International examples of Sustainable Product Development

Directory of 35 examples

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Austrian Ministry for Environment, Youth and Family
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BY HAN HEGEMAN

INTERNATIONAL EXAMPLES OF SUSTAINABLE PRODUCT DEVELOPMENT

DIRECTORY OF 35 EXAMPLES

by
Han Hegeman M.Sc.

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EXPRESSION OF THANKS

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Han Hegeman

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Han Hegeman (born 1962) is researcher SPD Examples at the UNEP-WG-SPD. Since joining the UNEP-WG-SPD in 1996 he has been working on the development of the international database on examples of sustainable product development (SPD).

For about 10 years Han Hegeman has been working as an environmental consultant and environmental scientist. The consultancies included demonstration projects and workshops on environmental management, environmental audits and coaching of companies and governments. The research at the Erasmus Centre for Environmental Studies consisted of demonstration projects on pollution prevention for small- and medium sized companies amongst others in the Euregion "Scheldemond" for the European Committee. It also included an international case study for the European Science Foundation (ESF) on Management of North Sea eutrophication. At the Institute for Environmental Sciences of the Free University the research included policy instruments for the reduction of pesticide use in agriculture and environmental effects of persistent pollutants in the long term.

He is also founder of the EcoSign Foundation which promotes cleaner production and consumption. This has resulted in the development of the EcoMarket website, a platform on the World Wide Web for green business suppliers, environmental labelling, Ecodesign examples, and information on environmental management.

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1.0 Introduction

This directory of SPD examples is a result of the UNEP-WG-SPD project on International Examples of Sustainable Product Development supported by the Austrian Ministry for Environment, Youth and Family and the Austrian Ministry of Science, Research and Culture.

The project comprises the collection and study of SPD-examples and their promotion and dissemination with the aid of a database tool. To date 35 examples have been collected in the database, including descriptions, contact details and illustrations. In the database they are classified among the UNEP-WG-SPD research themes on human needs and design approaches. The examples in the database can be printed and faxed in several formats for publications and workshops. They are also available for a world wide audience via an internet interface on the World Wide Web and can be discussed through an e-mail discussion list on internet.

The collection of SPD examples is divided into five steps.

1) Finding and selecting leads
2) Obtaining information and permission to use it
3) Input of examples into the database and final check
4) Output of examples from the database
5) Continued discussion

A large number of leads is available for product examples that illustrate sustainable product development. Finding and selecting them (step 1) is elaborated in more detail in chapter 2.0. For the input of selected information into the database, permission to use it is required with respect to the intellectual property rights on the example, the text and/or the illustrations (step 2). It is an essential step, as the information, once stored in the database, can and will be used for several purposes. It is the intention of the UNEP-WG-SPD International Centre to have no restrictions on the use of the information stored in the database, so that the examples can be widely and freely spread.

The information (text, photographs, slides) is edited and stored in the database (step 3) (see fig. 1). Once stored in the database the example record is sent to the provider of the information for a final check.

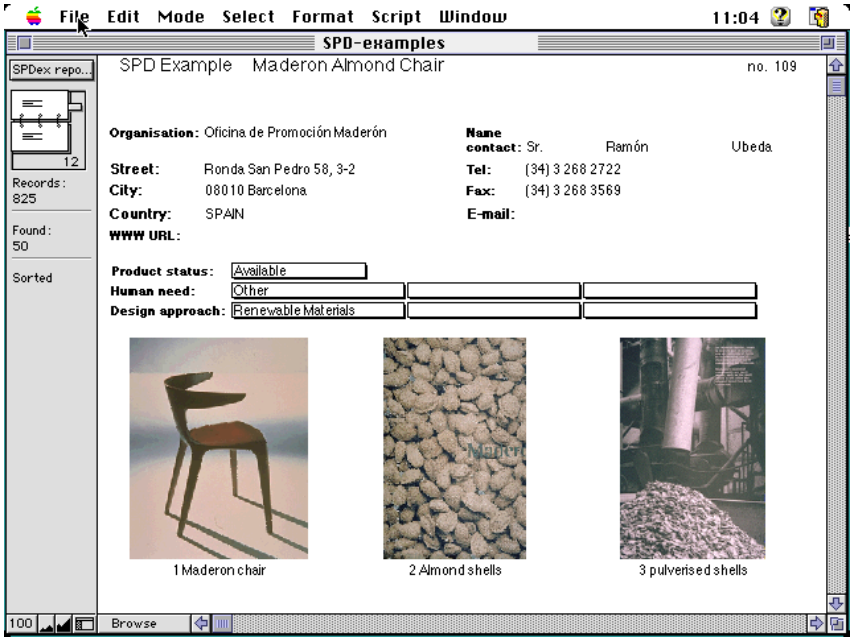


Figure 1: Database screen

After the final check, the examples can be used in many ways:
* Printing and faxing for publications, presentations and workshops
* A searchable internet interface for the database on the World Wide Web (see fig. 2)
* An internet e-mail discussion list on the examples.

As more information becomes available, an example may appear to be less interesting than it seemed to be at first sight. When this occurs it does not end up in the database. The examples that do make it into the database are discussed within the UNEP-WG-SPD on a regular basis as well as with the UNEP-WG-SPD network via an e-mail discussion list. This leads to:
* better examples,
* improved classification of examples, and
* new leads.

The debate on the examples is wide ranging. It covers subjects such as their sustainability and it provides a valuable input for the identification of directions for sustainable product development.

In this directory a description is presented of the 35 examples currently in the database. The next chapter gives an overview of the examples according to theme and finally descriptions and illustrations are provided of all 35 SPD examples arranged by archive number.

Figure 2: Web interface search facility

2.0 SPD example directory

This chapter describes the current 35 examples according to theme. The 13 themes of the UNEP-WG-SPD (see table 1) have been used as search directions for the selection of examples. All of the examples have been chosen because they somehow illustrate SPD.

By exploring practical SPD examples and ideas, the concept of SPD can be further developed.The overview of the current examples per human need or design approach gives an impression of the possibilities that exist.

A starting point for potential SPD-examples is that:

> **"SPD considers innovative design approaches of products, services and systems for end users that meet elementary human needs, especially in developing countries."**

SPD focuses on:
* innovative improvements (reflecting a paradigm shift) rather than incremental improvements,
* end user products, services or systems,
* products, services or systems aimed at the fulfilment of elementary human needs,
* products, services and systems in developing countries.

These starting points for SPD can be found in several UNEP-WG-SPD publications and have resulted into 13 research themes for the UNEP-WG-SPD. The focus on elementary human needs has resulted in a choice of 6 themes on human needs. Concerning the design approaches 7 have been singled out (see table 1). These themes of the UNEP-WG-SPD have been used as search directions for the selection of examples.

Table 1: Human needs and design approaches:

Human Need	**Design Approach**
* Clothing & textiles	* Dematerialisation
* Communication	* Life cycle design
* Cooking	* Longevity
* Cooling	* Optimised design
* Transport	* Renewable energy
* Use of water	* Renewable materials
	* Services

Several hundred leads that were found in literature, magazines, network contacts, workshops, etcetera, have been screened and the most interesting examples have been followed up, especially those concerning the UNEP-WG-SPD themes for 1996: renewable materials, communication and renewable energy. Examples concerning the other themes (not included in the 1996 program) have been collected in order to provide a first impression of the area. Most themes have been covered so far with at least a few examples.

The themes have been used as starting points or search directions for exploration of the subject. They must not be regarded as stringent criteria. It is clear that for every example numerous drawbacks or disadvantages can be raised which question the example. We did not use those to exclude examples, because in the end one can think of drawbacks for every example in specific situations. Rather, examples have been selected that illustrate one or more of the search directions. Indicated existing or imaginable drawbacks serve to fuel the discussion.

2.1 Renewable materials

The design approach renewable materials is based upon the idea that future products, services and systems will be based on materials that can be used without depleting their natural resource. The renewable sources are renewed within years or decades at the most.

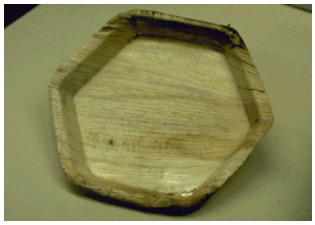
Many products are made (partly) of renewable materials. For a number of products, such as paper, wooden furniture and cotton clothes, this is the normal situation. From the large number of products based on renewable materials the following examples were selected because they stand out for different reasons. However, basically all of them have to do with the notion that in the long run most of the material use in society will have to be based upon renewable resources. Some interesting directions for sustainable development with renewable materials are:
* Grown products based on structural plant parts,
* Products made from vegetable material,
* Whole crop use.

2.1.1 Grown products based on structural plant parts

The gourd packaging (#107a), the leaf plate machine (#126) and the bamboo bicycle (#100) illustrate that products from nature can be used as they grow with little but clever processing. The gourd is moulded while it grows and thus is rendered more suitable as a container than is a natural (round) gourd. The leaf plate machine is used to press leaves into a shape fit for use. Potential other examples of grown products are leaf packaging and square trees. In Benin and other countries leaves are used to package food. Some experiments show that it may be possible to grow trees with a square shape, which makes the process of making wooden shelves more efficient.


bamboo bicycle (#100)


gourd packaging (#107a)


leaf plate machine (#126)

Bamboo might be considered as a promising renewable resource, because more products can be made with it beyond it's traditional use. Common products of bamboo include baskets, tools, and fences. Less wellknown is that bamboo can serve as a basis for plate material. The most illustrative aspect of the bamboo bicycle is that it shows that a renewable material such as bamboo can be applied as a constructive element for demanding structures such as a bicycle frame. The tubular structure of bamboo is also used in scaffolding in Asia and is sometimes applied in bridges.

Wood is commonly applied all-around the world as a structural element in products. So, the example of the Compwood compressed wood bending is selected for a different reason. This technology extends the possibilities for wooden products, as it makes bending more feasible.

Compwood compressed wood bending (#115)

2.1.2 Products made from vegetable material

Products can be made from vegetable material in many ways. The Maderon chair is made of agricultural waste. The plant markers (#111) are made of the renewable material polyhydroxybutyrate (PHB). This polymer is produced by the fermentation of a sugar feed stock such as sugar beets and cereal crops by naturally occurring micro-organisms. Fasal biowood is made of wood particles and a maize-based binder.

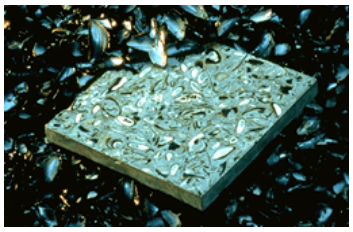
Maderon Almond Chair (#109)

Plant marker of PHB (#111)

Fasal biowood products (#117)

All three of these examples illustrate that vegetable materials can be applied for products in which currently plastic is the dominant material used. The markers are platen cut from rolled PHB sheet. The Maderon Almond Chair and the Fasal biowood products are injection moulded. This illustrates that injection moulding can be applied to renewable resources based materials.

A similar example is the mussel tile. It is made from waste material of the mussel growing industry. So, it consists of animal waste material.



Mussel tiles (#107b)

2.1.3 Whole crop use

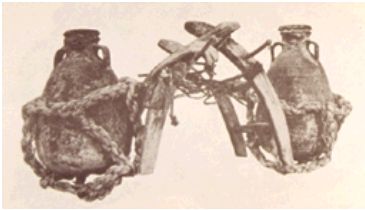
Some examples (#106, #113a, #113b) illustrate only a few of the numerous products that can be made from palms. At a meeting of the expert group on renewable materials during the conference “Challenges of Sustainable Development” in August in Amsterdam this has directed the attention to the concept of the “whole crop use”. In Egypt prof. El-Mously realised that a lot more can be done with date palms than harvesting dates. The palms have to be pruned every year anyway and the waste material of pruning can be put to use. Furniture for instance can be made of date palm leave midribs (#106).
This is especially interesting as it can be a viable alternative for the scarce wood resources in

Arab countries, as there the date palm is abundantly available locally. Wood and wooden products are imported into Egypt in large amounts. So, the date palm can be a local alternative for wood.

Some other palm products consist of all kinds of baskets and containers (#113) or sandals made out of palm tree leaves (#113a). In more general terms the whole crop use may prove to be a good starting point for sustainable use of renewable resources.

Furniture made of (#106)
date palm leave midribs

Sandals made of (#113a)
palm tree leaves



Baskets and containers of (#113b)
date palm leaves

2.2 Communication

Whether or not communication is sustainable depends on what has to be communicated, to whom and in what way. Possible search directions for more sustainable communication then may can include:

* communication with sustainable development as a message (what),
* the type of communication fit for a specific sender and target group (whom),
* more sustainable means of communication (how).

In search of examples on communication in these directions, one frequently encounters the rapid developments in telecommunication: ever increasing numbers of telephones, satellite connections and internet communication. This may offer opportunities for more sustainable means of individual communication. Sending an e-mail message requires much less material than sending a letter once the infrastructure is there. On the other hand, one may argue that mouth-to-mouth communication tends to get neglected due to all this technology.

The examples found so far, mostly concern more sustainable means of communication as this is the most tangible direction. Some of them have to do with conveying a sustainable message. The Encyclopedia on cycling (#101) shows all kinds of possibilities for cycling, the exhibition (#114) illustrates for many people that Ecodesign can improve the environmental aspects of many different products. Potential examples such as the SimIsle computer game (in which the player learns that in protecting a tropical forest very complex relations are involved) and an Ecogames competition, convey the message of sustainable development.

Exhibition "from Doom- (#114) thinking to Do-thinking”

Encyclopedia on cycling (#101)

It is questionable whether or not these examples would be the best way of communicating sustainability if a lot more of those would be screened for different circumstances. They should merely be regarded as starting points for the discussion. The type of communication fit for a specific sender and target group would require a lot more study. An example in this direction that may be considered is the Interlink Rural Information Service (Way Beyond, Vol I, Issue 2, 1996). This organisation works on several ways for communicating information to poor communities with low literacy rates in rural areas.

2.2.1 More sustainable means of communication

Most examples so far have to do with more sustainable means of communication. Even in this case very different examples have been collected. Some of them present a more sustainable means of communication because the environmental impact produced upon use is reduced. The Freeplay Clockwork radio (#105) is human-powered and among others eliminates the environmental impact of battery use for radio’s. The Xerox Eco-serie copier (#125) has less environmental impact in several stages of the life cycle compared to other copiers. The chain management system takes care of reuse and recycling of many parts of the machine. This reduces the environmental impact of spreading information via copied pieces of paper. A potential example such as the electronic book is at a different level because it replaces the use of

paper as an information carrier with floppy disks.

Freeplay Clockwork radio (#105)

Xerox Eco-serie copier (#125)

The remaining examples on means of communication illustrate the reduction of environmental impact in an indirect way. The cycling maps with inversed road hierarchy (#103) improve information on cycling possibilities and thus the environmental impact of transport. The tricycle production manual (#136) improves the information on producing tricycles for illiterate workshop workers in developing countries and thus enhances the local production of tricycles. This has environmental advantages such as local material use for local needs (see paragraph 3.7.1) and better repair possibilities. A potential example such as the green map system improves information on green shops and facilities for local cities and thus indirectly their use.

Cycling maps with (#105)
inversed road hierarchy

Tricycle production manual (#136)

2.3 Renewable energy

The design approach renewable energy is based upon the idea that in the future products, services and systems will be based on energy that can be used without depleting the resource. The sources are renewed within years or decades at the most. So renewable energy can include energy sources such as the sun, human power, biomass, wind power and hydropower. Here, the focus is on the most direct sources of renewable energy: human power and the sun.

2.3.1 Human-powered products

Human power is a versatile source of renewable energy. Often it is taken for granted as all of our activities require human power. You can think of normal human powered activities such as walking, cycling (transport) and writing (communication). Also for many tools such as scissors, hammers and staplers it is the most common source of power. For other products it is much less common, for instance for a torch or a dry shaver.

Bamboo bicycle (#100)

Rattan bicycle (#118)

Brox modular transport (#129)

The examples illustrate extended possibilities for human power. Bicycles are very common in countries like The Netherlands and China (#100, #118, #129). However, there is a huge potential for human-powered transport with bicycles in many cities.

Others extend the use of human power with the aid of a storage device. The clockwork radio (#105) and clockwork dry shaver (#132) store human power in a spring, as we all know it from clockworks. The gyroscopic dry shaver (#135) uses a flywheel to store the human power for a short period.

Freeplay Clockwork radio (#105)

Clockwork dry shaver (#133)

Gyroscopic shaver (#135)

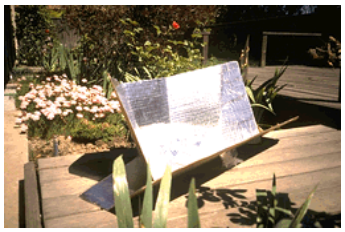
Other potential examples are a human power washing machine, a mud block press that provides a human powered alternative for bricks and a rolling water container for transport of water in rural area's in developing countries. People walk for hours to fetch water in all kinds of water carriers. The rolling water container can be a more efficient alternative: more water with less effort. Simply by applying the ancient idea of the wheel for transport to a new use.

2.3.2 Solar energy

The solar energy examples illustrate the variety of possibilities that exist to make use of the energy of the sun. A very common ancient use of the sun is drying, simply by putting food or clothes out there in the sun (sun-drying). One step further is to make this drying process more effective: solar drying. Solar drying enhances the use of solar energy. Potential examples include solar drying of fruit, timber or clothes with the aid of drying boxes or buildings. Examples of this are quite common. Out of these numerous examples, so far no particularly outstanding examples have been selected.

Other ways to use the heat of the sun are:
* cooking: the open solar cooker (#110),
* disinfection: solar water disinfection (#131) and
* heating water: SunWatt solar hybrid module (#140).

For all of these applications many examples exist. The open solar cooker was chosen because it is a simple design that has been applied successfully in refugee camps in Kenya as an alternative to wood fuel. The solar hybrid module is a multi functional design (see paragraph 3.6.5) and the solar water disinfection makes clever use of the sunlight in two ways. The heating of the water disinfects it, but also the solar radiation (UV) helps disinfecting the water.

