

Bachelor's thesis

Degree program in Sustainable Development

2012

JenniKoho

THE CONNECTIONS BETWEEN GREEN ECONOMY AND BIOMIMICRY



TURUN AMMATTIKORKEAKOULU
TURKU UNIVERSITY OF APPLIED SCIENCES

BACHELOR'S THESIS | ABSTRACT

TURKU UNIVERSITY OF APPLIED SCIENCES

Sustainable Development

2012 | 45 pages + 1 appendix

Instructors: Sirpa Halonen, Ilpo Penttinen

Jenni Koho

THE CONNECTIONS BETWEEN GREEN ECONOMY AND BIOMIMICRY

The half of human wealth is coming from natural capital, which we are depleting with our current economic model. Economic activity of human beings consumes more biomass than the Earth can produce on a sustainable basis. The flaw of the current model is that costs and losses of destroying the Earth are absent from the prices in the marketplace.

While our current model, "brown economy" is causing negative impacts on the environment, green economy decouples resource use and environmental impacts from economic growth decreasing the harmful effects of economic activities and aiming at sustainability over the long haul.

Biomimicry is an innovation method seeking sustainable solutions for problems we humans face by imitating nature's patterns and strategies that have formed during thousands of centuries. The method seeks to create earth-friendly products, processes, and policies that are sustainable in the long run.

The aim of the study was to show connections between green economy and biomimicry and to point out applicability of the method in greening economic activities. This study is a theoretical research based on data, which consists of literature and articles written on biomimicry and economy.

The study shows clear connections between biomimicry and green economy. Biomimicry is about innovating new technologies and green economy stresses the importance of technology transfer to developing countries. Biomimicry can be applied exactly on the same sectors of economy which have most export potential in green economy: in primary and secondary industry and in energy sector.

If green business is defined as a combination of practices and values, biomimicry fits in the picture with flying colors due to the coverage of the method. Deeply green products and technologies have markets in the future, and therefore biomimicry brings competitive advantage to companies.

Adopting biomimicry as part of sustainability practices works in both ways: either biomimicry can help making businesses greener and hence contributing to transition towards green economy or after countries start shifting towards green economy biomimicry can help businesses to do their share. On the basis of this study it can be stated that biomimicry has potential in serving as a bridge between current and future economy.

KEYWORDS:

biomimicry, green business, green economy, sustainability

OPINNÄYTETYÖ (AMK) | TIIVISTELMÄ

TURUN AMMATTIKORKEAKOULU

Kestävä kehitys

2012| 45 + 1 liitesivu

Ohjaajat: Sirpa Halonen, Ilpo Penttinen

Jenni Koho

BIOMIMETIIKAN JA VIHREÄN TALOUDEN VÄLISET YHTEYDET

Puolet ihmiskunnan vauraudesta koostuu luonnonpääomasta, jota kulutamme loppuun nykyisen talousmallimme takia. Ihmisten taloudellinen toiminta kuluttaa enemmän biomassaa kuin mitä maapallo pystyy kestävästi tuottamaan. Nykyisen taloudellisen mallin ongelma on, että kuluja ja menetyksiä maapallon tuhoamisesta ei lasketa mukaan markkinahintoihin.

Vihreä talous pyrkii kytkemään talouskasvun irti luonnonvarojen kulutuksesta ja siitä aiheutuvista ympäristövaikutuksista, mikä johtaa haitallisten vaikutusten vähenemiseen. Vihreä talous pyrkii myös kestävyteen pitkällä aikavälillä.

Biomimetiikka on innovaatiomenetelmä, jonka avulla pyritään ratkaisemaan ihmiskunnan ongelmia matkimalla luonnossa esiintyviä muotoja, prosesseja ja järjestelmiä. Menetelmän avulla pyritään tuottamaan ympäristöystävällisiä tuotteita, prosesseja ja käytäntöjä kestävä kehityksen mukaisesti.

Tutkimuksen tavoitteena oli selvittää vihreän talouden ja biomimetiikan välisiä yhteyksiä sekä osoittaa menetelmän soveltuvuus taloudellisten toimintojen muuttamiseksi kestävämmälle pohjalle yritys näkökulmasta. Tämän teoreettisen tutkimuksen aineisto perustuu kirjallisuuteen ja artikkeleihin, joita on kirjoitettu biomimetiikasta sekä taloudesta.

