routine and into the open.

EXAMPLES OF CREATIVITY TOOLS

1> Classical Brainstorming

The term Brainstorming has become a commonly used word in the English language as a generic term for creative thinking. The basis of Brainstorming is generating ideas in a group situation based on the principle of suspending. The generation phase is separate from the judgment phase of thinking. Basic rules for Brainstorming are:

> The facilitator writes down all the ideas on a large sheet of paper or board;

> The participants call their spontaneous ideas as a reaction on the problem definition;

> The participants associate on each others ideas;

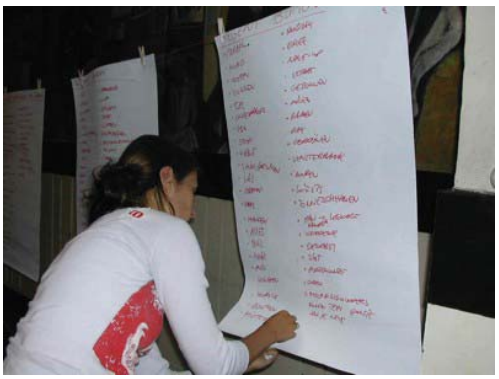


FIGURE 66 ___ CLASSICAL BRAINSTORMING SESSION FOR IDENTIFYING NEW APPLICATIONS FOR RENEWABLE ENERGY TECHNOLOGIES.

> The participants do not express their critics on each others ideas and;
> The participants try to do this at a high speed.

2> BrainWriting

BrainWriting is a technique similar to brainstorming. There are many varieties, but the general process is that all ideas are recorded by the individual who thought of them. They are then passed on to the next person who uses them as a trigger for their own ideas. BrainWriting enables people who have ideas but are concerned about voicing them in a broader group to anonymously make them visible. They thus do not have to 'compete' with others to be heard. It also helps that all ideas are visible and can be easily scanned to trigger new ideas. It can speed things up because everyone is offering ideas all of the time. Examples of this include:

Problem statement: How to...			
	IDEA 1	IDEA 2	IDEA 3
1			
2			
3			
4			
5			
6			

FIGURE 67 ___ 6-3-5 BRAINWRITING WORKSHEET.

FIGURE 68 ___ PARTICIPANTS IN A BRAINWRITING SESSION CREATING SOLUTIONS FOR PACKAGING WASTE ON THE STREET.

*BrainWriting Pool_* Each person, using Post-it notes or small cards, writes down ideas, and places them in the centre of the table. Everyone is free to pull out one or more of these ideas for inspiration. Team members can create new ideas, variations or piggyback on existing ideas.

BrainWriting 6-3-5:_ The name comes from the process of having 6 people write 3 ideas in 5 minutes. Each person has a blank 6-3-5 worksheet (see Figure 67).

Every participant writes the problem statement at the top of his or her worksheet (word for word from an agreed problem definition). They then write 3 ideas, on the top row of the worksheet in a complete and concise sentence (6-10 words). After five minutes, the worksheets are passed on to the next person upon which each participant writes down another 3 ideas. The process continues until the worksheet is completed resulting into a total of 108 ideas on the 6 worksheets.

3> Mind Mapping

Mind mapping, also called 'spider diagrams' represents ideas, notes, information etc. in far-reaching tree-diagrams.

To draw a mind map:

> Lay-out a large sheet of paper in landscape format and write a concise heading for the overall theme in the center of the page.

> For each major sub-topic or cluster of material, start a new major branch form the central theme, and label it.

> Each sub-sub-topic or sub-cluster forms a subordinate branch to the appropriate main branch.

> Carry on in this way for every finer sub-branches.

It may be appropriate to put an item in more than one place, cross-link it to several other items or show relationships between items on different branches. Coding with colour, character or size can do this. Alternatively, the use of drawings instead of writing may help bring the diagram to life.

Software packages, like Freemind (for free downloadable from http://freemind.sourceforge.net/) are available that support working with mind maps, thus making it easier to amend and reshuffle the map.

4> Five Ws and H

The 'Five Ws and H', are six universal question and are an influential, inspirational and imaginative checklist. The technique uses basic questions generating prompts:

Who?
Why?
What?
Where?
When?
How?

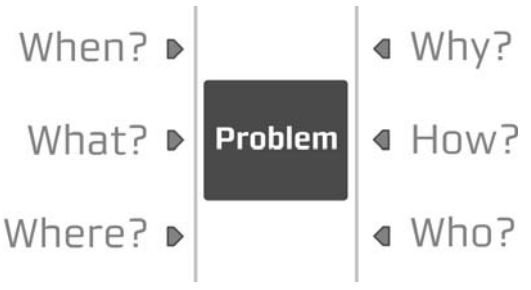


FIGURE 69 ___ START OF USING A MIND MAP FOR FIVE WS AND H.