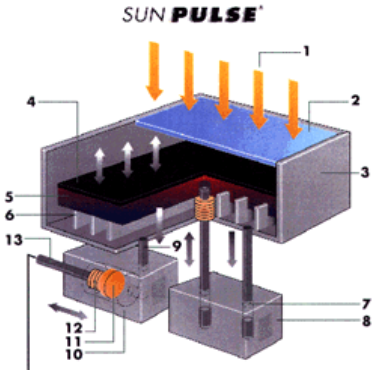


Open Solar Cooker (#110)

Solar water disinfection (#131)

SunWatt solar (#140)
hybrid module

The Stirling engine (#127) is a promising way to turn heat into mechanical energy. Many heat sources can be used to power a Stirling engine including the sun. The example of the Stirling engine from Bomin stands out because they use a simple, robust design for a low-temperature engine. It uses no crankshafts or flywheels nor special gases such as Helium.



Sunpulse Stirling engine (#127)

Potential other examples include solar water desalination and water purification with the aid of “living machines”, in which plants use solar energy to grow and to purify water.

2.3.3 Other examples on renewable energy sources

Some other examples in the area of renewable energy have been selected just to give an impression. The small-scale wind pump technology transfer (#120) shows the use of wind energy. Extra features of this example are its fitness for use in developing countries and the innovative gearbox. With this gearbox the windmill can begin to spin at low wind speeds.

The Fleming hydro-ram water pump (#123) is a special application of hydropower. This device was invented in the nineteenth century and can pump water from rivers or streams uphill with the aid of the power from the river itself. Due to its simple construction it can be used for a very long time with very little maintenance. Apart from the American producer other ram producing companies have been found in England (Vulcan Ram company) and in India (Inteco). Especially the latter can be interesting for our database but to date no further information is available.

Small-scale wind pump (#120)

Fleming hydro-ram water pump (#123)

2.4 Services, longevity, dematerialisation and life cycle design

The themes on services, longevity, dematerialisation and life cycle design are discussed together because all current examples in these area's are related to more than one of these themes.

For services possible directions are:
* repair and maintenance services,
* leasing or sharing of products,
* services instead of products,
* improved services.

For the other themes no further directions have been elaborated yet.

The Grammer office chair (#108) has a service component in the form of a take-back service for repair and reuse or recycling. The Xerox Ecoserie copiers are also taken back by the producer for reuse and recycling. In this case it has been made possible by a leasing system and in addition a repair and maintenance service. In both examples the product life is extended (longevity). The Grammer chair is designed to be fit for use for 30 years. The reuse and recycling of the copier prolongs the life of its parts and materials. Both of these examples also relate to life cycle design as in several stages of their life cycle the environmental impact has been improved.

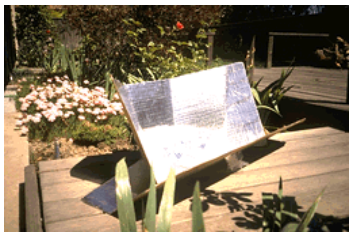
108
Grammer Office Chair

125
Xerox eco-serie
copier chain management

2.5 Remaining themes

2.5.1 Use of water

Search directions for this theme so far include disclosure of resources and cleaning/purifying water. All the examples concerning the use of water are also related to renewable energy. Both the open solar cooker (#110) and the solar water disinfection (#131) use solar energy to purify/clean water in order to make it fit for drinking.



Open solar cooker (#110)

Solar water disinfection (#131)

The other examples use renewable energy to disclose a water resource: the fog collection (#102), the small-scale wind pump technology transfer (#120), the Fleming hydro-ram water pump (#123) and the Sunpulse Stirling engine (#127). All of them use pumping, except the fog collector. The fog collector in Chile uses a mesh panel in an ingenious way to catch fog for drinking water purposes in dry, remote areas. As the fog is caught uphill no pumps are needed. The fog collectors natural equivalent are some intertwined olive trees in Oman. In the fog season these catch hundreds of litres of water per day (see #102).

Fog collection (#102)

2.5.2 Clothing and textiles

The examples on clothing and textiles are all based on renewable materials. They all have something in addition, that makes them outstanding. The 'Foxfibre' cotton clothing (#104) is made of organic cotton, and moreover it is naturally coloured. This last characteristic makes Foxfibre stand out from (many) other organic clothing. The Sandals made of palm tree leaves (#113a) make use of local resources and can be part of a whole crop use system. The Flax clothing Cotton Country Line-N (#137a) is grown locally in addition to being grown organically and improved production methods.

Foxfibre cotton clothing (#104)

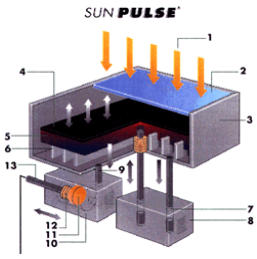
Sandals made (#113a)
of palm tree leaves

Flax clothing (#137a)
Cotton Country Line-N

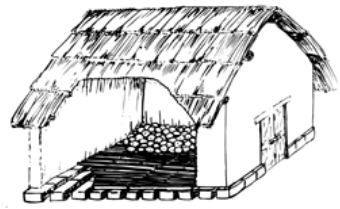
2.5.3 Cooling

The current examples on cooling illustrate three different directions. Starting with a common cooling device in mind, such as a refrigerator, this can be described as follows. Numerous examples exist that improve a refrigerator in the sense that they save energy through efficiency improvements and better isolation. Also, many refrigerators are designed nowadays without the need for halogenated hydrocarbons in the cooling fluid or the isolation. This reduces the environmental impact on the ozone layer dramatically.

As this is becoming quite common, more sustainable directions that take the improvements further are sought. With the aid of a Sunpulse Stirling engine (#127) a refrigerator can be powered by the sun, a renewable resource. This is another way of powering a refrigerator. Also a refrigerator can be replaced by another cooling method as in the rustic potato storage (#116). This requires no external input of energy. The evaporation of water provides the cooling. The trehalose-based vaccine formulations (#112) can be regarded as an alternative to cooling. Using the trehalose sugar renders the need for cooling superfluous, by preserving the vaccine at room temperature or even higher temperatures.



Sunpulse Stirling engine (#127)



Rustic potato storage (#116)

Trehalose-based (#112)
vaccine formulations

2.5.4 Transport

The available examples illustrate that the bicycle is an interesting human-powered means of transport. As a bicycle is a quite common product they all of the bicycle examples collected have been chosen because of their special character. The Bamboo bicycle (#100) and the Rattan bicycle (# 118) are partly made of renewable materials. The Brox modular transport (#129) has a versatile modular design which makes it useful for several functions, such as transport of humans as well as transport of goods. The tricycle production manual (#136) illustrates how a tricycle can be made in local workshops in rural areas in developing countries.

Bamboo bicycle (#100)

Rattan bicycle (# 118)

Brox (#129)
modular transport

Tricycle (#136)
production manual

The other two examples show communication means for enhancing the use of the bike: the Encycleopedia (#101) and the inversed cycling maps (#103).

Encycleopedia (#101)

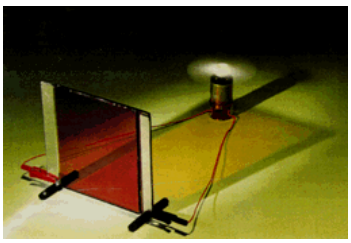
Inversed cycling maps (#103)

Potential examples include even more bicycles (such as the journeyman bike for China). The most important direction to be added is public transport. Interesting examples include

* Curitiba public transport system
* Zeppelin transport
* Public cable railway in Bhutan

2.5.5 Optimised design

The Electricity producing window (#124) and the SunWatt solar hybrid module (#140) combine several functions. The window lets the daylight through for lighting and at the same time absorbs infrared daylight for producing electricity. The SunWatt combines electricity production with water heating at the same time. The Brox modular transport (#129) combines functions in a different way. Various modules can be installed for different purposes. The standard chassis can carry for instance a van module or a passenger module, although not at the same time of course.



Electricity producing window (#124)

Brox modular transport (#129)

SunWatt solar hybrid module (#140)

3.0 SPD examples discussion

The overview of the current examples has resulted in a number of additional or more specific search directions on SPD. Several ideas or questions about SPD relate to different examples, across the human needs and design approaches. We discuss some of these in more detail here:

* The term local as an argument in favour of sustainability.
* The question whether an example is innovative or not gives rise to a number of questions.
* Also the situation in which a product is used is very important: the society and culture in which the product is used and the surrounding technology and infrastructure.

3.1 Is more "local" is more sustainable?

For several examples the local aspect is important. For the furniture made out of date palm leave midribs (#106) the local availability of the date palm resource makes it more sustainable. The small-scale wind pump (#120) is designed for local circumstances in developing countries. The sustainable aspect here is that wind energy (a renewable resource) is made available for local use in developing countries. The tricycle production manual (#136) is drawn for use in local workshops. This makes local production more viable and therefore local resources will be used and local repair possibilities will be improved.

Furniture made of (#106)
date palm leave midribs

Small-scale wind pump (#120)
technology transfer

Tricycle production manual (#125)

In the first two cases (#106, #120) the local aspect can be regarded as an additional argument for using renewable resources (material or energy). If use can be made of renewable resources on a local scale this can be more sustainable. The tricycle production manual shows that this holds true for non-renewable resources (metal) as well.

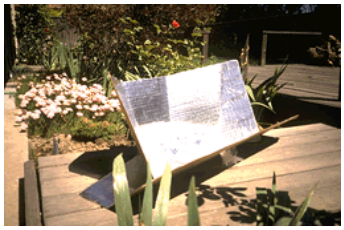
How does the local aspect contribute to sustainability? Not yet mentioned in these three cases is that these products meet needs in specific local circumstances. This can be found in other SPD examples as well. The Freeplay clockwork radio (#105) is designed for communication in rural area's in African countries. The open solar cooker (#110) was successful especially in the specific situation of refugee camps in Kenya and the trehalose-based vaccine formulation (#112) addresses the need for vaccines in far-away / distant locations that are very difficult to reach. So, addressing local needs appears to be an important factor. A worthwhile starting point for further exploration of SPD-examples than is:

Local resources for local needs

This is not to state that everything should be produced locally for a local market. Due to availability of resources or economies of scale, certain products can be produced more sustainable on a regional scale for a regional market or at an international level. It can also be that the local demand exceeds the carrying capacity of the local environment. This is often the case for wood production and consumption.
But the starting point that in the future more local resources have to be used for local needs will

lead to more sustainable products. Another way to put it would be that for a product (or service, or system) the best scale of production for a certain market scale is identified from an environmental point of view. The resulting, more sustainable direction for this, would in many cases be a more local one.

Freeplay clockwork radio (#105)



Open solar cooker (#110)

Trehalose-based (#112) vaccine formulation

In the discussions on this subject several other local matters were mentioned, such as:

* connection to local knowledge and technology,
* use of indigenous knowledge,
* local involvement and capacity building,
* sustainable islands.

Many of these subjects can be classified under local resources for local needs. If knowledge, labour and technology are included in local resources together with materials and energy, than these items can be addressed. Sustainable islands can be very interesting in this context as islands by nature have a more locally oriented resource basis. Sustainable islands therefore may provide interesting examples of SPD.

3.2 Innovative products and functionality

One of the distinguishing features of an SPD-example is supposed to be that it is an innovative improvement (reflecting a paradigm shift) rather than an incremental change. The examples have been selected because they are outstanding. However, several questions arise when considering if they are innovative or not.

First of all it is difficult to draw a strict line between incremental improvement and innovative redefinition. Some of the SPD-examples concern totally new products such as the fog collector (#102), some have improved product parts such as the bamboo bicycle (#100) and the clockwork radio (#105).

Bamboo bicycle (#100)

Fog collection (#102)

Freeplay clockwork radio (#105)

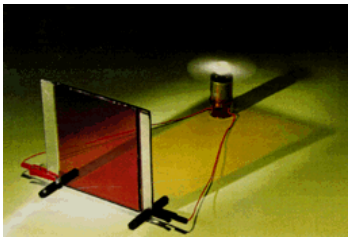
Some SPD-examples may not be called innovative at all, because they are ancient rather than innovative. This holds true for bicycles and the hydraulic ram (#123). These were both invented

long ago. Another common ancient product that is being considered as an SPD-example is a semi permeable water container for natural cooling of water. In many cultures water has been kept cool in containers that are a little bit permeable for water. The water can evaporate through the wall and in this way retrieves heat from the content of the container: an elegant way to keep water cool. Another potential example is an ancient way to make ice in the Arabian deserts. Just by covering a pond during the day and not during the night it is said that it gets you ice in a few days time. In this example clever use is made of natural circumstances.

Fleming hydro-ram water pump (#123)

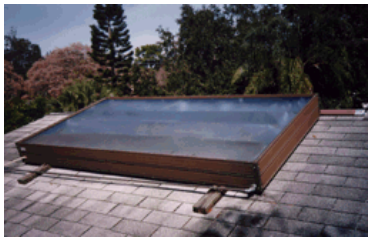
So, an undefinable element, which strikes as new, unexpected, elegant or even ancient, plays an important role in identifying more SPD-examples. As these depend very much on the background of the researcher identifying SPD-examples it is important to have input from and discussion with people from many different countries in the UNEP-WG-SPD network. To someone living in the desert the way to make ice in the desert described above might not be special at all.

Another possible distinction for more sustainable innovative products could be that the product functionality is questioned and improved. SPD-examples such as the electricity producing window (#124) and the SunWatt solar hybrid module (#140) clearly concern the product functionality as they combine functions. For examples such as the trehalose-based vaccine (#112 an alternative for cooling) the product function is questioned in relation to the surrounding circumstances. So, functional modification or functional alternatives can distinguish innovative products to some extent.



Electricity producing window (#124)

Trehalose-based (#112) vaccine formulations



SunWatt solar hybrid module (#140)

3.3 Starting point for comparison

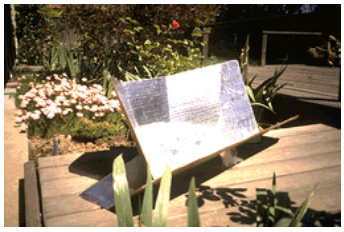
It has already been mentioned that the situation in which a product is used is very important: the society and culture and the surrounding technology and infrastructure. For each example it depends very much on the situation whether it can be called an SPD example or not. In other words, a number of directions for SPD are identified but as soon as they are applied to specific examples, the situation in which they are applied determines to a large extent whether or not the example turns out to be an improvement. Some examples of this are the following.

In a Western country a car sharing project can be an SPD-example because the starting situation is a country in which there is an infrastructure for cars and most people own a car. A car sharing project can be a more sustainable service, because the cars are used more efficiently and when people do not own a car themselves they are more likely to use e.g. public transport or bicycles in cases a car is not really necessary. In a country where public transport or the bicycle are more important from the start, a car sharing project would not be appropriate as an SPD-example.

Another potential SPD-example in the transport sector is the idea to use cable railways for public transport in Bhutan. The potential here is much bigger than in a mountainous country such as Austria where it is additional to existing road infrastructure. The advantages in Bhutan are closely linked to the fact that it is a mountainous country with little existing transport infrastructure in the form of roads. Using cable railways can be an alternative for the construction of many miles of winding roads. In this case, the natural conditions as well as the existing society, its culture, organisation and infrastructure make it an interesting SPD-example.

For many of the SPD-examples in the database, their surrounding determines to a great extent their potential. This becomes very clear if it is considered the other way round. The fog collection (#102) is of no use in a flat rainy country like The Netherlands, the solar cooker (#110) is of no use in very Northern or Southern countries, the Xerox eco-serie copier (#125) is of no use in a country if electricity or paper suppliers are missing.

Fog collection (#102)



Open solar cooker (#110)

Xerox Eco-serie copier (#125)

So, a way is required to take the surroundings of an SPD-example into account (contingent approach). One way to do that is to look at different classifications of the examples that include the surroundings. Classifications of the surroundings can be used such are:

* kind of production: artisan, handicraft, serial production,
* demand-driven versus supply-driven production,
* scale of resource use, production and usage,
* country or region of application of the example.

A drawback of this approach is that these classifications require quite detailed information on examples. An alternative could be to work with analogy to identify more sustainable directions with the aid of examples. Where environmental scientists use the product life cycle to establish environmental impact, SPD may use the analogy of **product ecology** to relate SPD examples to their complex surrounding.

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101 Encycleopedia on cycling

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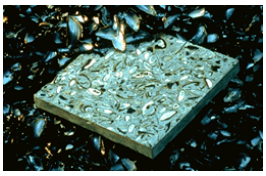
105 Freeplay Clockwork radio

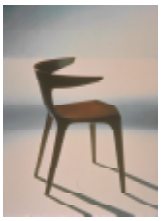
106 Furniture of Date Palm Leave Midribs

107a Gourd packaging

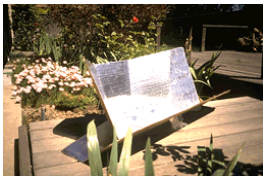


107b Mussel tiles

108 Grammer Office Chair



109 Maderon Almond Chair

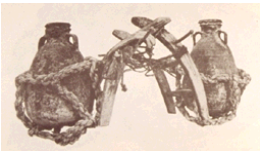


110 Open Solar Cooker

111 Plant marker of PHB

112 Trehalose-based vaccine formulations

113b Sandals of palm tree leaves



113b Baskets and containers made of date palm leaves

114 Exhibition "from Doom-thinking to Do-thinking”

115 Compwood compressed wood bending

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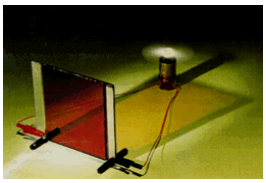
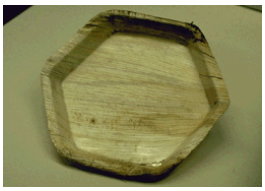
123 Fleming hydro-ram water pump

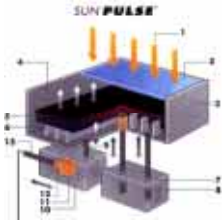


124 Electricity producing window

125 Xerox eco-serie copier chain management



126 Leaf plate machine



127 Sunpulse Stirling engine

129 Brox modular transport

131 Solar water disinfection

132 Dynamo torch

133 Clockwork dry shaver

135 Gyroscopic shaver

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137a Flax clothing Cotton Country Line-N

140 SunWatt solar hybrid module

SPD Example Bamboo bicycle

no. 100

Organisation: Hermes Paris,
Direction de l'information

Name contact: Flavie Chaillet

Street: 24, rue du Faubourg Saint-Honore

Tel: (33) 1 4017 4717

City: 75008 Paris

Fax: (33) 1 4017 4934

Country: FRANCE

E-mail:

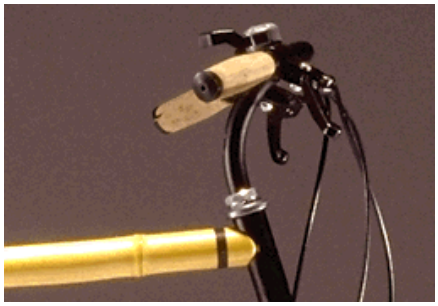
WWW URL:

Product status:	Prototype		
Human need:	Transportation		
Design approach:	Renewable Materials		

1 bamboo bicycle

2 bamboo frame

3 beech rim



4 cork handlebar

SPD Example Bamboo bicycle

no. 100

Example summary

The Bamboo bicycle (fig 1) was designed by Antoine Fritsch exclusively for Hermes. The frame (fig 2) is made in block-dyed black chrome and hand-shaped and tied bamboo. The bamboo frame is reinforced with wood for stability and carbon fibre is used to get rigid frame joints. The handlebar grips (fig 4) are in cork, the rims (fig 3) are in beech wood and the seat is leather. The three handlebar speeds are integrated into the hub and the bike has drum brakes.