Tutkimus osoittaa biomimetiikan ja vihreän talouden välillä olevan selkeitä yhteyksiä. Biomimetiikan tavoitteena on innovoida uusia teknologisia ratkaisuja ja vihreän talouden puolestaan teknologiansiirto kehitysmaihin. Biomimetiikkaa voidaan hyödyntää juuri niillä talouden sektoreilla, jotka ovat tärkeitä kehityskohteita vihreän talouden edistämiseksi.

Mikäli vihreä liiketoiminta nähdään käytäntöjen ja arvojen yhdistelmänä, biomimetiikka sopii kuvaan loistavasti menetelmän kattavuuden ansiosta. Aidosti vihreillä tuotteilla ja teknologisilla ratkaisuilla on kysyntää tulevaisuuden markkinoilla, joten biomimetiikka tuo yrityksille myös kilpailuetua.

Biomimetiikan avulla yritykset voivat tehdä toiminnoistaan vihreämpiä ja siten edesauttaa vihreään talousmalliin siirtymisessä. Toisaalta voidaan myös ajatella, että valtioiden siirtyessä vihreään talousmalliin, yritysten on helpompi tehdä oma osuutensa käyttämällä biomimetiikkaa apunaan. Tutkimuksen pohjalta voidaan esittää, että biomimetiikalla on potentiaalia toimia siltana nykyisen ja tulevan talousmallin välillä.

ASIASANAT:

biomimetiikka, kestävyys, vihreä liiketoiminta, vihreä talous

CONTENT

1 INTRODUCTION	6
2 EXECUTION OF THE STUDY	8
2.1 Research problem	8
2.2 Research method and data	8
2.3 Validity, ethicality and reliability of the study	8
3 GREEN ECONOMY AND BUSINESS	10
3.1 Capitalism and market economy	10
3.2 Green economy	11
3.3 From current to green business	13
3.3.1 The Light Bulb Conspiracy	14
3.3.2 Towards sustainability	16
3.3.3 Green products	17
3.3.4 What does it mean to be a green business?	18
3.3.5 How does a company benefit for being green?	19
4 BIOMIMICRY	21
4.1 Institutions related to biomimicry	21
4.1.1 Biomimicry Guild and Biomimicry Institute	22
4.1.2 Biomimicry Europa	23
4.2 Principles	23
4.3 The three levels of biomimicry – from shallow to deep	24
4.4 The deepest level of biomimicry – learning from ecosystems	25
4.4.1 Cycle of life	26
4.4.2 Moderation	27
4.4.3 Efficiency	28
4.4.4 Cooperation and communication	29
4.4.5 Localization	30
4.5 Case studies	31
4.5.1 Curbing CO ₂ emissions - Carbon Dioxide Technology by CALERA	31
4.5.2 Sustainable buildings: Eastgate Building in Harare	32

4.5.3 Water repellency of fabrics: GreenShield	32
4.5.4 Quieter energy saving commuting - The Shinkansen Bullet Train	33
5 THE BRIDGE BETWEEN	34
5.1 Biomimicry, green economy and green business	34
5.2 Production and biomimicry	35
5.3 SWOT-analysis	37
6 CONCLUSIONS	41
REFERENCES	43

APPENDICES

Appendix 1. Connections between green economy and biomimicry.

PICTURES

Picture 1. Water repellency. (Biomimicry Institute 2007-2012).	32
Picture 2. Kingfisher and bullet train. (Biomimicry Institute 2007–2012.)	33

FIGURES

Figure 1. Production in ecosystems.	27
Figure 2. SWOT-analysis.	40
Figure 3. Biomimicry connecting current and future economic model.	41

TABLES

Table 1. Green business and biomimicry.	35
---	----

1 INTRODUCTION

Market economy has brought us wealth but not without consequences. Irresponsible and short-sighted economic activities have resulted in varieties of different environmental problems and ecological scarcities.