The 'Five Ws and H' is a divergent creativity technique and can be used during the early stages of problem solving to gather information and to define more detailed the main (sub)problems to be solved. The checklist can be useful either as an informal or systematic way of generating lists of questions for which to find answers.

A Mind Map, with the 'Five Ws and H' as starting nodes can be used to facilitate the process (see Figure 69).

5> SCAMPER

The SCAMPER technique is a checklist that will assist in thinking of changes that can be made to an existing product to create a new one. These changes can be used either as direct suggestions of change or as starting points for lateral thinking. 'SCAMPER' stands for the following seven kinds of potential product changes:

S – Substitute – components, materials, people;

C – Combine – mix, combine with other assemblies or services, integrate;

A – Adapt – alter, change function, use part of another element;

M– Modify – increase or reduce in scale, change shape, modify attributes;

P – Put to another use;

E – Eliminate – remove elements, simplify, reduce to core functionality;

R – Reverse – turn inside out or upside down.

Start by isolating the product or subject that will be the focus. Next ask for the seven SCAMPER topic questions about the product or subject. Continue asking "How can…..?", "What else…..?", "How else…?" for every idea.

6> Analogies

Analogies are used to estrange the participants themselves from the original problem statement and to come up with inspiration for new solutions and approaches. These analogies can take a number of forms, which are presented in Table 12.

For more information: see Tassoul, 2005 and
http://www.mycoted.com/creativity/techniques/index.php
http://creatingminds.org/tools/tools_all.htm

ANALOGY	DESCRIPTION
Direct analogy	Starting from some aspect in the problem, one looks for comparable or analogous situations.
Personal analogy	What if you were an element in the problem?
Nature analogy	What kind of situations in nature does this remind me of?
Fantastic analogy	Can you place the problem in a fairy tale or other mythical situation and develop it from there?
Paradoxical analogy	Characterize the issue in two words which are each other's opposites.

TABLE 12 ___ TYPES OF ANALOGY.

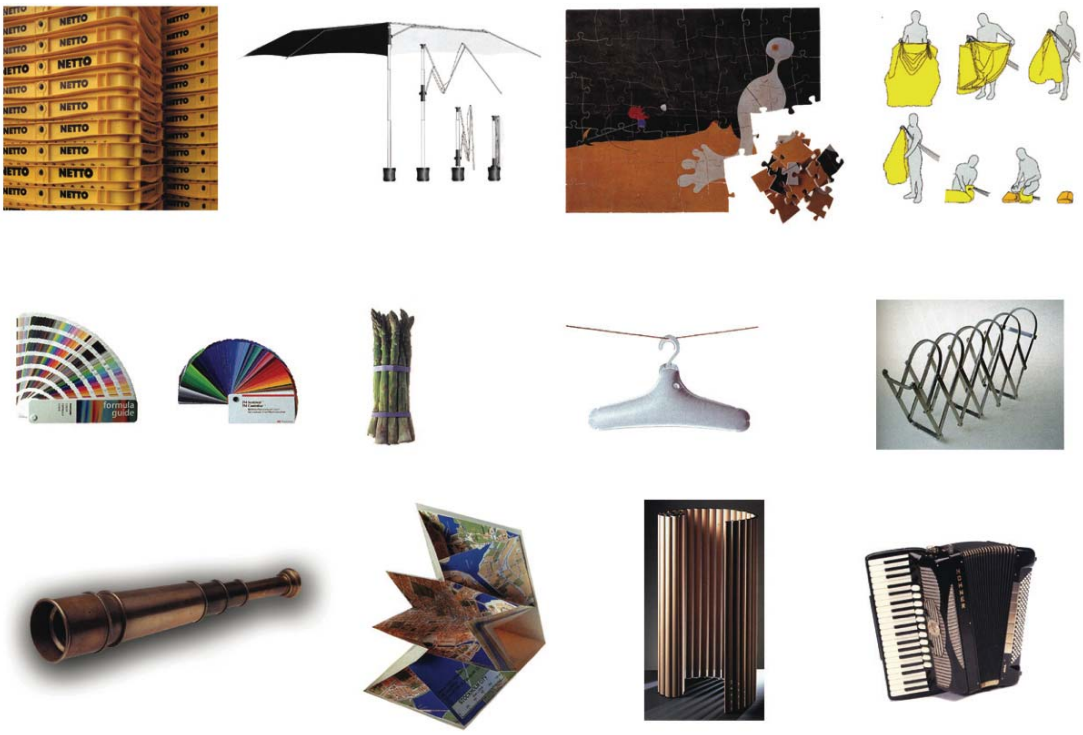


FIGURE 70 ___ ANALOGIES FOR CREATING A FOLDABLE COVER FOR A BICYCLIST.