It is a men's model leisure bike, assembled in France. The bicycle is still in development. E.g. one of the problems to overcome is that enough high quality bamboo is required for the frame.

UNEP-WG-SPD text source: Hermes Paris

Sustainable aspects

Bamboo is a valuable renewable resource as it grows very quickly and is widely available. In the example of the bicycle the natural structure of bamboo is being used as it grows. Just the end parts of each tube of bamboo are mechanised on a turning machine to create references, simplify the adjustments with metal parts and to make easy serial mounting possible.

In other words, in this application the use of bamboo is well adjusted to it's natural characteristics. A major advantage of the bamboo used as a tube is it's strength relative to it's weight.

Of course, a bicycle as such is an ecologic means of transport with human power as it's energy source.

SPD opportunities

The bamboo bicycle illustrates that bamboo can be used as a constructive element for constructions that need to be strong, like a bicycle frame. Similar applications of the tubular structure of bamboo are scaffolding for building skyscrapers in Asia and bridges made of bamboo. Bamboo may very well be used for much more constructive applications, in which the tubular structure of bamboo is used as it grows naturally.

SPD Example Encycleopedia on cycling

no. 101

Organisation: Open Road Ltd

Name contact: Peter Eland

Street: The Raylor Centre, James Street

City: York YO1 3DW

Country: UNITED KINGDOM

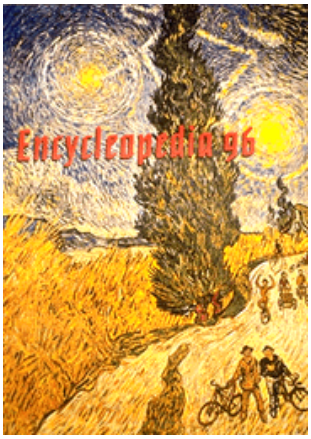
WWW URL: http://bikeculture.com/home/

Tel: (44) 1904 412200

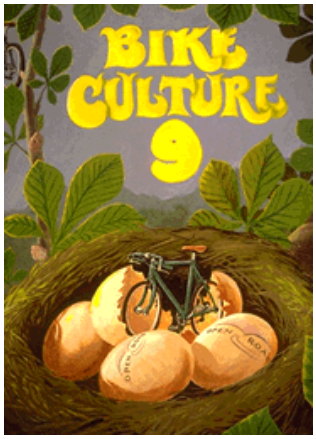
Fax: (44) 1904 411155

E-mail: peter@bcqedit.demon.co.uk

Product status:	Available		
Human need:	Communication	Transportation	
Design approach:			



1 Encycleopedia



2 Bike Culture Quarterly

SPD Example Encycleopedia on cycling

no. 101

Example summary

Encycleopedia is a yearbook of alternatives in cycling, published by Open Road Ltd, who hold all intellectual rights (fig 1). It seeks to promote and foster the development and use of pedal-powered alternatives to unsustainable, fossil-fuel-powered vehicles, for a range of uses beyond the conventional bicycle journey.

To this end it features products allowing the use of human power for the transport of heavy loads (including tricycles and quadricycle load-carriers, and trailers), use by disabled people (including a number of modular designs which can carry loads as well), use on longer journeys and more often (including recumbents and velomobiles, and options for family cycling), and use of mixed-mode transport (portables, which fold or separate for easier integration with train, bus or other public transport modes).

Another publication of Open Road Ltd is their cycling magazine: Bike Culture Quarterly. New thinking on bicycle design, practical vehicles and their uses, inspiring opinion on green and transport issues, cycle history, cycle art; all find a place in Bike Culture.

For more information contact Open Road or their national agents (see also the Open Road Web site at http://bikeculture.com/home/).

UNEP-WG-SPD Text Source: Open Road Ltd

Sustainable aspects

Encycleopedia should be seen as a resource for all those trying to find alternatives for a sustainable future. If a large proportion of our transport needs can be met by pedal-power, the undesirable and unsustainable development of a 'car culture' can perhaps be reversed.

In any case, bicycle technology is appropriate throughout the world where more elaborate motorised options are not. Equipment for bicycle maintenance and construction is widely available. The manufacturing process has generally little impact on the environment, and consumes relatively little raw materials. Because pedal-power is human power, it is a renewable, non-polluting energy resource and a sustainable technology (providing that the agricultural methods providing food to the pedaller are also sustainable!). Encycleopedia shows that even in a car-dependant culture, there are pedal-powered alternatives which can also be good fun. Encycleopedia and the video can be used as an educational resource, to show people that these things are possible.

As far as sustainability of the product itself is concerned, we use environmentally-friendly paper, and endeavour to use the least damaging printing and distribution processes available economically. Use of the unsustainable transport infrastructure for magazine distribution is at present a necessary evil - although we all commute to work by bicycle.

SPD opportunities

Encycleopedia appears once a year, and each time we try to include more wonderful products which fill one more gap in the spectrum of human-power, human-scale vehicles which we need to create a sustainable future. The main opportunity for us is to just make Encycleopedia bigger, better each year. With our full-colour design we make the products we feature attractive and credible. To spread the message more widely, we have set up distributors across the world.

SPD Example Fog collection

no. 102

Organisation: Environment Canada, Atmospheric Environment Service, Cloud Physics

Name contact: Robert S. Schemenauer

Street: 4905 Dufferin Street

Tel: (1) 416 739 4606

City: Canada M3H 5T4

Fax: (1) 416 739 4211

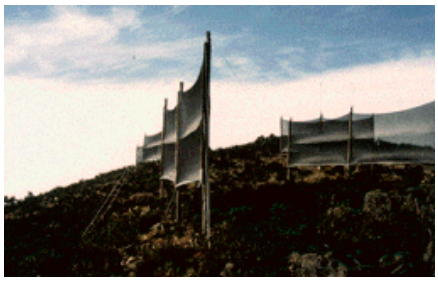
Country: CANADA

E-mail: robertss@armph3.dow.on.doe.ca

WWW URL: http://www.dow.on.doe.ca/armp/Events.html

Product status:	Prototype		
Human need:	Use of Water		
Design approach:			

1 Fog catching olive trees
© Robert S. Schemenauer



2 Fog catching mesh panel
© Robert S. Schemenauer

SPD Example Fog collection

no. 102

Example summary

In certain locations, persistent fogs cover coastal or interior mountains. The droplets from these fogs are collected by trees or other tall vegetation. They can also be collected by appropriately designed man-made collectors, to provide large volumes of water for domestic, agriculture or forestry uses. In coastal deserts or denuded upland areas, in the absence of vegetation, the fog will roll over the terrain and provide a potential water resource.

Fall velocities of raindrops, drizzle drops and fog droplets are sufficiently low to be be influenced by horizontal winds of a few metres per second. In the case of fog droplets, the fall speeds are so low that, even in very light winds, the drops will travel almost horizontally. This means that the appropriate collector for fog droplets is a vertical, or near vertical surface. Trees can be good fog collectors depending on their height and leaf structure (fig 1) and artificial collectors used to provide water for villages are built in the form of vertical mesh panels (fig 2).

The amount of water that then can be collected depends on the surface area of the collector, the efficiency with which the collector captures the droplets, and the wind speed. A review of the collection of fog by isolated trees has shown that the vertical cross section of a tree collects at a rate of about 10 litres per square metre per day (l/m2/d). The highest rates found, came from the Dhofar region of southern Oman where two small intertwined olive trees dripped an average of 580 or 860 l/d in two separate periods (fig 1). These trees were in a windy environment and were almost constantly in fog and light drizzle. The trees in Dhofar produced much more water than they required in this humid environment and considerable surface runoff was evident below the trees.

The use of artificial collectors is illustrated by the fog collection project for the fishing village of Chungungo in the arid coastal desert of northern Chile. This is the largest project to date and has provided an average of 11.000 litres of water per day to the village of 330 people for five years.

The following agencies have supported the work on fog collection:
* The International Development Research Centre (IDRC)
* The Canadian International Development Agency (CIDA)
* Environment Canada
In addition there have been contributions by many universities, NGOs, and national agencies, in particular the Geography Institute of the Pontifical Catholic University of Chile.

UNEP-WG-SPD text source: R.S. Schemenauer and P. Cereceda

Sustainable aspects

The largest fog collection project to date has taken place on a ridge line above the fishing village of Chungungo (29' 27'S; 72' 18'W) on the north central coast of Chile. Up until 20 years ago, Chungungo received water from the iron mine of El Tofo. When the mine closed, water was trucked to the 330 villagers from a well 40 km away. The water delivery was irregular, the water not of the best quality, and the cost high.

The fog collection system

The coastal ridge line (780 m elevation) at El Tofo, above the village of Chungungo, is frequently covered in fog. The incoming cloud layers are thin, 100 to 300 m, and rarely produce drizzle or rain. At the El Tofo site 50 large fog collectors, each consisting of 48 m 2 of a double layer of polypropylene mesh, were constructed by the Corporacion Nacional Forestal (CONAF) in late 1987 with funding from the international Development Research Centre (IDRC, Ottawa), as part of a multi-agency scientific and operational programme. In 1992 25 additional collectors were constructed and a 6.2 km pipeline to the village of Chungungo was completed with help from the Canadian Embassy. A 100 m3 storage tank above the village feeds fog water through a PVC distribution system to 106 houses. The system has been operational since March 1992.

The average water production from the collectors has been approximately 3 l/m2/d of collecting surface from November 1987. This is an average production of 11.000 l/d. Production rates vary with conditions, from zero on clear days, to a maximum of about I 00 000 l/d. With the current array size, each of the 330 villagers should receive about 33 l/d of water. Thus the fog water system has met and has somewhat exceeded the estimated requirement of 27 l/d per capita.

Water quality
Water in the incoming fog and from the fog collectors can be expected to be of good quality. It will contain some marine salts and soil dust but little contamination from anthropogenic sources given the remote locations of most proposed sites. The ion and trace element concentrations in the fog water at the El Tofo collection site have been studied in detail and found to meet Chilean and World Health Organisation (WHO) drinking water standards. As with any water supply system, once the source water is known to be acceptable, the quality at the point of use will depend on having suitable maintenance procedures for the system.

The management of the fog water supply
A potable water committee (PWC) in the village has been set up and is run by the villagers. The PWC has five elected, unpaid members from the village and a paid administrator. He maintains the main 100 m3 storage tank and the distribution system, monitors water use in each home, and collects a monthly fee based on consumption. The fee pays the administrator's salary and minor maintenance costs, and a portion is saved to meet future expenses.

Another important role of the PWC is to regulate consumption in the village. Because the supply of water varies with the presence of fog on the mountain, the PWC monitors the main reservoir and alerts villagers to reduce consumption in periods of low supply. In turn, in periods of excess production, water is diverted to a large 400 m3 open reservoir for agricultural purposes. Initially, 0.3 ha of a 0.7 ha plot is being irrigated.

The change from the storage of trucked water in 200 l oil drums, and paying for the water when it arrives, to using metered water taps and paying once a month has been a significant adjustment for the villagers. In particular, because the water is now so easy to obtain from the water taps, the people must be careful not to use more than they can pay for and they must restrict consumption in periods when the water production is lower. Overall, the current level of village involvement in the distribution of the water appears to be working well. Aspects where more involvement should have been encouraged are in the construction of the collectors and the pipeline themselves, and in the maintenance of the collectors on the ridge line.

The cost of the water supply dropped from more than 7 US$/m3 for the trucked water to a fixed rate of 1.38 US$ per month plus a charge based on consumption. This charge varied from 1.06 US$/m3 to 1.26 US$/m3 depending on the amount of water consumed.

SPD opportunities

There is a lot of potential for fog collection elsewhere. Projects have been undertaken in Chile, Peru, Ecuador and Oman.

There has been a history of small fog collection experiments along the coast of Peru. The results of an assessment project near Lima showed that this site, on an annual basis, should have a greater productivity than the El Tofo site in Chile. Subsequently, two private companies were established to build systems. At a school near Lima 1200 m2 of mesh were installed to provide fog water for the school, in a park north of Lima 500 m2 of mesh were installed to produce fog water for reforestation purposes, and several other small projects were undertaken, including a reforestation project in the south.

Ecuador has stretches of semi-arid coastline where the people experience water shortages and high water costs, as they do in Chile and Peru. There is also a lack of adequate and potable water supplies in some rural areas in the high Andes. Small evaluation projects in the mountains of Ecuador in the early 1990s showed considerable fog collection potential. There is now an operational fog collection project for the village of Caspigasi del Carmen north of Quito. The collectors are on the crater rim at Pululahua at an elevation of 2800 m. A second project to the southwest of Riobamba at 3800 m in the village of Pachamama Grande is on it’s way.

A major fog collection experiment was undertaken in the Sultanate of Oman. During the south- west monsoon, the mountains of Dhofar (17' OO'N, 54' 04'E) are covered in a thick deck of fog with frequent drizzle. Because of the extended dry period between collection seasons, and because of the other options available in Dhofar (bore holes, desalination) the most likely application will be reforestation of the mountains. However, a study of the water quality has shown that the water is potable and, therefore, suitable for all purposes.

Fog collection potential in other countries
Altogether, a review by Robert S. Schemenauer and Pilar Cereceda shows that there are 22 arid countries on six continents where literature references to the collection of fog by trees or small collectors would support an evaluation

of the amount of water that could be produced by operational fog collection arrays. In Africa, for example, one could explore the water production rates in parts of the Sudan, Kenya, South Africa, Namibia, Angola, Ascension Island, the Cape Verde Islands and the Canary Islands. Some of these are developing countries in dire need of water. Others are developed countries with water scarcity but with resources for funding other non-conventional sources of water such as desalination. The same pattern exists elsewhere in the world. Currently, evaluation projects are underway in Namibia, South Africa and the Canary Islands.

California has fog-covered coastal mountains and a demonstrable water need but it also has the resources to pay for major water diversion projects. On the other hand, Yemen also has suitable conditions and may well benefit from a fog water programme that can be implemented in rural areas for either village use or for reforestation. A broader look at the meteorological and oceanographic conditions on a worldwide basis, as well as the topography, will lead to the conclusion that many other countries may have the potential to benefit from fog collection programmes. Continuing with the example of Africa, evaluation programmes could be considered in parts of Eritrea, Ethiopia, Somalia, Tanzania, Madagascar and Morocco, among others.

The collection of fog water also has extensive application in both seasonally arid countries and in countries or locations where there may be an adequate amount of water but where water may be bacterially or otherwise contaminated. An example of the former is the Philippines. Annual precipitation in the upland areas may be 4000 mm or more and, particularly during the monsoon season, the people are deluged with water. Rainwater is collected by many homes and spring water is readily available. Yet for six or more months of the year the same people suffer from serious water shortages and are forced to buy water from tanker trucks at rates of US$4.00/m3 or more. In rural areas, where the incomes are very restricted, this produces major limitations on living conditions and affects the health of the people. To date no fog collection projects have been undertaken in the Philippines, but discussions with NGOs and villagers in the mountains of northern Luzon, for example, indicate that there may be sufficient fog during the dry season to augment or replace the water that is being purchased from the trucks.

The opportunities for the future will also be an important topic at the first international conference on fog and fog collection in Vancouver, Canada, 19-24 July 1998. For more information see also the web page on the conference.

SPD Example Cycling Maps with inversed road hierarchy

no. 103

Organisation: Cyclecity Guides, Dome Publishing

Street: 3/4 Zig Zag

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Country: UNITED KINGDOM

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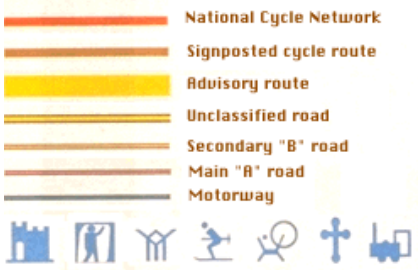
Product status:	Available		
Human need:	Communication	Transportation	
Design approach:			

1 Map covers

2 Bristol map city centre

3 Oxford map

4 East Kent map introduction panel



5 East Kent map symbols panel

6 East Kent map

SPD Example Cycling Maps with inversed road hierarchy

no. 103

Example summary

CycleCity maps (fig 1) are a reversal of the traditional. Designed for cyclists, the double-sided maps include a changed road hierarchy which reduces the size of motorways and main roads and increases the width of minor roads and country lanes. The change has been possible by the manipulation of digital map data held by Ordinance Survey, Britain's national mapping agency.

One side of the map is a 1:18,000 detailed street plan, marked with traffic-free paths, official signposted cycle routes and a third category of routes recommended by local cyclists. The other side includes an area of about 80 km x 50 km at a scale of 1:125,000 where the road hierarchy is reversed (fig 2, 3, 6). Tourist attractions and signposted cycle routes are marked as is the beginnings of Britain's National Cycle Network. Text explains the way the system works and clear symbols provided (fig 4, 5).

UNEP-WGD-SPD text source: Martin Whitfield

Sustainable aspects

The principle behind the maps is to encourage the use of cycles, the most efficient method of sustainable transportation, for both commuters and sustainable tourism. The intention is that the maps can be used to find the safest and most convenient way across a city - heavy traffic and pollution are the greatest deterrents to urban cycling - while also being suitable for leisure and weekend riding to tourist locations in the countryside. Map users can easily plan routes to avoid the roads with the most traffic. The map paper has been chosen to be able to be folded many times without cracking or tearing and can be put into a pocket.

SPD opportunities

The same principle of reversed road hierarchy can be applied to any map designed specifically for cyclists or walkers. It creates the right priority for the appropriate user. As with most maps, the scale is crucial - detail starts to be lost above 1:120,000 and it is important to mark key locational symbols, such as church spires, radio masts and large public buildings. Although the map paper is very durable, it is not recycled which would be more appropriate.