Extraction of raw materials, manufacturing and transportation are causing the lion's share of the most severe impacts of economic activities. Nonrenewable resources are depleted; renewable resources like forests and fish reserves are being used faster than they can regenerate themselves; water, air, and soil are being polluted; landfills are expanding. These examples show that the way we conduct business in today's world is far from the goals of sustainable development.

The world famous, although vague, Brundtland commission's definition for sustainable development goes as follows: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN Documents). To achieve these goals something needs to be done to our current economic model. Green economy is presented to be answer to balance the shaken relationship of human economy and natural world.

There are no specific guidelines defined how to carry out green economy. This gives countries and businesses freedom to implement green economy in the way that best suits their aspirations and operations.

Biomimicry is a method to consider in greening economic activities. In this theoretical research connections between green economy and biomimicry are studied, and the applicability of the method in greening economic activities is pointed out.

In chapters three and four the concepts of green economy and biomimicry are defined, and chapter five is dedicated to analysis of the connections. SWOT-

analysis on biomimicry and its relation to economic activities will clarify the applicability of biomimicry as a tool for companies to implement green business.

2 EXECUTION OF THE STUDY

2.1 Research problem

The research problem of this study is divided into two sections. The main objective is to find out what kind of connections there are between green economy and biomimicry. Pointing out the applicability of biomimicry in greening economic activities in a company level is the sub-objective of the study. Carrying out this study is worthwhile since mankind needs new sustainable ways of conducting business.

2.2 Research method and data

The research method of this study is a qualitative mapping research, and the analyzing method used is context analysis. In context analysis the research data is examined by condensing, itemizing, and finding similarities and differences. Context analysis is text analysis in which already existing written data is analyzed. (KvaliMOTV)

The research data of this study consists of literature and articles written on biomimicry and both on current and green economy. Internet is used as a source more than usually is recommended since writings especially on biomimicry are fragmentary. The forgoing data serves as the theoretical context of the study. The concepts are introduced in their own chapters and on the basis of this theoretical context the connections and similarities have been analyzed.

2.3 Validity, ethicality and reliability of the study

In theoretical research it is challenging to ensure the validity of the study. Validity means that the study will give answers to the research problem. There is a risk that the study will end up being only a summary of already existing literature. The validity of this study is ensured by carefully analyzing the data, and

presenting the connections justifiably. Biomimicry is usually approached from technology or design point of view. This study is approaching biomimicry from the viewpoint of sustainability and economy.

Ethicality of the study is fulfilled by not plagiarizing the literature or giving false statements. Not being partial is important when reliability is at stake. This means that downsides of biomimicry are presented in the study as well. Also using sources which are acceptable in scientific publication adds the reliability of the study.

This study was made in a relatively short period of time, which may have an effect on the reliability up to a point. Because of the time span profitability calculations or similar numeric comparison weren't executed.

3 GREEN ECONOMY AND BUSINESS

3.1 Capitalism and market economy

The core concept of capitalism is the economic concept of capital. Jonathon Porritt (2007, 138) defines capital as “a stock of anything that has the capacity to generate a flow of benefits which are valued by humans.” There are five different types of capital: natural, manufactured, human, social and financial capital. Natural and human capital is prerequisite for manufactured and social capital. In fact, they are the two sources of wealth. Financial capital has only instrumental value; it keeps the whole system operating.

In economic terms natural (environmental or ecological) capital is flow of energy and matter that yields valuable goods and services. There are different natural capitals to be distinguished: resources, sinks and services. Resources, both renewable and non-renewable, are most familiar. Sinks are the systems in nature which absorb, neutralize or recycle waste. Climate regulation, soil binding and hydrologic cycle are examples of the variety of services nature provides. The importance of natural capital is evident. All production in human economy is based on natural capital and more importantly it is the provider of services without which human society could not sustain itself. (Porritt 2007, 138–149.)

Market economy has clearly brought wealth and improved well-being of several societies over time, but it has also created negative externalities such as environmental risks and ecological scarcities. This proves that current economic model fails to recognize the true costs of producing goods. Focusing only on gross domestic product (GDP), which has been the most favored macro indicator of progress, doesn't tell the whole story. Economic activities of human beings consume more biomass than the Earth can produce on sustainable basis. The flaw of the current model is that costs and losses of destroying the Earth are absent from the prices in the marketplace. (Hawken 2010, 16; UNEP 2009, 2.)