RESOURCES AND FURTHER READING

Information is provided on additional available resources and on sources used and/or referenced in each of the chapters. Information includes internet sites and publications and is not exhaustive.

UNEP DTIE

UNITED NATIONS ENVIRONMENT PROGRAMME
DIVISION OF TECHNOLOGY INDUSTRY AND ECONOMICS

UNEP has a history of working with companies to identify and promote best practices – among them- the development of more sustainable products and services. Examples include a collection of best practice product service systems examples, the Efficient Entrepreneur Calendar (which outlines a simple step-by-step approach that companies can use to understand how their activities affect the environment); awards schemes, support to reporting initiatives such as the Global Compact and the Global Reporting Initiative, and the promotion of dialogue fora for companies to exchange experience. UNEP also works in specific sectors such as mobility, telecommunications, advertising, retail and sustainable construction to facilitate change through business-to-business channels. UNEP is also active in promoting life cycle thinking and innovation strategies through its Life Cycle Initiative. The Initiative's activities aim to develop and disseminate practical tools for evaluating the opportunities, risks, and trade-offs associated with products and services over their entire life cycle to achieve sustainable development. UNEP is also supporting the recently launched United Kingdom supported International Task Force on Sustainable Products, which is a result of the Implementation Plan of the World Summit of Sustainable Development. On the right is a selection of relevant UNEP web-sites and publications.

Web-sites

www.unep.fr
www.unep.fr/pc/sustain/
www.talkthewalk.net
www.unep.fr/en/branches/partnerships.htm
(see comments on the left)

Publications

Products and services

Brezet, J. C. and C. G. v. Hemel (1997). Ecodesign: A promising approach to sustainable production and consumption. UNEP, Paris.

UNEP (in collaboration with the Interdepartmental Research Centre Innovation for the Environmental Sustainability (C.I.R.I.S)) (2002). Product Service Systems and Sustainability: Opportunities for Sustainable Solutions. UNEP, Paris.

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UNEP (in collaboration with the McCann WorldGroup). (2002). Can Sustainability Sell?, UNEP, Paris.

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D' Almeida, N. and C. Pardo (2004). Meeting report of the global compact policy dialogue on sustainable consumption, marketing and communications. UNEP (in collaboration with Global Compact.)

Ryan, C. (2002). Sustainable consumption: a global status report. UNEP (in collaboration with the International Institute for Industrial Environmental Economics (IIIEE)), UNEP, Paris.

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D4S and environment (Chapter 2, 5 and 6)

Web-sites

Biothinking
http://www.biothinking.com/

Ecodesign Awareness raising campaign for electrical and electronics SMEs
http://www.ecodesignarc.info/

World Business Council for Sustainable Development
http://www.wbcsd.org/

Life Cycle Assessment
http://www.pre.nl/life_cycle_assessment/default.htm

Ecodesign in Central America
http://www.io.tudelft.nl/research/dfs/ecodiseno/
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O2 Global Network
http://www.o2.org

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Boks, C. and A. Stevels (2003). "Theory and Practice of Environmental Benchmarking for Consumer Electronics," Benchmarking - An International Journal 10(2): 120-135.

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Product Innovation and Needs Assessment (Chapters 3 and 4)

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Business Strategy
http://www.tutor2u.net/revision_notes_strategy.asp

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Ulrich, K. and S. Eppinger (2003). Product Design and Development.

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Case studies (Chapter 7)

Web-sites

http://www.segesti.org

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Evaluation Questionnaire

DESIGN FOR SUSTAINABILITY

A Practical Approach for Developing Economies

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1> QUALITY

Please rate the following quality aspects of the publication by ticking the appropriate box:

	VERY GOOD	ADEQUATE	POOR
Objectivity	O	O	O
Rigour of Analysis	O	O	O
Up-to-Date	O	O	O
Readability	O	O	O
Organization	O	O	O
Presentation	O	O	O

2> USEFULNESS

In general, how much of the publication is:

	MOST	ABOUT HALF	LITTLE
Of technical/substantive value to you?	O	O	O
Relevant to you?	O	O	O
New to you?	O	O	O
Will be used by you?	O	O	O

3> EFFECTIVENESS IN ACHIEVING THE OBJECTIVE

The objective of this publication is to give readers information on what is meant by the concept of D4S, current barriers to improved implementation, an action list on how to overcome these barriers and appendices of existing information sources. In your opinion, to what extent will the publication contribute to the achievement of this objective?

Please tick one box O FULLY O ADEQUATELY O
INADEQUATELY

Please state reasons for your rating

4> USES

a. Please state how publication will affect or contribute to your work, illustrating your answers with examples.

b. Please indicate, in order of importance (first, second, or third), the usefulness of the publication to you

	FIRST	SECOND	THIRD
For your own information	O	O	O
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	FIRST	SECOND	THIRD
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