SPD Example Foxfibre cotton clothing

no. 104

Organisation: Fachhochschule Hannover, Fachbereich Kunst & Design

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Country: GERMANY

WWW URL:

Name contact: Prof. Christiane Wöhler

Tel: (49) 511 9296 529

Fax: (49) 511 9296 510

E-mail:

Product status:	Available		
Human need:	Clothing & Textiles		
Design approach:	Renewable Materials		

1 All Foxfibre clothes

2 Foxfibre sweater

3 Naturally coloured cotton

4 cotton bale and textile

5 textile in natural colours

6 textile unwashed / washed

SPD Example Foxfibre cotton clothing

no. 104

Example summary

In 1982 Sally Fox (fig 1) was introduced to coloured cotton (fig 3), which were strains of cotton that have been hand spun for centuries by the people of Central and South America. The fibre qualities of these strains were not sufficient for machine spinning. After many years of breeding the coloured cotton, Sally Fox succeeded in producing and testing a fibre , FoxFibre, the quality of which allowed it to be used in the commercial textile industry.

In 1989 Sally developed her company Natural Cotton Colours Inc. and now contracts production of the cotton to farmers in Arizona and Texas as well as continuing her research on a certified organic farm near Wickenburg, AZ. In addition Sally designs fabrics with her cotton (fig 1), to develop data necessary for commercial mills to utilise her cotton as well as to illustrate to her clients the potential of her product. FoxFibre is now used by brands such as Levi Strauss, Fieldcrest Cannon, L.L. Bean and Esprit (fig 2).

UNEP-WG-SPD text source: Sally Fox

Sustainable aspects

FoxFibre has the ability to reduce the generation of waste and the use of pesticides associated with the production and manufacturing of conventional white cottons. FoxFibre in addition to being bred for fibre and colour quality was bred for pest resistance, facilitating organic production. Contrary to white cottons which are bleached and then dyed during the manufacturing process, FoxFibre has its own colour (coyote brown, palo verde green and buffalo brown, fig 5) eliminating the need for these processes and avoiding the associated waste. In addition to its colour the cotton:

• darkens with washing, providing the consumer with a longer lasting product (fig 6).
• allows for efficient textile handling and processing, with a natural wool-like elasticity
• can be spun from 100% solid colour to any percentage blend. FoxFibre colours can be combined with each other or with white cotton. All of the colour shades can be created within the beige, khaki, brown, red brown, dark brown, and green colour spectrums.
• provides a natural fire retardant tendency. Presently they are in the initial stages of conducting research and tests in order to evaluate the potential of these inherent qualities for their Coyote and Buffalo colours.
• A cost advantage exists as a result of pesticide use avoidance and dye and bleaching savings.

SPD opportunities

Research is required on (indigenous) knowledge and experience with respect to the various ways organic (coloured) cotton may be used for other product areas than for textiles and clothing. In this way the market for organic cotton can be expanded. For example people in Peru use organic cotton for making their fishing nets. Cotton can also be used for paper making.

With respect to the introduction of organic cotton in third world countries: In Africa farmers seem to have a comparative advantage as organic cotton is more labour intensive, which is positive where there is a need for jobs. Besides chemical inputs are very expensive, so a system in which these are not required is favourable. Developing countries have the advantage that they are often not so much involved (yet) with the pesticides industry. They are in a position to choose for a more environmentally friendly way of producing cotton.
In West Africa the government is very much involved in the well structured cotton export market. Here one must deal with government in order to change the system.
In the last few years projects in this area have been set up in the following African countries: Benin, Senegal (2 projects: 1 German, 1 British), Uganda, Tanzania, Zimbabwe, Zambia & Mozambique.

Research on the improvement / further development of organic coloured cotton involves:
- Seed variety.
- Possibilities of combining organic cotton with other natural fibres
- Dying organic cotton with natural dyer.

SPD Example Freeplay Clockwork radio

no. 105

Organisation: BayGen Power Europe

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Fax: (44) 171 702 3248

Country: UNITED KINGDOM

E-mail:

WWW URL:

Product status:	Available		
Human need:	Communication		
Design approach:	Renewable Energy		

1 Freeplay clockwork radio

2 people using the radio

SPD Example Freeplay Clockwork radio

no. 105

Example summary

The BayGen Freeplay radio is a people powered product designed by Trevor Baylis. Baylis invented it after watching a programme about the spread on Aids in Africa, in which the World Health Organisation said the biggest problem in spreading reliable health information was that so few people could afford batteries. So, the clockwork radio was devised as a communications tool for developing countries. Running without the need for batteries, the Freeplay radio offers its users more than obvious environmental attractiveness. In developing countries even finding batteries to buy can be difficult and prohibitively expensive. The Freeplay radio therefore fills the gap for a cheap, simple to use and maintain information source that is not reliant on batteries or any external electricity supply.

(UNEP-WG-SPD Text Source: Yorick Benjamin)

Sustainable aspects

The two main sustainable aspects are the use of renewable energy and it's adaptation to local circumstances (appropriate technology).

Renewable energy

The people powered radio is operated with a winding handle. The handle is folded into a carriage and can be taken out to wind-up the radio. 60 turns of the handle provide power for approximately 40 minutes of listening time. The spring life is estimated at 10,000 to 30,000 winds, or 6,666 to 20,000 hours. If the radio is switched off before the spring has finished unwinding, an electronic spring saver will slow down the unwinding form 1.5 rpm to 0.1 rpm and hence conserve energy until the radio is switched on again.

Appropriate technology

The Freeplay radio is meant for people in developing countries where affordable energy is scarce or non-existent. Radios are often the only way for illiterate people to keep abreast of current events. The radio can be helpful in work like preventive health care, refugee assistance programmes, aid relief and distance learning (see figure 2).

SPD opportunities

Clearly, this renewable energy source can be used for other applications. For example, Baygen is working on a people powered torch. The BayGen torch would use the energy stored in a spring.

Probably because of the use in distant places a robust maintenance free material is chosen for the radio: ABS. From an SPD point of view other plastics or local materials would be more appropriate.

Some may also question the need for this western communication tool if they see the radio in figure 2 in it's African surroundings. Of course, a radio is a radio whether or not it is human powered or not. The British charity Warchild organises a pilot study in Afghanistan to see how useful it would be. More research is needed into the communication needs, such as what is used at the moment in remote areas of Afghanistan? What is the present access to information? Would these radios provide the sort of information that would be of use in extreme conditions? Are they going to pick up government propaganda or information that could be used for health education and so on.

SPD Example Furniture of Date Palm Leaf Midribs

no. 106

Organisation: Ain Shams University Faculty of Engineering

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WWW URL:

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Fax: (20) 2 284 2472

E-mail:

Product status:	Available		
Human need:	Other		
Design approach:	Renewable Materials		

1 Date Palm pruning
© *Ain-Shams University*

2 DPLM furniture board
© *Ain-Shams University*

3 DPLM table
© *Ain-Shams University*

SPD Example Furniture of Date Palm Leaf Midribs

no. 106

Example summary

Annual pruning of date palm's in Egypt results in a harvest of their leaves (fig 1). The midrib of this leaf is woody and can be manufactured into board with mechanical properties comparable to spruce or beech. In their row state the midribs are fabricated into a variety of products like screens and tables (fig 3).

UNEP-WG-SPD text source: Han Hegeman

Sustainable aspects

The main sustainable aspects are the use of renewable materials and it's adaptation to local circumstances (appropriate technology).

In Egypt and other Arabian countries wood is a scarce material that must be imported. However, Date Palms are abundant in these countries and, as shown in this example, can provide wood like materials. Annual pruning of the Date Palm harvests Date Palm Leave Midribs. This local material can be used itself or it can be processed into furniture board (fig 2) with local technology.

SPD opportunities

The applications of DPLM may be expanded into other area's. There may be more applications of wood for which DPLM can be an alternative in Arabian countries.

SPD Example Gourd packaging

no. 107a

Organisation:

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City: 3551 XW Utrecht

Country: THE NETHERLANDS

WWW URL:

Name contact: Mr. Jan Velthuizen

Tel: (31) 30 243 2043

Fax: (31) 40 246 6850

E-mail: jan@edc.nl

Product status:	Prototype		
Human need:	Other		
Design approach:	Renewable Materials		

1 gourds growing in moulds

2 full-grown gourd

3 gourd grown with text label

4 resulting containers

5 gourds on bathroom shelf

6 Kenyan gourd instrument

SPD Example Gourd packaging

no. 107a

Example summary

Cosmetic products are often packaged in glass or polyethylene plastic. Reuse or recycling of these is often difficult to realise. It can even be unattractive due to the high environmental impact of transport of product packaging with a low turn-over or very diffuse distribution in the economic system.

Throughout history, the gourd has served several purposes, a.o. as an instrument (fig 6) and as bottle. To serve as a bottle for cosmetics nowadays, the gourd has to be adapted to the current demands for use and transport. These gourds, designed by Jan Velthuizen en Ronald Wall, are grown into a rectangular shape (fig 1) to ease transport and storage.

The fruit, that has grown into the form, is harvested after the stalk turns woody (fig 2, 3). The gourd is dried in a warm place, in an oven, or outdoors in the sun (fig 4). Once dried the sides are woody. The gourd container is watertight by itself, but can be made waterproof through greasing with wax, oil or through painting.

UNEP-WG-SPD text source: Jan Velthuizen

Sustainable aspects

The cosmetics bottles are realised by leading gourds into geometrically shaped moulds. Text, for product information, is also possible using this technique (fig 3). The gourd is an annual plant which can be grown outdoor's so there are no heating costs. The gourd seeds contain oil which could be used in the production of the cosmetics. Even the leaves and stems could be put to use. The bottles are biodegradable.

SPD opportunities

The gourds are suitable for storing several cosmetic products like bath oils, bath salt and powder soap (fig 5), but other applications are also possible.

In warmer climates it might be possible to have two or more yields a year.

SPD Example Mussel tiles

no. 107b

Organisation:

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Country: THE NETHERLANDS

WWW URL:

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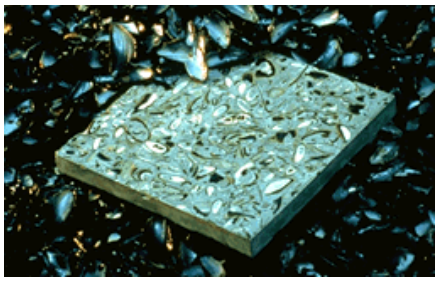
Tel: (31) 30 243 2043

Fax: (31) 40 246 6850

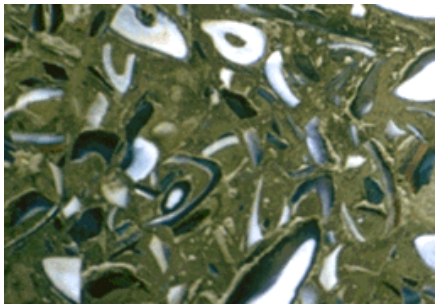
E-mail: jan@edc.nl

Product status:	Prototype		
Human need:	Other		
Design approach:	Renewable Materials		

1 mussel shell waste



2 mussel tile



3 tile detail

SPD Example Mussel tiles

no. 107b

Example summary

Mussel shells are a waste product of the sea-food industry (fig1). The shells are often stored, transported by ship and finally dumped at sea. The shells are too tough and sharp to be used in the food for poultry. From this waste tiles can be made (fig 2). The tiles consist of mussel shells and cement. Designer: Jan Velthuizen.

UNEP-WG-SPD text source: Jan Velthuizen

Sustainable aspects

The application of the mussel shells in tiles turns waste into a useful product.

SPD opportunities

The shells have a nice decorative effect when the tiles have been polished (fig3). A possible application could be that of garden tiles.

SPD Example Grammer Office Chair

no. 108

Organisation: GRAMMER Office Chairs GmbH

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Country: GERMANY

E-mail:

WWW URL:

Product status:	Available		
Human need:	Other		
Design approach:	Longevity	Life Cycle Design	Services

1 Grammer chair

2 Chair parts

SPD Example Grammer Office Chair

no. 108

Example summary

Grammer AG, a German chair manufacturer, in November 1993 presented the collection 'Natura', a new family of office chairs (fig 1). Central to the development of this group of products was the objective that a chair, its parts and the materials from which it is built should have a maximum life time. In addition, it should be fit for high level reuse and consist of environmentally benign materials only. Therefore, at the end of their life cycle, the chairs should be returned to Grammer, to ensure the reuse of parts and materials (fig 2). Grammer had to overcome some clear problems of course with regard to costs, organisation of product return and client involvement. But the company managed to resolve them.

UNEP-WGD-SPD text source: Hans van Weenen

Sustainable aspects

A 'Natura' chair has been developed to have a life of 30 years. In the purchase of the product, its takeback and reuse by Grammer is guaranteed without costs to the consumer. Where possible returned old chairs will be carefully disassembled, the old parts will be separated, tested, renewed and used in the manufacture of new office chairs. This reuse concerns 90% of an old chair. Only parts and materials that cannot be reused by Grammer have to be transported for external reuse or for disposal. The chairs consist of materials which have comparatively benign environmental properties (e.g. wood, naturally tanned leather).

At the basis of the concept is a comprehensive costs-model. In the year of sale, the company puts aside a share of the revenue in the form of a reuse budget. Of course it is difficult to predict how long it will take for a chair to be returned and what at that future time the actual costs of disassembly and reuse will be. It is also uncertain what the cost then will be of disposal of parts which cannot be reused. It is similarly difficult to indicate what the raw material, energy and production costs savings will be when parts and materials are being reused. For financing the return and the reuse or recycling activities however, only a moderate increase (2-4 %) of the selling price was found to be required. It became clear that an almost cost neutral system could be realised.

SPD opportunities

Although still some uncertainty will remain, it will gradually decrease as every year the cost model is renewed and better estimates are made. In this respect a consideration has been that with rising expenditure for raw materials and energy, as well as for waste disposal, the ecological alternative will become increasingly economical while improving Grammer's competitive position. The attractiveness of the Grammer concept is that especially those measures that make economic sense, should also be favoured from an ecological point of view. In order to keep the resources and energy costs low, office chair parts and materials must be reused and reintroduced into the production process, thus at the same time reducing emission and waste disposal costs as well.

It has been relatively difficult to involve the suppliers in the new concept. But the 'Natura' collection proofs that it can be done. In the mean time already existing chair programmes of Grammer have been adjusted accordingly.

SPD Example Maderon Almond Chair

no. 109

Organisation: Oficina de Promoción Maderón

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Fax: (34) 3 268 3569

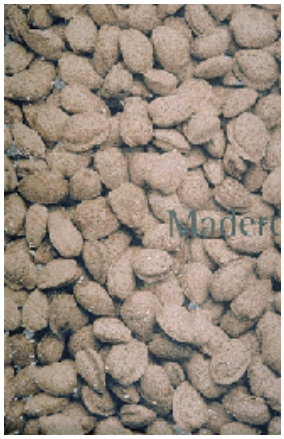
Country: SPAIN

E-mail:

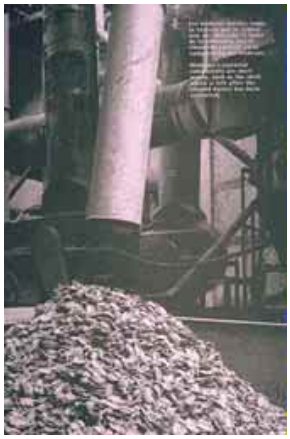
WWW URL:

Product status:	Available		
Human need:	Other		
Design approach:	Renewable Materials		

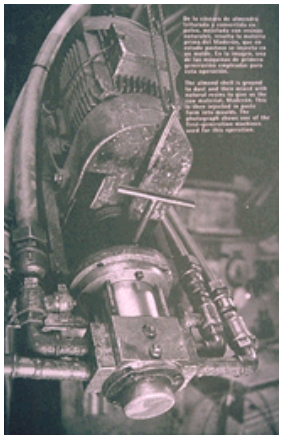
1 Maderon chair



2 Almond shells



3 pulverised shells



4 press-moulding

SPD Example Maderon Almond Chair

no. 109

Example summary

The Almond chair, designed by Alberto Lievore, is made from almond shells, a renewable material. (see fig 1)

UNEP-WG-SPD Text Source: Nick Mahony

Sustainable aspects

The shells (fig 2), an agricultural by-product, are pulverised (fig 3) and mixed with natural and synthetic resins and using pressure and heat the almond past is press moulded (fig 4) and transformed into a solid and rigid product retaining the shape of the mould. The resulting material, called 'Maderon', combines many of the qualities of wood with the advantages of plastics manufacturing technology.

Material Choices

Clearly Maderon is a renewable material; it also seems to be from a source that's sustainable - the basic wood-like ingredient is available annually and may be collected without damaging the source: wood without harming the tree.

The Almond chair, designed by Alberto Lievore, is made from almond shells, a renewable material.

SPD opportunities

Potential applications for the material come from it's aesthetic quality, tactile and environmental characteristics. These make this technology ideal as a wide ranging material substitute for the fossil-fuel (non-renewable) plastic contents of many products.

According to the producer synthetic as well as natural binder can be used. Clearly, from the point of view of renewable materials for SPD the natural binders are preferred over the synthetic ones.

SPD Example Open Solar Cooker

no. 110

Organisation: Solar Cooker International (SCI)

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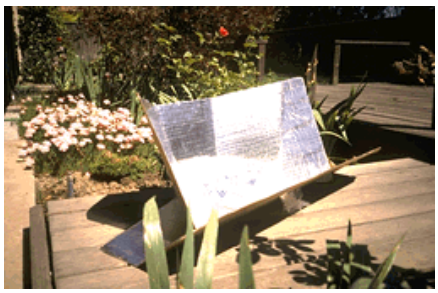
Country: U.S.A.

E-mail: sbci@igc.apc.org

WWW URL: http://www.accessone.com/~sbcn/index.htm

Product status:	Available		
Human need:	Heating	Use of Water	
Design approach:	Renewable Energy		



1 open solar cooker

2 foods

3 collecting wood

4 local trainer

5 teaching neighbours

SPD Example Open Solar Cooker

no. 110

Example summary

The new, open solar cooker (1) is a streamlined hybrid of parabolic and oven-type solar cookers, which is clean, safe, low-cost, easy to make from varied materials, and user-friendly. It consists of a reflective panel and a plastic bag, and is used with any dark cooking pot. In sunny climates it can save families up to half of their traditional cooking fuel, reducing wood consumption to sustainable levels. It also easily pasteurises drinking water to reduce water-borne diseases, a major killer of children in many poor countries.