The half of our wealth is coming from natural capital (the other half from human capital, the hands, the brains and the spirits that transform natural capital into manufactured capital), which we are depleting with our current economic model. Clearly our economy has taken a wrong path to follow. It is worrying that we are moving from an era in which the man-made capital (human, manufactured and financial) was the limiting factor, to an era in which natural capital will be the one limiting our endeavors. (Porritt 2007, 138–149.)

While our current model, “brown economy” is causing negative impacts on the environment, green economy decouples resource use and environmental impacts from economic growth decreasing the harmful effects of economic activities. (UNEP 2009, 2.) The idea of continuous economic growth still exists but the growth is meant to be implemented in an Earth-friendly way. In the next chapter this new, more sustainable economic model, the right path to follow is presented.

3.2 Green economy

According to UNEP green economy is “a system of economic activities related to the production, distribution and consumption of goods and services that result in improved human well-being over the long term, while not exposing future generations to significant environmental risks or ecological scarcities.” (UNEP 2009, 2.)

Poverty in developing countries and global crises related to food, fuel, freshwater and finance have roused international concerns, and the need for green economy is recognized in a global level (UNEP 2009, 2). Green economy is a topical issue, and it is one of the themes to be handled in Rio+20 United Nations Conference on Sustainable Development (UNCSD) in June 2012. (UNCSD 2012.)

To promote green trade in a larger scale, countries must start building green economies. Adopting strategies and policies to promote a shift into green econ-

omy has positive effects on trade flows and trading opportunities. Associated with a green economy, greening of markets may open up opportunities to export goods and services which have low environmental impacts. This is a good opportunity especially for developing countries. Green economy improves global trade governance but also domestic trade environment and at the same time ensuring the trade is sustainable and eradicates poverty. (Rio+20 Issues Briefs 2011, 1.)

Technology transfer was mentioned in Agenda 21 action plan which was an outcome of UNCED meeting held back in 1992 in Rio de Janeiro. In Rio+20, technology transfer is strongly highlighted. Implementing green economy will mean a large-scale transfer of technologies and acquirement of technological capabilities in developing countries. (Rio+20 Issues Briefs 2011, 5.)

Environmental standards and competitiveness are often seen as an oxymoron and that's the reason why some countries have been concerned about green economy and its effects on export industry. The fact is actually quite opposite. Environmental regulation pushes firms to innovate and become more internationally competitive. The green sectors that have export potential are agriculture, fishery, forestry, tourism, energy and manufacturing. For poorer countries committed trade financing can enhance in transition to green economy. Green Climate Fund (GCF) for example has agreed to assist poorer countries to finance development of new green sectors with export potential. (Rio+20 Issues Briefs 2011, 1-5.) Public and private investments in green sectors of economy will provide the mechanism for rearranging businesses, infrastructure and institutions, and for the adoption of sustainable consumption and production processes. (UNEP 2009, 2.)

Interestingly, while it will be necessary to measure progress towards a green economy, it is counter-productive to develop generic green economy indicators applicable to all countries since there are vast differences in natural, human and economic resources between them. This results in quite different ways of implementing green economy. The most important thing is that countries all over

the world are striving for this common target. (UNEP 2009, 3.) We don't need another GDP.

3.3 From current to green business

If countries transfer from conventional economic model to the green one, it facilitates also businesses' efforts in doing their share in this huge and challenging task. Especially industrial businesses, both from primary and secondary (manufacturing) production, have an important role to play.

Transition from overconsumption to appropriate consumption is the basis for sustainable society (Chiras1992, 77). The challenge is therefore how to do business that is based on need, not greed. Like Gandhi once said: "The World is big enough for everyone's needs, but it is too small for the greed of one man". Companies' management and shareholders have a great responsibility but the attitudes and actions of investors matter, too. Business can be done with zero profit, which would automatically lead to smaller volumes on sales and thus smaller volume of produced goods. When making profits, investments for example could be directed to green sectors of economy as it turned out in the previous chapter.

In trading supply and demand rules. Companies will provide what consumers demand. Consumers and clients, the ones that bring in the money, are essential for companies to stay alive in the market place. This is a reason why consumers' attitudes and values, their consuming behavior, also have an enormous effect on sustainability of economic activities. Environmentally-driven widely recognized consumer pressure matters (Rio+20 Issues Briefs 2011, 1), so if a company cannot or won't change for example its production methods into more sustainable way, it pretty soon means bankruptcy. The challenge here is, however, that in a commercial world advertising is creating false images on needs. When people get wealthier, their wants become needs (Porrit 2007, 101). People don't question things they believe are needs. We think it's our basic right to fulfill them.

For profit seeking companies the possibility to cut down the variety and amount of products they sell may be a bit frightening option, since it is likely to effect on competitiveness and profits. Sarah Severn, director of corporate responsibility horizons at Nike, has claimed that consumption is not the problem, it's the nature of consumption (a little conflict of interests here). Life span of most products is relatively short, also Nike's, and pretty soon the products will turn into unusable waste. (Makower 2009, 228.) The horrifying concept, planned obsolescence, is one reason to this premature end of life span. The next chapter (3.3.1) in which planned obsolescence is explored, is written on the basis of the documentary Light Bulb Conspiracy (The Light Bulb Conspiracy 2010).

3.3.1 The Light Bulb Conspiracy

Planned obsolescence dates back till 1920s when industry started to shorten the life spans of products to increase consumer demand. An influential advertisement magazine warned companies that an article that refuses to wear out is tragedy of business.

The first example of planned obsolescence is the story of light bulbs. Initially manufacturers strived for producing long life span for their light bulbs, they lasted even 2500 hours. The light bulb of Livermore fire station in California has been burning continuously since 1901. In 1924 a group of businessmen gathered together and founded the Phoebus cartel to lower the life span of the bulbs to 1000 hours to control markets and customers worldwide. In 1925 a board named 1000 hour life committee was found. It forced companies to design light bulbs with the burning time of maximum 1000 hours. If companies exceeded the burning time of their bulbs noticeably, they were fined. By the 1940s the cartel had reached its goal: 1000 hours had become the standard life span of light bulbs. If you still have some conventional light bulbs left in your closet, check out how many hours they will burn, you will be surprised.

Nylon stockings have the same destiny as well. They were designed to be too durable and they didn't sell too well. Inferior quality of the stockings was the an-

swer to the problem. In 21st century there are examples of technological appliances that are designed to fail. For example in some printers there is a microchip, a counter chip, which is placed inside the printer. When certain amount of prints gets full, the printer stops working. A Russian IT-specialist has developed user friendly software to zero the counter to make the printer work again. Apple got negative publicity because its i-Pods were clearly designed planned obsolescence in mind. The batteries died within a year, and couldn't be replaced with new ones. A group complaint was made and Apple had to act on it.

To prevent recession like the one that shook the economy in the 1930s, a man called Bernard London proposed that planned obsolescence should be entered into legislation. The aim was to define short life spans for products so that consumers would keep on buying them and thus employment would be safeguarded. It never happened, but instead in the 1950s planned obsolescence was made desirable with the help of advertising. Industrial designer Brook Stevens' propaganda on the behalf of planned obsolescence made the concept the gospel of the time. Design and marketing seduced consumers to desire always the latest models which were more beautiful and advanced than the ones they already owned. Sounds familiar? That's exactly what consumers are doing today.

During fifties natural resources were believed to be endless and continuous growth was considered as a necessity. Nowadays we know that we are living in a limited system with finite resources, but still we are trying to convince ourselves that continuous economic growth is needed to create and sustain prosperity, and that the only way to do that is by consuming frantically. Planned obsolescence is nowadays even taught in schools for the future engineers and designers. Frequent repeated purchase is the aim of majority of companies worldwide. Engineers and designers have to be able and willing to design the way that is required in the business strategy in the company they work for. If a company wants to launch a new product every few years, designers need to be ready to fulfill their requests.

3.3.2 Towards sustainability

The mercantilist view of economic welfare (dates back to 16th century) argues that nation's prosperity is directly relative to raw materials that are available for industry to use. This kind of economy leans on flow-through –economy, which means that after use natural resources will become waste. (Gustafsson 2005, 127.) With planned obsolescence ruling, the majority of our manufacturing systems are a bit outdated to say the least!