SCI provides training and assists adaptation of the simple device to varied climates, foods (2), cooking pots and cultures. SCI is an international information clearinghouse on solar cookers use, technology and dissemination.

UNEP-WGD-SPD text source: Kevin Coyle

Sustainable aspects

The simple open solar cooker uses solar energy; it thereby helps reduce wood consumption for cooking meals to sustainable levels. Reducing the need for wood also lightens the burdens and costs for the many women in poor countries who must gather and carry heavy loads of wood ever greater distances, even when they are pregnant, nursing infants, or elderly (3).

This solar cooker can be made of a wide variety of recycled and recyclable materials; it can be introduced and adapted to local needs with a training process which empowers local women to become trainers of others (4). In a pilot project in Kenyan refugee camps, refugee women themselves are now spreading solar cooking skills to their neighbours (5).

Solar cooking reduces smoke and related lung diseases; it is free from soot and foods don't burn or stick to the cooking pot, thereby saving food, soap and labour. This solar cooker promotes health: it is safer than open fires, it can pasteurise water, and also retains vitamins in the foods cooked.

SPD opportunities

There is a continuing need to adapt this simple technology to local, diverse needs and conditions. It can be readily produced at or near areas of use with minimal technical skills, though aluminium foil and plastic bags - or suitable substitutes - may need to be imported. This solar cooker is compact, convenient, and one of the most affordable: its cost of production is $3 to $5 US.

Education for women on its use is essential for it to be readily useful to those who can't afford to take any risks with scarce food. Adoption of solar cooking and its usefulness for refugees is now documented; we are just beginning to test its usefulness in settled communities. Its potential for use in emergencies and disaster relief is also great.

Larger models and other types of solar cookers have considerable potential in institutions such as health centres (sterilising medical supplies and heating water) and schools (cooking food), and have been used in businesses (bakeries, processing honey, silk production, dyeing fabrics, heating paint, etc.). Basic prototypes have been developed, but there is need for regional adaptation and production.

SPD Example Plant marker of PHB

no. 111

Organisation: Proterra

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Fax: (31) 31 7467 660

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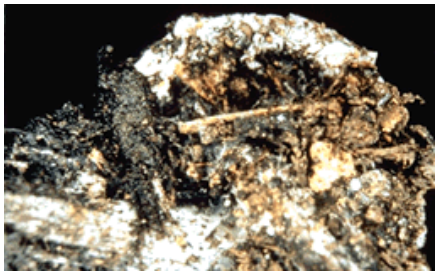
WWW URL:

Product status:	Available		
Human need:	Other		
Design approach:	Renewable Materials		

1 plant markers of PHB



2 biodegradation of PHB

3 other PHB products

SPD Example Plant marker of PHB

no. 111

Example summary

The garden plant-marker (fig 1) illustrates the potential of renewable materials. It is made of a biodegradable polymer called polyhydroxybutyrate (PHB) and the ink is soya-based. After approximately 9 months, the season of any annual plant, the marker begins to rot naturally in the soil (fig 2). This plant-marker example is estimated to save 650 tons of conventional oil-based thermoplastic waste per year.

The plant marker has been developed by Jorn Behage of Kiem Design for ’Fleurmerc’ with technical assistance from ICI Zeneca, the former manufacturer of 'Biopol'. 'Biopol' is the brand name for the PHB polymer of which the plant-marker is made. Some time ago this ICI department together with the brand name 'Biopol' has been taken over by the Italian company Monsanto. So, PHB is now brought on the market by Monsanto under the brand name 'Biopol'.

UNEP-WG-SPD text source: Proterra

Sustainable aspects

The most important element from a sustainable development point of view is that the plant-marker is made of the renewable material PHB. PHB polymer is produced by the fermentation of sugar feed stock such as sugar beets and cereal crops by naturally occurring micro-organisms.

Rolled PHB sheet is platen cut into the marker which biodegrades after approximately 9 months. This depends on circumstances like the amount of moisture available. The printing ink used for the label information is soya-based - another renewable resource.

SPD opportunities

Biopolymers made from renewable resources that are biodegradable can be used for numerous other products. Other existing applications are medical applications such as stitches that dissolve after a few days (or weeks).

The biodegradability of the biopolymer from renewable resources varies depending on the circumstances. They are not suited for (very) long-life products. The 'Biopol' based on sugar is firm enough to make clockworks or even packaging of products like shampoo (fig 3). Not until the shampoo bottle is thrown way together with normal organic household waste it degrades and can be turned into compost. For packaging of shampoo PHB is well suited as a takeback system is difficult to achieve due to a low turn-over rate.

The biodegradability of the biopolymers adds a new functional possibility to the product. This makes it possible to design biopolymer products in which the ease of use is combined with achieving environmental goals. For instance, consumers need not be bothered with returning dozens of different packaging bottles for reuse with when they can be composted altogether in the household waste.

A disadvantage may be that the biodegradability can encourage people to use more throw-away products in stead of reusable products as “they degrade anyway”. Also, a number of throw-away products have appeared on the market that were partly biodegradable, as they were partly made from regular oil-based plastics like polyethylene (PE) of polypropylene (PP). Throwing these away in nature causes the same problems as normal plastics. For instance, birds accumulate the small plastic remainders in their stomach.

Finally, biodegradable plastics can also be made from non-renewable resources. From an environmental point of view this is not preferable, as a good opportunity to use renewable resources is missed.

SPD Example Trehalose-based vaccine formulations

no. 112

Organisation: Quadrant Holdings

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Country: UNITED KINGDOM

E-mail:

WWW URL:

Product status:	Prototype		
Human need:	Cooling		
Design approach:	Life Cycle Design		

1 vaccine administration

2 Cryptobiotic Artemia Salina

SPD Example Trehalose-based vaccine formulations

no. 112

Example summary

Quadrant, a health care technology company,utilises the unique properties of a substance called trehalose during drying and subsequent storage at room temperature. This results in products which are stable even in high relative humidities and at high temperatures.

In collaboration with vaccine and pharmaceutical company Chiron Biocine, Quadrant develops a combination vaccine for the treatment of diphtheria, tetanus and whooping-cough (pertussis) in children (fig 1). The Trehalose-based formulation technology will be applied to the combination vaccine in order to enhance stability whilst in storage and during transportation at high temperature, thereby eliminating the need for a cold chain.

UNEP-WG-SPD text source: Rebecca Oxenford

Sustainable aspects

Millions of years ago organisms evolved with a drought-survival system based on Trehalose. An example of such a “cryptobiont” organism are the embryos of the brine shrimp Artemia Salina (fig 2). In 1674 Antonie van Leeuwenhoek describes the existence of cryptobionts. In 1985 Quadrant demonstrated the stabilising effects of trehalose at ambient temperature. Recently, the first applications have been realised of the so-called Q-T4 technology. This technology seems very appropriate for formulation of vaccines.

Because vaccines are perishable, a logistic network of refrigeration and transport is needed to deliver vaccines. These networks, called “cold chains”, require a big effort, especially in rural areas throughout the world. In Papua New Guinea vaccines are transported over land for two weeks by porters who store them in gas refrigerators that are held on bamboo poles. In Nigeria, motor launches take white “cold chain” boxes upriver. On the Afghan-Pakistan border, they are packed with ice and stored in caves.

The WHO (World health Organisation) has developed several ways to improve these cold chains. For areas without electricity a refrigerator has been developed which is lined with water-filled tubes that can make enough ice in eight hours to store vaccines safely for up to a 16-hour lapse of electricity. Also, solar-powered refrigerators have been developed for this purpose. Another improvement is a chemical monitor which indicates whether a vaccine is still fresh or not.

The ultimate goal of the WHO however is the elimination of the cold chain itself. This would save energy and at the same time ensure better quality of vaccines by reducing transport and storage failures. This may be achieved with the Trehalose-based vaccine formulation. Thus manufacture is cheaper than that of conventional vaccines and no refrigeration is required for storage or distribution.

SPD opportunities

At the moment Quadrant and Chiron Biocine develops combination vaccine for the treatment of diphtheria, tetanus and whooping-cough (pertussis) in children with the Trehalose formulation. Quadrant is currently working with six partners to provide safer, stable products. The technology can also be used to stabilise other pharmaceuticals or diagnostic reagents.

SPD Example Sandals made of palm tree leaves

no. 113a

Organisation:

Name contact: Ms. Iris Eyal

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Tel: (972) 2 6434 820

City: 96265 Jerusalem

Fax: (972) 2 6434 820

Country: ISRAEL

E-mail:

WWW URL:

Product status:	Available		
Human need:	Clothing & Textiles		
Design approach:	Renewable Materials		

1 Date palm tree

2 Bedouin sandals

SPD Example Sandals made of palm tree leaves

no. 113a

Example summary

Sandals made of palm tree leaves (fig 1), a 'Renewable Material', have been produced by the Bedouins living in the Sinai desert. Sandals made of palm fibres, dating back to the Roman period were found in Syria.The sandals, part of the Bedouin 'Clothing' (fig 2), are hand-made. The use of this 'Material' can contribute to 'Waste Reduction' in the date palm industry by utilising by-products.

UNEP - WG - SPD Text Source: Iris Eyal

Sustainable aspects

The lower leaves of the palm tree dry out and have to be cut once a year. After separating the small leaves from the spine, they are dried and then woven to form the sandals. The production is done by hand, using no fossil energy. No external binders are added to the material and the parts are joined using the same material. Therefore this product can easily be recycled as organic waste or used as non pollutant fuel.

SPD opportunities

Sandals are widely used in the Mediterranean countries during the hot summer. Some of them, particularly the beach sandals, are made of plastic. The palm leaves sandals can replace those, providing a light, airy, comfortable solution.

SPD Example Baskets and containers made of date palm leaves

no. 113b

Organisation:

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Country: ISRAEL

WWW URL:

Tel: (972) 2 6434 820

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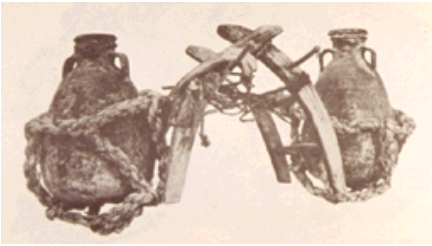
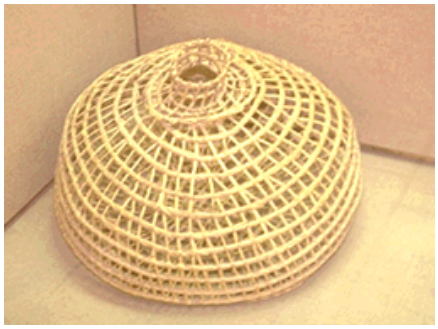
E-mail:

Product status:	Available		
Human need:	Other		
Design approach:	Renewable Materials		



1 Camel back baskets



2 Date palm basket

3 Different basket models

4 mat

5 Baskets and mats

SPD Example Baskets and containers made of date palm leaves

no. 113b

Example summary

Baskets and containers made of woven date palm leaves, a 'Renewable Material', were made by Jews living near the Dead Sea at least 2000 years ago. Very similar products are currently produced and used by the Bedouins, a nomad society, living in the Sinai desert, for transporting their belongings when moving from one area to another (fig 1, 2 ,3). The baskets are hand-made. The use of this material can contribute to 'Waste Reduction' in the date palm industry.

UNEP - WG - SPD Text Source: Iris Eyal

Sustainable aspects

The lower leaves of the date palms dry out and have to be cut once a year. This also enables access to the fruit. The leaves are used for different products. The small leaves are seperated from the central part, dried and then hand woven (figure) to form long strips (fig 4). Those are connected to each other with a thread made of the same leaves, according to desired shape. The basket is strengthened by a vertical rope made of the tree fibres.

This technology does not use fossil energy. No glues or binders are added to the material and the joining is done with the material itself.

These baskets are produced from renewable material from a sustainable source - the palm leaves are available annually and this production uses the tree without harming it. Using only a single component these products can easily be recycled as organic waste. They can also be used as a relatively low pollutant fuel.

SPD opportunities

More applications for this material and technique may be found to fit the need for containers in the domestic environment such as waste paper baskets, shopping bags, etc. These are often made of non renewable materials like plastic. In order to be able to mass produce these products it is essential to consider an industrial manufacturing process.

Other products made of the smae material and using the same technology are:
* Baby carrier (fig 3 front)
* Mats (fig 4, 5)
* Portable chicken pens with a little door in front, allowing to carry chicks and ckicken on the camel back
* Fan with a handle made of the leaves spine
* Fly swat
* Basket to catch fish

SPD Example Exhibition "from Doom-thinking to Do-thinking"

no. 114

Organisation: European Design Centre b.v. (EDC)

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WWW URL:

Product status:	Available		
Human need:	Communication		
Design approach:	Positive Elements		

1 resources
(gourds and packaging)

2 production
(vacuum cleaner)

3 production
(television)

4 consumption
(coffee machine)

5 recycling

SPD Example Exhibition "from Doom-thinking to Do-thinking"

no. 114

Example summary

"From Doom-thinking to Do-thinking" is a project by Studium Generale of the Technical University Eindhoven (TUE), the European Design Centre (EDC) and the Academy for Industrial Design Eindhoven (AIVE). The aim is to give companies and public organisations insight into the various possibilities to improve the environmental performance of products during the life cycle. It also aims at offering consumers an overview of existing "green" products.

With an active environmental policy companies not only contribute to a reduction of pollution, but often it also contributes to commercial success. A sound environmental care system prevents levies and saves energy and materials. So good housekeeping saves money. Also the environmental innovation of processes and products often saves costs and generates profits. Especially in the long run, because in future environmental legislation will only be more tight and the demand for green products will grow. Companies with a pro-active approach take a lead because they anticipate to new markets. Environment and innovation go hand in hand.

The exhibition shows fifty examples of products with less environmental impact during one or more phases of the life cycle. It shows examples of design offices and industry, both big and small. The exhibition also presents methods, guides and software for environmental product development. These are the first steps towards sustainability and - just as the exposed products - examples of Do-thinking in stead of Doom-thinking.

UNEP-WGD-SPD text source: Jos Brouwer

Sustainable aspects

Sustainable aspects are the life cycle as a subject, travelling of the exhibition and the composition of the exhibition.

The life cycle

Products go through a life cycle. From the winning of raw materials (fig1), via the processing into materials and parts and the manufacturing into finished products (fig 2, 3). After assembly products are packed and distributed. During consumption (fig 4) the product is used, and sometimes reused. In recycling (fig 5) materials are processed into raw materials that are fit for new life cycles. Each phase takes energy and causes waste and pollution. The combination of these effects, from cradle to grave, determine the environmental impact of a product. The life cycle forms the basis of this exhibition. In each stadium of the life cycle products with less environmental impact in that phase are exposed.

The travelling exhibition and it's composition

The exhibition is a travelling exhibition, which is shown at different places. Advantages are that the exhibition is reused a number of times and people can visit the exhibition when it is nearby. Also in the composition of the exhibition the environmental impact is taken into account. The walls of the exhibition consist of fifty "econoboxes": reusable boxpallets from recycled plastic. The information stand was equipped by Wilkhahn with Picto chairs. Wilkhahn has obtained the dutch ecolabel for the office chair named "Picto".

SPD opportunities

In the exhibition about 50 product examples are shown in which design bureaux and manufacturers have made environmental improvements in one or more phases of the life-cycle. The lay-out of the exhibition is inspired on this life-cycle from raw materials to recycling. Also a part shows the current methodologies and manuals for ecodesign.

Because of the physical presence of the products, the attractive presentation and because of the clear and concrete explanation, industry and users are convinced of the importance of ecodesign and the (business) opportunities it offers.

SPD Example Compwood compressed wood bending

no. 115

Organisation: Compwood Machines Ltd. A/S

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Fax: (45) 3154 5066

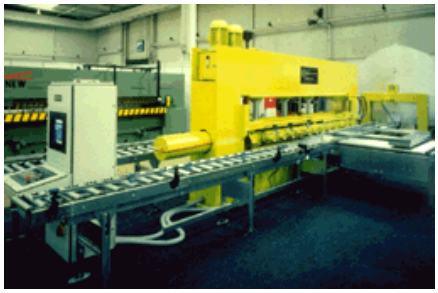
Country: DENMARK

E-mail: 101625.3502@compuserve.com

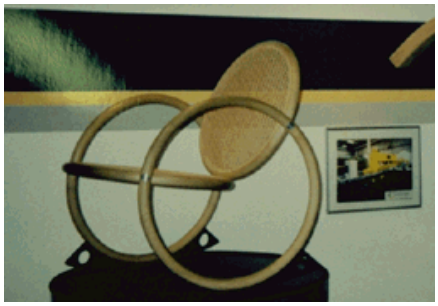
WWW URL:

Product status:	Available		
Human need:	Other		
Design approach:	Renewable Materials		

1 Compressed bent wood



2 Compwood™ System



3 Chair of compressed wood

4 Chair of compressed wood

SPD Example Compwood compressed wood bending

no. 115

Example summary

Compwood Machines Ltd. are the exclusive manufacturers of the so called Compwood™ Systems for compressing of solid wood in preparation for bending. During the process wet timber blanks are heated to 100 degrees Celsius whereby the timber becomes "plastic". After heating the wood is compressed in the longitudinal direction to approximately 80% of the original length.

When the pressure is relieved the wet plank seeks back to the original length but maintains a permanent length reduction of about 5 %. All the axial fibres have now folded walls, just like the folds in a concertina. The wood can now - also like the folds of a concertina - be bent in any direction (fig 1). The wood can also be packed in plastic, where after it can be stored for several months before usage. After bending the wood in the desired shape it has to be fixed during drying. After drying the wood regains it's original stability and strength and can then be processed like normal wood.

Figure three and four show the kind of chairs that can be made with the bended wood.

UNEP-WG-SPD text source: Compwood Machines Ltd.

Sustainable aspects

The compression gives a number of advantages compared to traditional steam bending. Compressed wood can be bent in sharper curves, in several dimensions and can be bent in hot and cold condition. You also have considerable less amount of wood waste, which means less processing (planing, sanding etc.) and also less clamping marks. The tools required for the bending of compressed wood are lighter and less complex than the tools required for bending traditional steamed timber. Actually many shapes can be bent by hand without any tools at all.

Compwood has so far been successful with compressing Beech, Oak, Ash, Maple, Elm, Cherry, Walnut, Malaysian Rubber wood and also certain Eucalyptus species.

SPD opportunities

Compwood Workshop is a department of Compwood Machines Ltd. The concept with this workshop is to inform the Danish and international wood industry about the compressed wood process. In the workshop a complete Compwood™ System (fig 2) is in operation which daily turns out compressed wood. The workshop is fully equipped with drying chamber and recently also various woodworking machines have been added with which semi finished fumiture parts can be made.

The Compwood™ System addresses itself first and foremost to larger furniture manufacturers, but also sawmills and timber distributors can with a Compwood System supply many small furniture factories and other wood industrial companies, which do not necessarily have a need nor means to install a Compwood System themselves, with compressed wood. Consequently a sawmill or merchant can with a Compwood System raise their product level from a simple wood plank to a "high-tech" product.

SPD Example Rustic potato storage

no. 116

Organisation:	Society for the Development of Appropriate Technology SOTEC	**Name contact:**	Mr. P.S. Chowfin
Street:	P. O. Box 75	**Tel:**	(91) 581 472 138 / (91) 581 2519196
City:	Bareilly 243001	**Fax:**	(91) 581 457 180 / (91) 581 472758
Country:	INDIA	**E-mail:**	
WWW URL:			

Product status:	Available		
Human need:	Cooling		
Design approach:	Renewable Energy		

1 rustic potato storage

SPD Example Rustic potato storage

no. 116

Example summary

In India, there are various village level storage systems mainly for grains. This particular project came into being when it was noticed that every few years there was a glut of potatoes in the major potato growing region of North India and because of their inaccessibility to cold storage the small farmers were compelled to go for distress sale of their produce causing them severe economic losses. SOTEC therefore came up with 2 concrete ideas of a) Storage and b) Processing by drying the stored product (potatoes) for viability. Here we will deal only with the storage part.

The profitability of the village units is greatly reduced or eliminated unless potatoes for processing are purchased at the peak of the harvest and stored during the drying season. Therefore, it was necessary to design an inexpensive, practical way to store 60 metric tons of potatoes to be processed over 90-120 days. A passive evaporative storage building, which we call a rustic store was developed.

Sustainable aspects

The rustic store, a passive evaporative storage building, was developed for bulk storage of up to 20 tonnes of potatoes piled 1 meter high on a slatted floor. The walls are of mud and roof of thatch. These are typical village construction materials and techniques for this region. The base of the building is a flat, cement plastered, brick platform, with a 4 inch high rim around the outside edge so that it will hold water. Bricks are placed on this platform in a way that allows air to flow in all directions and will also support a split bamboo floor. A fine chicken wire mesh is stretched over the bricks but under the bamboo floor and another from wall to wall at ceiling level to keep rodents out.

The rustic store developed by SOTEC is a cheap alternative to cold storage. The cost of constructing of a rustic store (in Indian Rs.) is a Rs. 650/tonne, i.e., Rs. 13,000 per 20 tonne capacity store.

Crops such as potatoes, onions and garlic can be stored for up to four months without using any kind of energy and sold off when the market price is high. In the winters, these stores can be used for cultivating mushrooms, a crop that requires very little management, but which is highly profitable. Potatoes from the rustic store process better than those from the cold store. During the off season, the store can be used for other crops, like onions, garlic and also for mushroom cultivation.

SPD opportunities

SPD Example Fasal biowood products

no. 117

Organisation: Interuniversitäres Forschungsinstitut für Agrarbiotechnologie

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City: 3430 Tulln

Country: AUSTRIA

WWW URL:

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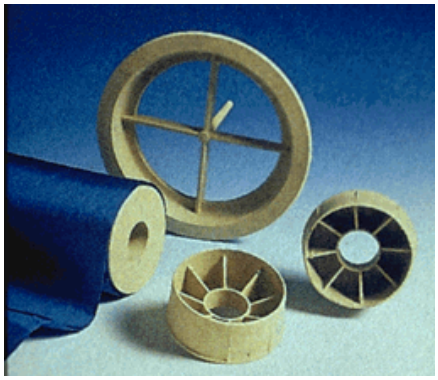
Fax: (43) 2272 6628 0303

E-mail: wimmer@ifa1.boku.ac.at

Product status:	Prototype		
Human need:	Other		
Design approach:	Renewable Materials		

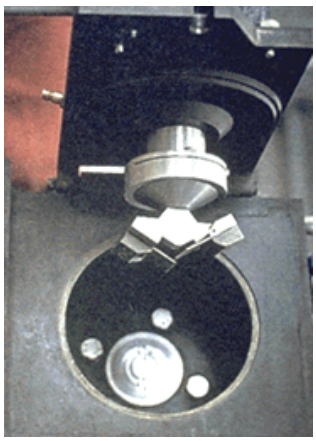
1 Biowood granulate and products

2 Biowood pin and key-ring

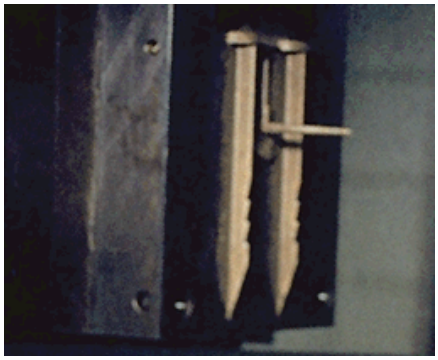


3 Some technical parts

4 Mixing process



5 Granulating machine



6 Injection moulded part

SPD Example Fasal biowood products

no. 117

Example summary

The Institute for Agrobiotechnological research in Austria is developing injection moulding techniques for use with a granulate of the renewable resources wood and corn. The granulate is a mixture of wood fibres and maize, in which the major part consists of wood, e.g. 65%. Other resins can be added to attain specific properties.

The granulate has proven to be suitable for injection into moulds. After mixing (fig 4) and extrusion (fig 5) the resulting granulate can be used for injection moulding (fig 6). The resulting products (fig 1, 2, 3) can be components like door handles, latches or packing boxes for example. The advantageous properties of wood are combined with the easy workability of synthetics, allthough no synthetics can be found in the finished products.

The finished components have properties similar to those of wood, including the pleasant surface touch, the adhesive property, and the mechanical workability, such as suitability for drilling, cutting, milling, screwing and nailing. The surface can be worked and finished just like wood.

Sustainable aspects

Biowood is composed entirely of renewable natural resources, primarily wood and corn, both of which are a familiar part of the pastoral landscape, and thus readily available. The major component is waste wood in the form of wood shavings or sawdust. To this, a row of secondary constituents are added, including ground corn, natural resin and small amounts of other naturally occurring and renewable raw materials. Biowood can also be tinted using inorganic, environmentally neutral pigments. It is also possible to use other renewable fibres beneath wood.

SPD opportunities

The characteristics of the Biowood combine the best attributes of natural wood with the processing advantages of plastic. It can be moulded into shapes, which natural wood could never cost-effectively achieve. Many products and product parts that are now being made of plastic could in the future be made of Fasal. Whereas plastic parts outlive the products into which they are built, products made of Fasal wiil be environmentally friendly. After their useful lifetimes, they can be safely disposed of either by burning or natural decomposition.

SPD Example Rattan bicycle

no. 118

Organisation: Lixeha

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Fax: (84) 4 8517617

Country: VIET NAM

E-mail:

WWW URL:

Product status:	Available		
Human need:	Transportation		
Design approach:	Renewable Materials		

1 Rattan bicycle
© Lixeha

2 Man's model
© Lixeha

3 Woman's model
© Lixeha

SPD Example Rattan bicycle

no. 118

Example summary

The aim for this rattan bicycle is to replace metal parts by rattan as much as possible. The front baskets, fenders, chain-covers and grips are 100% rattan. The pedals are partly made of rattan. Covered by rattan are:
* frames (rattan tube)
* saddle (woven rattan)
* forks, handle bars, luggage carriers, fender stays (wound rattan)

The frame is covered by rattan tubes because the rattan tubes themselves were found to be not strong enough for a bicycle frame. So, the rattan is at the moment applied in a limited number of parts. Apart from that the rattan is used as a decorative metarial to create an attractive “return ot nature” design for users. Man’s models as well as woman’s models are available (fig 2, 3)

UNEP-WG-SPD text source: Han Hegeman

Sustainable aspects

These bicycles show that the renewable resource rattan can be used in several parts of a bicycle. The basic construction and mechanism are the same as for a conventional metal bicycle. For instance, it has not been possible so far to use rattan for the frame as this is a demanding construction.

The life span of a rattan bicycle maybe shorter, because rattan parts can be damaged earlier. This depends on the environment (moisture) and maintenance. Rattan takes 10 to 15 years to grow before it can be harvested. 10 to 15% of the harvest can be used for making bicycles. The rest has to be used for other purposes.

All rattan parts are treated to prevent wrap and shrinkage. The rattan has been selected sufficiently old so it rarely shrinks. Boiling in fuel oil and sulophur smoking are next steps. After assembling all rattan parts are filmed with transparent glue. The exact composition of the glue is not known.

SPD opportunities

The bicycles shows that a renewable resource like rattan can be used for more than baskets and chairs. Some questions at this time are what kind of material is used to treat the rattan and what is their environmental impact.

Furthermore, it would be interesting to know wether the rattan can be applied to even more parts of the bicycle.

SPD Example Small-scale windpump technology transfer

no. 120

Organisation: IT Power Ltd

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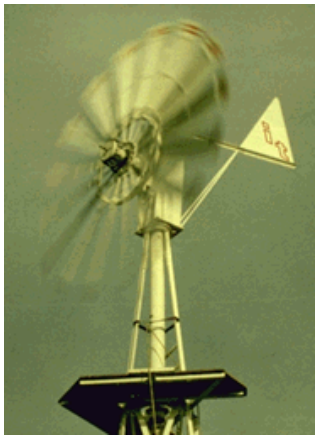
Country: UNITED KINGDOM

E-mail: itpower@gn.apc.org

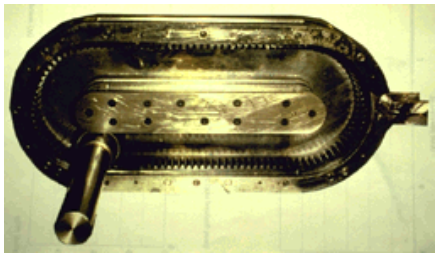
WWW URL:

Product status:	Demonstration		
Human need:	Use of Water		
Design approach:	Renewable Energy		

1 Small windpump test
© IT Power Ltd



2 Rotor close-up
© IT Power Ltd



3 innovative gearbox
© IT Power Ltd

SPD Example Small-scale windpump technology transfer

no. 120

Example summary

IT Power has developed an innovative design of mechanical water-pumping windmill (fig 1, 2). This windpump is aimed at meeting the water supply needs of farmers and small communities in developing countries (by utilising renewable energy through appropriate technology), several of which have a suitable wind regime for utilising windpumps, but do not have a suitable product. Many existing windpump designs are inappropriate for production and sustainable use in less developed areas.

The new IT Power windpump design seeks to produce an optimised design using modern design methods and local material use to combine excellent performance with ease of manufacture, low maintenance and high reliability. The design is being licensed to developing country manufacturers.

Windpumps are well established and understood in some regions around the world but they tend to be used only in areas where they are a familiar technology through having been in general use for many years. The most common application by far is lifting of drinking water for livestock (usually cattle or sheep) and/or for small human settlements. The main justification for using windpumps is the need for high reliability in pumping water with limited human intervention.

Windpumps have failed to reach vast areas where a potential market exists. This appears to be because most commercially manufactured windpumps presently available, although effective when correctly installed and maintained are generally obsolete in design, so they tend to be heavy, more expensive than necessary and difficult in terms of the skills and effort needed for successful installation and maintenance. They are also generally produced by smallish agricultural engineering companies with quite a low profile which do not tend to promote their products outside their immediate local market.

The current work, to produce a pre-production prototype and to commence the technology transfer, is supported by the UK Overseas Development Administration. The aim has been to develop the lessons learnt in testing the first prototype and incorporate them into a design for a 1.8-2.0m machine. If you are interested in the manufacture of this new machine, or would simply like to be kept informed of the project progress please contact Frances Crick.

UNEP-WG-SPD text source: Frances Crick

Sustainable aspects

Windmill pump design

The new windpump is innovative in having a form of epicyclic rack transmission mechanism, a novel development of a simple rack and pinion, (patented) that produces a quasi-constant torque load (combined with speed reduction) which addresses the start-up problem common to conventional crank driven windpumps (fig 3). This problem demands significantly higher wind speeds for starting than to keep the system running due to the fact that the starting torque requirement is generally in the order of 300% of the mean running torque. The new mechanism is expected to offer useful improvements in performance either by reducing the cut-in wind speed for a given pump size and head, or by allowing a larger pump size to be used for a given cut-in wind speed. It is also mechanically simple as it only requires two rolling element bearings plus two more to support the rotor.

The new IT Power windpump can be manufactured in a range of rotor sizes. The design tip-speed ratio is 1, which we believe offers good starting torque characteristics with a minimum amount of material, hence reducing weight and cost.

The tower is fabricated from steel angle section. It is three cornered, offering a small but useful economy in materials and construction compared to a four cornered one. The tower is hinged at the base to allow the whole machine to be assembled horizontally at ground level. It is raised using an A-frame and hand operated winch.

Technology transfer

One of the key aspects of any technology transfer project in the involvement of the technology recipient at an early stage. For this project the recipients will be manufacturers in developing countries.

Following a publicity campaign to find potential manufacturers interested in the new design, six were selected from the many that responded. Representatives from these six organisations (from Zimbabwe, Botswana, Indonesia, Mongolia and two from India) were invited to the UK for a demonstration seminar. The purpose of this seminar, held in July 1994, was for the potential manufacturers to see the prototype and to discuss and evaluate the design and the opportunities for technology transfer. Participants were also asked to report on their interest in windpumping, their view of the market in their own country, their company and its capabilities.

The participants of the seminar concluded that the new IT Power small windpump design was very interesting and that they were all interested in collaborating on further work, leading to their companies manufacturing and marketing a production model of the windpump. In addition to the collaborators already identified IT Power is keen to licence manufacture of this new machine to parties other than the initial project collaborators.

SPD opportunities

The prototype is being developed further in the following steps:

Production of next stage design (for smaller machine, 2.0m rotor diameter) from present design;
Continued discussion with potential commercial collaborators;
Construction of a second stage prototype;
Testing of a second stage prototype;
I T Power visits to commercial collaborators;
Prototype manufacture by commercial collaborators;
Preliminary results from commercial collaborators;
Concluding discussion incorporating recommendations for the future;
Licensing the design to further interested parties beyond the original collaborators.

SPD Example Fleming hydro-ram water pump

no. 123

Organisation: The Ram Company, Dept. EH

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Tel: (1) 804 277 8511

City: Lowesville, VA 22951

Fax: (1) 804 277 8333

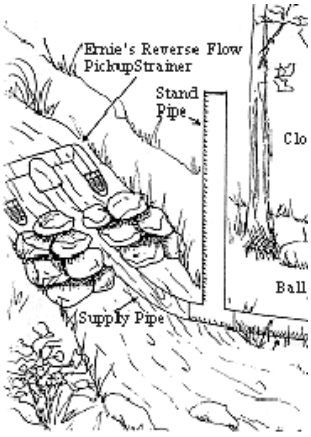
Country: U.S.A.

E-mail: RFlem68328@AOL.COM

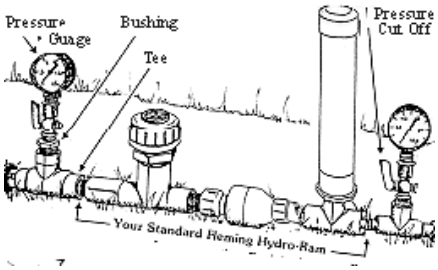
WWW URL: http://www.ibt.net/ramco/

Product status:	Available		
Human need:	Use of Water		
Design approach:	Renewable Energy	Longevity	

1 waterfall



2 ram pump inlet



3 the ram pump

SPD Example Fleming hydro-ram water pump

no. 123

Example summary

Hydro-rams pump water uphill without using any outside form of energy other than the renewable resource of water flowing downhill.

Dependable, efficient, low-cost and light weight, Fleming Hydro-ram pumps are designed to meet homestead and agricultural water needs. They are used worldwide to pump water uphill where there is a falling stream or a reservoir producing a minimum "drop" or "fall" of water to the pump of 0.6 meter (2 feet).

Sustainable aspects

They can pump water uphill as much as 10 times the "fall" of water to the pump. Example: with 1 meter (3-1/3 feet) head, they can pump water uphill as high as 10 meters (33 feet) ...all without using any outside energy. Uses include providing water to homesteads; watering animals, gardens, farms, and orchards; for drip irrigating crops, keeping cattle out of the creek, etc. With only 2 water-lubricated moving parts, Fleming Hydro-ram pumps provide long-life with little or no maintenance. They are simple to set up and use and are very effective water pumps.

SPD opportunities

Fleming hydro-ram pumps can be licensed for production in host countries.

SPD Example Electricity producing window

no. 124

Organisation: Swiss Federal Institute of Technology

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City:

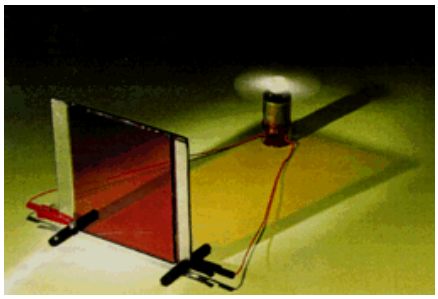
Fax: (41) 21 693 6100

Country: SWITZERLAND

E-mail: augustin.mcevoy@dcqm.epfl.ch

WWW URL:

Product status:	Concept		
Human need:	Other		
Design approach:	Optimized design	Renewable Energy	



1 Cell prototype
powerin a small fan

SPD Example Electricity producing window

no. 124

Example summary

Windows could be letting in light , as well as providing us with power. A team of chemists led by prof. Michael Graetzel at the Swiss Federal Institute of Technology in Lausanne has made a breakthrough in their pioneering design of a transparent solar cell (fig 1). The transparent cell prototype now converts 10 percent of the energy in sunlight into electricity. Allthough this cannot yet match the efficiency of commercial silicon-based solar panels, it is estimated that these cells will cost only a tenth as much.

UNEP-WG-SPD @ text source: Han Hegeman

Sustainable aspects

Both types of panel rely on the photoelectric effect. The current they produce is created when electrons bound within atoms are liberated by incoming light. In conventional solar cells this takes place within silicon structures making use of semi-conductors. The transparent cells make use of a redox process, which is more like the natural photosynthesis process in plants.

These cells rely on an electrolytic process between two panes of glass. The inside surface of the glass is coated with a titanium dioxide film and on top of it is a layer of photosensitiser chemical. The photosensitiser harvests the sunlight and the titanium dioxe film harvests electrons and transfers them to and from an external circuit.

To what extent the environmental aspects of the material use of the transparent cells compares to the conventional silicon ones is unclear at the moment. The transparancy however make a unique optimised design possible by combining the energy production with regular windows.

SPD opportunities

The estimated low cost of the transparent cells can provide a huge potential in developing countries with sunny climates. Up till now the cells have been used in solar-powered watches, in which the glass of the watch is providing it's energy at the same time. One promising potential development is the use of the transparent solar cells in windows. A keen choice of the photosensitiser chemical is essential. The substance should capture the infra-red light to use it for electricity production and it should let the visible light enter the building for normal lighting purposes.

An additional advantage would be that less heat from the sun is entering the building, because the infrared light is captured in the window for electricity production. This may reduce energy use for cooling in hot sunny climates.

SPD Example Xerox eco-serie copier chain management

no. 125

Organisation: Rank Xerox (Nederland) Manufacturing B.V.

Name contact: Rens Hendrikx

Street:

Tel:

City: VENRAY

Fax:

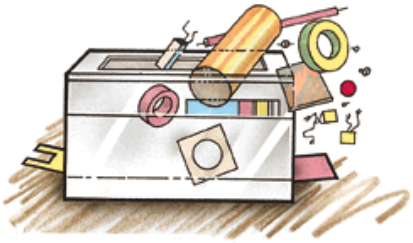
Country: THE NETHERLANDS

E-mail: Rens.Hendrikx@RXV.RX

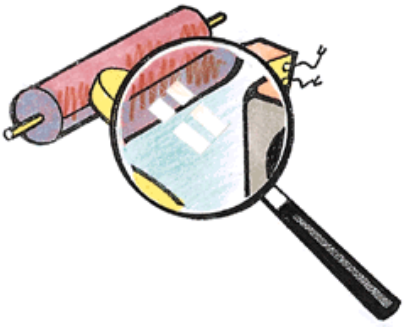
WWW URL:

Product status:	Available		
Human need:	Communication		
Design approach:	Life Cycle Design	Services	Longevity

1 Xerox eco-serie copier

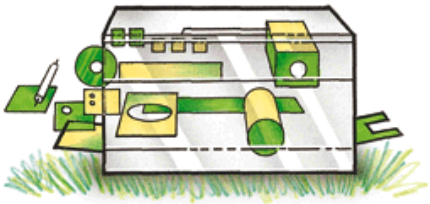


2 dismantling



3 testing for reuse

4 recycling



5 assembling

6 shipping

SPD Example Xerox eco-serie copier chain management

no. 125

Example summary

Rank Xerox started in 1968 with dismantling of their copying machines and recycling parts. This approach developed into a system for chain management, in which the total logistic and technical proces is aimed at recycling of the copying equipment and supplies. Up to three quarters of the components can be reused and some parts can be recycled up to 98%. All existing and reusable components are tested and if they meet the same criteria as those for new components, they are used again in the Xerox Eco-Serie (fig 1).

These products are covered by a three year “Total Satisfaction Guarantee” if the user takes a full service maintenance agreement. This commits Xerox to replace the product with an identical or similar model free of charge if the user is not fully satisfied with it.

Users of Xerox equipment can take part in the Xerox chain management system. Partners in this system take part in the logistic system for used parts and supplies, so that spillage of those is minimised.

Sustainable aspects

Used copiers are dismantled at a special factory (fig 2). Parts are tested (fig 3) and selected for re-use. Worn out parts are turned into scrap. The scrap is used as raw material for producing new parts (fig 4). The scrap material that remains is processed in an environmentally sound way.

A new copier is assembled from reused parts, (partly) recycled parts and new parts. The resulting Eco serie copier is completely equivalent to other new copiers, as it meets the same specifications and it is tested in the same way. The copier is delivered to the customer in reusable or recyclable packaging. The packaging material is taken back by the service field engineer.

On top of this system customers can take part in the chain management for supplies. This additional customer relationship ensures improved reuse and recycling of supplies and used machine parts. One example is the Rank Xerox “Compatible Lasercartridge”. Used cartridges are taken back by Xerox, where they are thouroughly cleaned and reloaded with toner. Parts are replaced where necessary. As a result, the reproduced cartridges have exactly the same quality as a new one.

SPD opportunities

This system shows that it is possible to design complicated products in a way that a large part can be reused or recycled. The take back of a large number of machines is furthered by leasing the machines in stead of selling them. The additional maintenance service improves the reuse and recycling rate of supplies and used parts. The “Total Satisfaction Guarantee” ensures the user the quality of the output of the machines.

Such a shift towards integrated chain management (including suppliers and consumers) and more service in stead of just selling a product can also be applied to other complicated products.

SPD Example Leaf plate machine

no. 126

Organisation: ProMarket International

Street: 1226 A Wellington Street

City: Ottawa, Ontario K1Y 3 A1

Country: CANADA

WWW URL:

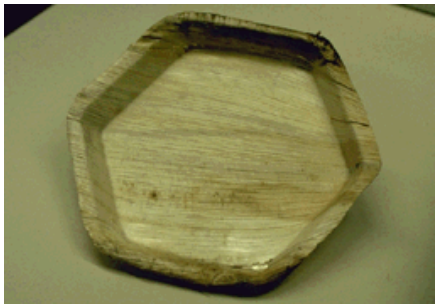
Name contact: Mr. Ravi Philar P. Eng., MBA

Tel: (1) 613 7296 030

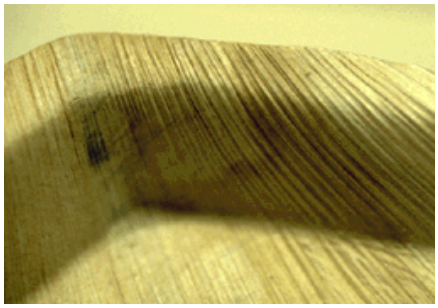
Fax: (1) 613 7293 752

E-mail: rphilar@pro-market.com

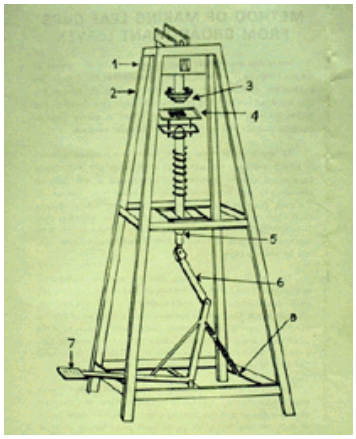
Product status:	Available		
Human need:	Other		
Design approach:	Renewable Materials		



1 Leaf plate



2 Plate detail



3 Machine drawing

SPD Example Leaf plate machine

no. 126

Example summary

Leaf plate products are biodegrable, disposable, hygienic and inexpensive alternatives to conventional paper, plastic or reusable (metal, ceramic, plastic) plates and bowls (fig 1, 2). Developed in India, Leaf plate products have been used for many years for serving dry or moist foods at roadside food stalls or small restaurants in rural or urban areas, and at large gatherings such as weddings and receptions. If they are used for dry foods, the leaf plates can be reused.

Leaf plate products can be made from a variety of partly dried biomass derived from trees and plants, e.g., Areca or Manila palm spathe, banana leaf and its pseudo-stem, and leaves of Butea frondosa, Tectona grandis, Butea monosperma, and Madhuca indica among others that are common to the tropical areas of Asia, Africa, Central and South America. Smaller leaves can be sewn together to make larger plates and bowls. Leaf plate products can also be used as packaging for short term storage or shipping of a variety of goods. These products will retain shape and rigidity for long periods if stored in low humidity environment.

Sustainable aspects

The Leaf plate machine stands about 1. 5 m high, takes up 0.5 sq. m floor space and weighs 110 kg (fig 3). It has four angle iron supports, matching male and female die assembly, a heat source for the male die such as an electrical resistor or a kerosene/propane torch, and a multi-jointed ram that houses the female die and that can be raised or lowered with a foot pedal.

The leafy material is pretreated to bring its moisture content to approximately 25%, then wiped clean with a wet cloth dipped in a 1 % bleach solution to disinfect the surface. It is then placed on the female die, and pressed firmly against the heated male die by stepping on the foot pedal for about 10- 15 seconds, and then releasing it. Raising and lowering the female die more rapidly, trims the product edges. The product is removed and stored in a low humidity environment to prevent mildew and to retain product shape, colour etc..

The machine can be easily operated by men, women and handicapped persons after less than30 minutes training. They can also quickly team up for the other tasks, such as gathering, pretreating, cleaning and storing the raw materials, manufacturing, as well as storing and selling the finished product. A Leaf plate machine, with a set of up to 6 matching dies of various shapes and sizes, crated and ready for shipping, costs about U.S.$500, ex-factory in India. It may be possible to reproduce this in other countries.

The Leaf plate machine uses partly dried leafy materials that are gathered after they have fallen naturally to the ground in forests, groves etc., or when they have been discarded after harvesting crops such as bananas. The indiscriminate defoliation of plants and trees by humans is thus avoided. The finished products are inexpensive substitutes for coated paper or plastic plates and bowls, usually imported by developing countries, or which require large investinent in machinery and importation of raw materials such as paper, coating chemicals or resins. Leaf plate products are completely biodegradable and may be discarded after single use, by composting or as livestock feed. One may use renewable energy sources such as biogas, produced from livestock waste, to heat the dies. Leaf plate products can eliminate unhygienic practices at stalls that serve food in reusable plastic or metal plates/bowls, and reduce the spread of litter from paper or polystyrene products.

SPD opportunities

The Leaf plate machine and its products, made in India, can be sourced through Ravi Philar at ProMarket International, which has successfully tested the machine in Trinidad with support from the International Development Research Centre, Ottawa, Canada (IDRC). It produced quality products using local materials such as the Manila palm spathe. ProMarket is now attempting to produce plates/bowls from birch bark etc., and to redesign the Leaf plate machine.

SPD Example Sunpulse Stirling engine

no. 127

Organisation: Pascher Consult

Name contact: dr. Claus Colsman-Freyberger

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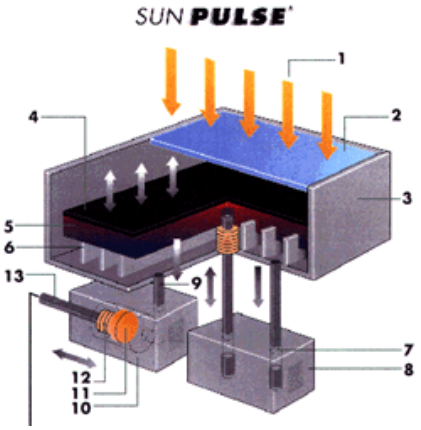
Fax: (49) 6172 962727

Country: GERMANY

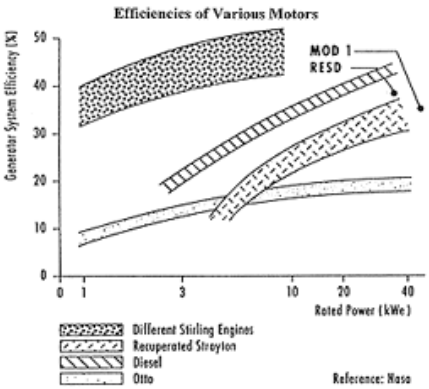
E-mail:

WWW URL: http://www.tiac.net/users/pcag/

Product status:	Prototype		
Human need:	Cooling	Use of Water	
Design approach:	Renewable Energy		



1 Sunpulse scheme



2 Motor efficiencies

SPD Example Sunpulse Stirling engine

no. 127

Example summary

At the beginning of the 19th century, the Scottish minister Robert Stirling invented a "hot-gas motor" which he introduced in 1817. During the second half of the 19th century, this engine was employed when decentralised power supply was needed. However, with the introduction of large steam engines and later of combustion engines (technically more complex but with better weight/performance characteristics) the employment of the Stirling engine subsided. With the advent of electrical motors, Stirling motors were only rarely used and then only for very special purposes.

Stirling engines theoretically achieve the highest possible energy conversion efficiency of all heat/power engines. They can employ practically any kind of energy, from fossil energy (gas, oil) to renewable energy (solar, biomass) and they can be employed with extremely low emission as generator, motor, heat pump or cooling system. In spite of these advantages, Stirling engines have still not made the market breakthrough as a mass product.

Bomin Solar, a Swiss/German company, has come up with a new concept and design of low- and medium-temperature Stirling machines. In contrast to the trend toward high-temperature/pressure engines which require expensive materials and complex designs, Bomin Solar's new developments achieve high energy-conversion efficiencies at a low temperature/pressure/frequency constellation. Simple in design and inexpensive to manufacture, Bomin Solar Stirling engines are designed for broad applications and mass markets.

SUNPULSE® is a solar-powered, low-temperature Stirling machine equipped with a built-in, flat-plate regenerator absorber. PULSE (as part of the name) underscores the innovative concept of the machine: pulsation of the regenerator absorber set into and kept in motion by a simple yet ingenious oscillator control system. The SUNPULSE® machine consists of three components: the solar collector box, the oscillator control system and the mechanical power system (fig 1).

UNEP-WG-SPD Text Source: Bomin Solar

Sustainable aspects

Working Principles of the Sunpulse Stirling Engine

Normal (i.e., unconcentrated) sun radiation (fig 1, nr.1) enters the solar collector box (fig 1, nr.3) through the transparent box cover (fig 1, nr.2), is absorbed by the black top (fig 1, nr.4) of the regenerator absorber (fig 1, nr.5) and converted into heat. As shown, the regenerator is initially at its lower dead point. When temperature and pressure reach a certain level the entry valve (fig 1, nr.7) of the oscillator control system opens and initiates the start-up of the SUNPULSE® machine. During operation, the oscillator control system acting as a temporary storage device of pneumatic energy keeps the regenerator absorber in motion.

The air at the bottom of the solar collector box is cooled through a cooling system (fig 1, nr.6). Air can pass through the regenerator built of material pervious to air and is displaced periodically from the hot (upper) part of the collector box to the cool (lower) part by the regenerator absorber moving up and down. When the absorber is at its upper dead point the air in the collector box is at a low temperature and thus at low pressure whereas temperature and pressure are high when the regenerator absorber is at its lower dead point. A small fraction of the pressure fluctuation is used to activate the oscillator control system (fig 1, nr.8) which in turn supplies the regenerator absorber with pneumatic energy to keep it in motion.

The major portion of the energy created in the solar collector box is transmitted to the mechanical power system. During the high-pressure phase air flows through a pipe (9) into the mechanical power chamber (10) pushing its piston (fig 1, nr.11) back. When the pressure in the solar collector box is low, the piston in the mechanical power chamber is pushed forward by a spring (fig 1, nr.12). The resulting movement of the shaft (fig 1, nr.13) transfers kinetic energy to working devices such as a pump.

Advantages of Stirling engines

Prototypes of Stirling engines achieve energy conversion efficiencies which surpass those of Otto as well as Diesel engines (fig 2). Stirling engines involve internal combustion, thus changes in pressure are much more moderate; they run quietly with less vibration and they have an even torque. There are no valves, no exhaustion or spark plugs; consequently maintenance is very low. Energy supply is external to the motor, continuous and even and thus generates far less emission.

SPD Example Sunpulse Stirling engine

no. 127

A wide range of energy can be employed with Stirling engines, from fossil energy (gas, oil) to renewable energy (solar, biomass). The present development trend (extreme high temperature/pressure/frequency) for high-performance Stirling engines requires very expensive materials and complex designs, leading to high manufacturing cost. With the implementation of the SUNPULSE® technologies, Bomin Solar pursue a diametrically opposed approach. This has the following advantages:

* High solar energy/mechanical work efficiency: SUNPULSE® receives the sun radiation on its built-in regenerator absorber and converts it directly into kinetic mechanical energy. Coupled with a highly efficient, robust piston pump, SUNPULSE® achieves a solar energy/mechanical work conversion efficiency of about 6%. Photovoltaic systems achieve efficiencies of about 10% in the conversion of solar into electrical energy; however, the additional conversion from electrical energy to mechanical work (for instance, when powering water pumps) reduces the overall efficiency of the photovoltaic solar system to about 2 to 3%.

* No crankshafts/flywheels necessary: In conventional low-temperature Stirling machines the regenerator absorber and the piston of the mechanical power system are synchronised. To maintain a momentum of both at all times, costly crankshafts, heavy flywheels and other devices are necessary for temporary storage of mechanical energy. In addition, external energy is necessary to start the system. The innovative oscillator control system decouples in effect the movement of the regenerator absorber and the power piston, thus making crankshafts or flywheels superfluous.

* Robust structure and simple design: SUNPULSE® represents a low-tech solution with high energy-conversion efficiency. The system is simple, its physical structure compact and robust. It requires hardly any maintenance due to the absence of crankshafts, flywheel, rotating parts, bearings or precision parts, nor is there need for lubrication. The machine's life is practically unlimited, independent of the intensity of its use. Construction of the SUNPULSE® machine requires only simple and readily available materials. SUNPULSE® technology is simple as a system as well as in design, enabling serial production at low cost in practically any country.

* The economics of SUNPULSE® are favourable: For example a SUNPULSE® engine driving a water pumping system delivers water at a cost of 3.2 US cents/m3 and is thus well below the "Maximum Water Cost Target" of 6 US cents/m3 which was set in the World Bank study as the benchmark for pumping systems in order to be employed economically in sunbelt countries. In the recent World Bank study of 1993 costs to pump water from 15 m depth are 28 US cents/m3 for solar-powered pumps and 23 US cents/m3 for diesel-powered pumps. For SUNPULSE® water the costs are estimated at 13 US cents/m3.

SPD opportunities

Altogether, the SUNPULSE® low-temperature Stirling machine with exceptional efficiency (120 W mechanical output for 2 m2 solar radiation) and economics, is simple in design and equipped with an ingenious control system. It is ideally suited for use in sunbelt countries as a small-scale irrigation pump, for cooling and producing mechanical energy. SUNPULSE® can be modularly extended to form larger installations. For moderate climate zones, it serves as a cooling/heating system.

SPD Example Brox modular transport

no. 129

Organisation: Brox Corporation Limited

Name contact: Rob Brock

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Tel: (44) 161 775 4977

City: Manchester M44 6DZ

Fax: (44) 161 775 4881

Country: UNITED KINGDOM

E-mail:

WWW URL: http://www.strath.ac.uk/~cjbs23/brox.html

Product status:	Available		
Human need:	Transportation		
Design approach:	Optimized design		

1 Brox passenger module
© Rob Brock

2 Standard chassis
© Rob Brock

3 Van module
© Rob Brock

SPD Example Brox modular transport

no. 129

Example summary

Increasing motoring costs, appalling traffic congestion and concern over damage being done to the environment inspired Rob Brock to design the BROX Zero Emission Vehicle (fig 1). He saw that traditional pedal-powered load carriers from the East, such as rickshaws, have their limitations. He set out to apply Western technology to produce a modern load carrier which could be pedalled by unskilled riders.

So, the BROX Vehicle is designed to combine the economic and environmental advantages of a bicycle with the stability and load carrying capacity of four wheels. It is ideal for short journeys and local deliveries. A number of different bodies can be mounted on the standard chassis (fig 2) to form a van, pick-up, courier or passenger vehicle (fig 1, 3). Alltogether, a BROX is versatile and a practicle alternative to a motor vehicle.

Sustainable aspects

The most important advantage of the Brox bicycle is that is human-powered. There is no need to fill it up with petrol or diesel. Moreover, the recumbent driving position of a BROX is up to 25% more efficient than a bicycle, so you go further (or carry more weight) for the same amount of expended energy. It actually takes less effort to drive a BROX than it does to walk.

Because of the modular body design a BROX carries almost anything in addition to the driver: commercial goods, adult or child passengers, shopping, garden waste, furniture and many other awkward or bulky loads. To further increase it's potential the BROX has some extra's like:

Terrain Following System
TFS allows a BROX to be driven up and down kerbs, handle road camber and surface irregularities, it also allows a BROX to be driven over rough ground. The Brox has a four-wheeled braking system, and an articulating facility which keeps all four wheels firmly on the ground. This can be demonstratred by riding down flights of steps.

Clutch
The Brox is made even more user friendly by a disengagable clutch which allows the driver to change up or down to any gear whilst stationery. So you can get away to a smooth start without the enormous effort which it takes to start traditional load carriers. Both rear wheels are driven. The transmission is in two sections with two freewheel sets. Such an arrangement can give a very wide, yet closely spaced range of ratios with a 16" bottom gear. The Brox will certainly manage most urban climbs.

Twin Drive
Twin Drive provides drive through both rear wheels; if one wheel slips, the other still drives forward. Similar to a car, the Twin Drive also allows either wheel to freewheel through a turn, resulting in smooth cornering.

Pull Handle
The Pull Handle means a BROX can be pulled just like a hand trolly, offering very practical door to door delivery. In trolly mode a BROX is easily pulled up and down kerbs, over paved areas and even inside buildings.

SPD opportunities

The Brox is very conspicuous and is designed to give the rider the same head height as a Ford Fiesta.
Rob regards it as a van without an engine, and far less complicated: the ideal delivery vehicle for distances under five kilometres. Part of the company's mission statement is to break the dependency on motorised traffic, and they would be very happy if the vehicle was regarded as a mainstream transport option.

SPD Example Solar water disinfection

no. 131

Organisation: ProEco

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Tel: (503) 2240514

City: San Salvador

Fax: (503) 2237826

Country: EL SALVADOR

E-mail: proecosa@sol.racsa.co.cr

WWW URL:

Product status:	Prototype		
Human need:	Use of Water		
Design approach:	Renewable Energy		

1 SODIS plant (left)

SPD Example Solar water disinfection

no. 131

Example summary

The exposure of water to sunlight radiation improves the microbiological quality of water. This treatment process called solar water disinfection could be used at household level to treat small quantities of water for drinking purposes. Water temperatures with a threshold of about 50 degrees Celsius considerably increases the inactivation rate ofbacteria induced by solar radiation wheras the inactivation rate of viruses steadily increases with temperatures in the range of 20-50 degrees Celsius. The recorded synergetic effects of solar radiation and thermal water treatment favour a combined use of these two water-treatment processes.

Sustainable aspects

At least one-third of the population in developing countries has no acces to safe and reliable drinking water supplies. The lack of adequate water supply and sanitation facilities seriously exposes this unserved population to numerous water-related diseases, like diarrhoea.

However, public funds are not sufficiently available to cover estimated investment costs of $150 billion for full water supply coverage in developing countries. Choice of inappropriate technologies, missing operation and maintenance work, difficulties in the procurement of fuel and spare parts, and weak management structures often account for the poor performance of many existing public water supplies ind developing countries. In order to overcome these problems it is essential to:
* reduce substantially the costs of water supplies through increased use of appropriate low-cost technologies;
* install only water supply facilities whose operation and maintenance can bemanaged and sustained with local resources.

Self-help individual water supply systems operating at a houshold level is certainly one approach that will fulfil these criteria. Some drawbacks of techniques that are often propagated on the household level are:
* boiling of water requires too much firewood in rural areas
*disinfection by chlorine compounds is often rejected by comsumers becaus of taste and odour, apart from the problems with supply, distribution and correct dosage.
* filtration through ceramic filters is often too expensive.

Solar water disinfection is considered to be an alternative that is effective, practical and simple enough to be applied by indiviuals or households. The aim is to treat small quantities of drinking water in the order of 2 L per person per day or of approximately 10-15 L per family per day. Essentially, the treatment consists in filling clean and transparent containers with water which are then placed in full sunlight for several hours.

SPD opportunities

However, solar water disinfection has its limits too. Solar radiation is dependant on the geographic location and climatic conditions. Although the application is simple, the disinfection practice is used without profound understanding of the process. In a recent study the Swiss federal Institute for Environmental Science and technology and the Working Group of Environmental Hygiene of the University of Zurich demonstrated synergetic effects of solar radiation and thermal water treatment in disinfection of water. These two processes have been developed independantly so far, but the combination of water disinfection by solar radiation and thermal water treatment by solar energy seems to achieve best results.

A simple test with half-side black coloured bottles proved that the water temperatur could be raised over 50 degrees Celsius within 5 hours of exposure time. Thus water treatment by solar energy could become an adequate and sustainable process for the treatment of small quantities of water. However, field test are necessary before solar water disinfection can be widely promoted. The efficiency and affordability of the developed installations has to be assessed as well as the sociocultural acceptebility. Another question is how the quality of the water can be monitored.

SPD Example Dynamo torch

no. 132

Organisation: Not available

Name contact: Not available

Street:

Tel:

City:

Fax:

Country:

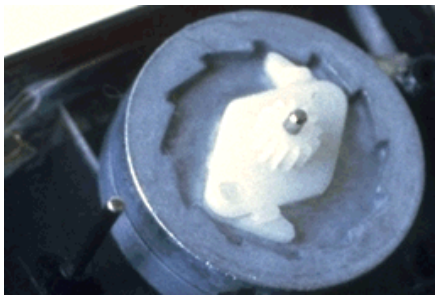
E-mail:

WWW URL:

Product status:	Available		
Human need:	Other		
Design approach:	Renewable Energy		

1 Dynamo torch
about 50 years old

2 Modern
dynamo torch



3 Nylon gear

SPD Example Dynamo torch

no. 132

Example summary

The design of a human powered torch is quite old. Examples are known that date before the 2nd World War - still working and never used a battery (fig 1). The mechanics of this modern torch (fig 2) are very simple and predominantly gears made of nylon (fig 3).

Although useful, it is not a totally mature product development. It does not give very much light, and the practicality of the product is frustratingly questioned when you need to work at night on a problem that needs two hands! BayGen (see example 'Clockwork' radio) hope to utilise their 'generator' in a torch. If so, this would presumably mean that the torch would use the energy stored in a spring and therefore should be much more practical product.

Sustainable aspects

Not available

SPD opportunities

Not available

SPD Example Clockwork dry shaver

no. 133

Organisation: Thorens (does not exist any more)

Name contact:

Street:

Tel:

City:

Fax:

Country: SWITZERLAND

E-mail:

WWW URL:

Product status:	Out of production		
Human need:	Other		
Design approach:	Renewable Energy		

1 Clockwork dry shaver

2 Winding key
and activating button

SPD Example Clockwork dry shaver

no. 133

Example summary

This Thorens Riviera ‘Clockwork Dry Shaver’ was purchased in 1958 in the United Kingdom. 8 full turns of the winding key provides 3 minutes of shaving. The small button on the side activates the shaving head by releasing the spring.

‘People Powered’ products have the benefit of being stand alone products with no need of additional power supply. There are no power leads and additional chargers, batteries, compressors or generators to add on to make the product function - generally the product is simpler, can last longer and requires less maintenance. They often integrate proven and well tested technologies that are reliable and understood; such as gears.

Sustainable aspects

Not available

SPD opportunities

Not available

SPD Example Gyroscopic shaver

no. 135

Organisation: University of Tennessee Knoxville
Center for Clean Products and Clean

Street: 600 Henley Street, Suite 311

City: Knoxville, Tennessee 37996-4134

Country: U.S.A.

WWW URL:

Name contact: Mr. Gary A. Davis

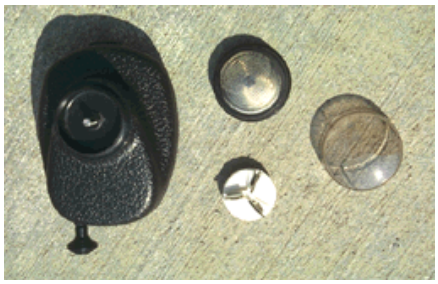
Tel: (1) 423 974 8979

Fax: (1) 423 974 1838

E-mail: gdavis@utkvx.utk.edu

Product status:	Unknown		
Human need:	Other		
Design approach:	Renewable Energy		

1 Gyroscopic shaver



2 shaver parts

SPD Example Gyroscopic shaver

no. 135

Example summary

The gyroscopic shaver is set in motion by pulling it's cord three times. This makes the three self-sharpening blades spinning at 15.000 revolutions per minute. The gyroscope, a heavy turning wheel, keeps it running for some time while you are shaving.

Sustainable aspects

As the shaver is completely human-powered it requires no batteries or electricity from the net.

SPD opportunities

The shaver uses a gyroscope to store energy, where other human-powered products such as the "Clockwork dry shaver" and the "Clockwork radio" use a wind-up system. So this is yet another way to extend the possibilities of human power for use in products.

Wether or not this is more advantageous than wind-up systems still remains unclear. Also, it is not clear how the environmental aspects compare to wet shaving, which is of course also manual.

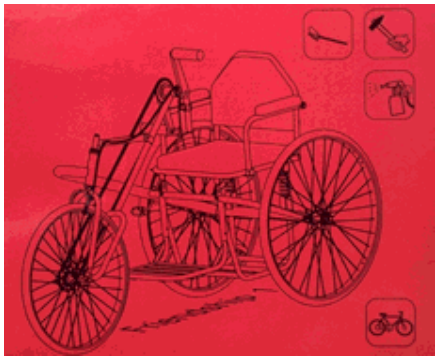
SPD Example Tricycle production manual

no. 136

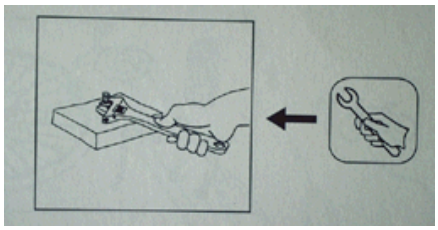
Organisation:	Delft University of Technology, Section for Environmental Product Development	**Name contact:**	Annemiek van Boeijen
Street:	Jaffalaan 9	**Tel:**	(31) 15 278 2738
City:	2628 BX Delft	**Fax:**	(31) 15 278 2956
Country:	THE NETHERLANDS	**E-mail:**	a.g.c.vanboeijen@io.tudelft.nl
WWW URL:	http://duto02.tudelft.nl/research/mpo/index.html		

Product status:	Available		
Human need:	Communication	Transportation	
Design approach:			

1 Tricycle



2 Tricycle production manual



3 Detailed picture instructions

SPD Example Tricycle production manual

no. 136

Example summary

The Tricycle Production Manual (fig 2) has been developed for basically equipped and skilled workshops in developing countries that want to start or improve the production of hand-operated tricycles (fig 1). The manual is based, as far as possible, on drawings with minimal text (fig 3), in order to make the information accessible for users with different languages and levels of education.

UNEP-WG-SPD source: Annemiek van Boeijen

Sustainable aspects

The manual is, as much as possible, adjusted to the knowledge and experience of workshop workers in developing countries. It contains mostly drawings and minimal text to keep the manual accessible to a large group of users.

The manual gives relevant information on tricycle design and is a step-by-step guide to the production of the tricycle. The tricycle production is explained by means of three-dimensional drawings and additionally supported by two-dimensional drawings. Measurements are limited to those which are stricty necessary for the drawings to be easily understood. Pictograms are used to indicate the production steps and actions. The structure of the manual is clear and practical.

Through this means of communication local workshops can improve products. In the design of the tricycle the use of basic tools is taken into account along with local availability of materials. In this manner local production with local materials is enhanced.

SPD opportunities

Especially in case of products like this tricycle the manual is beneficial. Charity organisations tend to donate products for the handicapped in developing countries. As a consequence, the potential for local production collapses as they can not compete with imported free products. A second drawback is that the imported donations can often not be maintained locally as it requires a spare part or equipment that is not locally available.

The manual on the other hand encourages production in local workshops. It provides a counterweight for unfortunate donations and imported products. Additionally, local repair facilities are improved and in the design of the tricycle is taken into account that it is able to widthstand heavy use for a long time.

The concept of the manual can be applied to other design manuals to further enhance local production and local material use.

SPD Example Flax clothing Cotton Country Line-N

no. 137a

Organisation: Cotton Country

Name contact: Pieter de Kimpe

Street: Gasthuisstraat 25

Tel: (31) 492 554 649

City: 5708 HH HELMOND

Fax: (31) 492 539 380

Country: THE NETHERLANDS

E-mail:

WWW URL:

Product status:	Available		
Human need:	Clothing & Textiles		
Design approach:	Renewable Materials		

1 Flax clothing

SPD Example Flax clothing Cotton Country Line-N

no. 137a

Example summary

Linen is made from flax and flax is one of the oldest cultivated plants on this planet. More than 5000 years ago linen was the symbol of divine purity. The Europeans also recognised the advantages of linen. In the Middle Ages Germany was the main linen producing nation as flax grows particularly well in a moderate climate.

Today the fields for Cotton Country are near the Dutch IJsel lake, on fertile land that has been reclaimed from the sea. The farmers are under contract to grow flax organically for which they receive special premiums. Cotton Country fashion thus combines the protection of the skin with the protection of the environment.

At the end of careful cultivation and manufacturing processes linen fabrics are achieved with stunning characteristics: strong, electrostatically neutral, hard wearing, washable, dust repellant and with a natural, silky shine. Through an improved weaving method the wrinkling of the linen garment is substantially reduced.

Sustainable aspects

The flax is grown by the rotation method. No pesticides or artificial fertilizers are used, weeds are removed mechanically and pest control is acieved by the introduction of natural predators. From there the flax is seperately stored from flax that has been grown by more conventional methods. No chemicals are used in the spinning process nor are the finished fabrics chemically treated in any way. The wonderful feel of the fabrics is achieved by mechanical and thermal treatments alone. Stringent internal checks combined with regular inspections by the internationally recognised Dutch accreditation organisation SKAL both guarantee our impeccable standards.

SPD opportunities

Not available

SPD Example SunWatt solar hybrid module

no. 140

Organisation: SunWatt Corporation

Name contact: Richard Komp

Street: RR1 Box 7751

Tel: (1) 207 4972204

City: Jonesport ME 04649

Fax: (1) 207 4972123

Country: U.S.A.

E-mail: sunwatt@juno.com

WWW URL:

Product status:	Available		
Human need:	Heating		
Design approach:	Renewable Energy	Optimized design	

1 SunWatt hybrid module

SPD Example SunWatt solar hybrid module

no. 140

Example summary

The SunWatt PV/Hot Water Hybrid Solar Module uses linear trough concentrators to double the amount of sunlight that falls on the solar cells, thereby doubling the output electric current produced by the expensive solar cells. Because the increase in light intensity increases the heat absorbed in the cells, this leads to a temperature increase and a loss in cell efficiency; arranging cooling tubes behind the fins holding the solar cells allows us to remove this heat and capture it for domestic hot water use.

A typical operating temperature of 50 to 60 degrees Celsius produces water hot enough for bathing, dishwashing and laundry use, even though this temperature is still about the same as or lower than the operating temperature of non-concentrating flat plate photovoltaic modules in tropical areas. The low concentrating ratio (2 to 1) and the compound parabolic shape of the reflectors allows the Hybrid to operate without any need for daily or seasonal adjustment; the unit can be fastened permanently in place. A typical PV/Hybrid module is rated at 100 watts electrical and 1000 watts thermal output under AM1 conditions.

Sustainable aspects

The PV/Hot Water Hybrid uses solar energy to produce both the electricity and hot water needed at a remote site, thereby eliminating the need to run power lines to this site, saving both the expensive cost and the environmental damage of a power line extension. If the site is more than 0.5 Km from the nearest power line, the PV/Hybrid is the lowest cost option, far cheaper than the life cycle cost of a gasoline or diesel generator.

Solar cells never "wear out" and the PV/Hybrid is capable of decades of operation with very little maintenance or repair. SunWatt PV/Hybrids have been in operation for over 12 years in developing countries as well as remote parts of the US. We have made these PV/Hybrids at two day workshops where the participants solder together the cells, bend up the reflectors, solder the copper tubing and assemble the finished module under supervision of Sunwatt. It is possible to use a number of different materials and we normally use at least some recycled or reused materials in the construction of the workshop modules. The latest workshops have been at remote sites where all the power for the assembly has come from PV or wind energy.

SPD opportunities

These PV/Hybrids can be used in developing countries where both hot water and electricity are desired but not currently available. "Eco-tourist" resorts need to furnish an approximation of middle class comfort while at the same time leaving a "light" footprint on the environment. Remote hospitals need a dependable source of hot water. Even used as a preheater, the SunWatt PV/Hybrid can be extremely useful in this application; but I have designed PV/Hybrids that made live steam and electricity at the same time (with some loss in cell efficiency but still capable of good electrical output into a battery storage bank).

Commercial buildings and even private homes in tropical environments need some hot water and dependable electricity; some SunWatt PV/Hybrids are in use in Florida as independent power supplies for times like hurricanes when the utility grid is down. The most Sustainable way the PV/Hybrid can be used in a developing country is if it is manufactured there. Almost everything except for the solar cells is probably available locally, and some countries like Mexico and India have photovoltaic manufacturing capability, making it possible for these countries to satisfy their internal needs as well as export PV/Hybrids to help their trade balance.