A new view for production methods was introduced in UNCED meeting in Rio 1992 when the term eco-efficiency was launched. The core idea of eco-efficiency is to do more with less. In business terms this means making more money and utility with less energy and material input. This results in less waste, pollution, and less cost. Eco-efficiency can be understood as an efficiency with which human needs are fulfilled by using natural resources or as a proportion of output and input where eco-efficiency is the value of products or services divided with environmental impacts caused by the economic activity. (Gustafsson 2005, 127; Penttinen 2010, 32.)

Cradle to Cradle –thinking (C2C), which is quite similar to biomimicry and therefore brought up here, arose to oppose planned obsolescence. C2C was developed by an architect W.McDonough and a chemist M. Braungart in 2002. C2C approach is a simple method which aims at new way of thinking and remaking things, using nature as an inspiration. The first principle of C2C, which actually refers to the name of the concept, is: waste equals food. Products and processes are to be designed keeping in mind that waste does not exist. It means closing the loops, in other words using output of processes as an input to system. The second principle is: use current solar income, not the fossil fuels. The third one suggests that our designs should respect and celebrate biodiversity. (García-Serna, Pérez-Barrigón & Cocero 2007, 12.)

Entropy, which means that matter disperses during time, creates its own challenge to closed-looped manufacturing. Combined with eco-efficiency virgin raw

material, renewable or non-renewable, would be conserved and production as a whole would be even more sustainable.

In his book *Lessons from Nature* Daniel Chiras (1992, 78) states that doing more with less is not enough, it's only a step in the shift towards sustainable society. Learning to do less with less is the fundamental change we should be heading at. Most importantly, we must learn to be happy with less. That is easier said than done. Who volunteers to go back to less comfortable and less convenient life?

3.3.3 Green products

Even if consumption was brought on an appropriate level, which means that nature has time to heal from the extraction of raw materials, and people start being happy with less, designing green products is still important. Deeply green products are designed by taken into account the whole lifespan – manufacturing, use and “afterlife” – of a product (Benyus 1997, 282). For a green company this would mean cradle to cradle –type of approach and closed-loop manufacturing systems brought up earlier.

Designers with the help of advertising people have a great opportunity to be “the good guys”. Making pro-environmental products fashionable and desirable will promote the sales of these products substantially. Making envy green is the way to go. (Benyus 1997, 282.)

Companies have realized the niche of green products, that's for sure. An increasing demand of green products creates the need for companies to provide them. This may lead to so called green wash, which consumers should eschew. You don't want to give your money to a fraud do you? Sometimes it's hard to tell if a company has made a conscious choice of being fake or is it just ignorance. On the other hand, companies have responsibility to be aware of the impacts of their activities, so there is no room for explanations really. Biodegradable diapers are a good example. At first sight and not knowing better it may seem like

a perfect choice for environmentally conscious consumer, but the reality is different. Despite the material is biodegradable the diapers won't decompose since there is no air available for microbes in landfills. (Chiras 1992, 87.)

Eco-labeling is one way to make sure that the product is really as green as told. But there are downsides here as well. As well as companies may advertise their non-green products as green, also labels can be made up. Therefore consumers should only trust accredited labels. Eco-label makes sure that the product has gone through a certain environmental audit.

3.3.4 What does it mean to be a green business?

According to the Business Dictionary a company is a green business, ideally, when it has no negative impact on the global or local environment, the community, or the economy. Typical for green business is also engaging forward-thinking policies for environmental concerns and policies that are affecting human rights.

To put it simple, being a green business means that a company chooses to operate in an environmentally friendly way. Green businesses are striving for making their policies, practices, and principles more sustainable and as a result there is a positive outcome to the environment. The reasons don't matter: businesses can try to solve environmental or societal problems or just attempt to produce products with smaller footprint. (Green Marketing TV 2011.)

Joel Makower claims that the problem defining green business lies in the lack of uniform standards. As he puts it, a toxics-spewing chemical company can call itself a green business simply if it assembles solar panels on the roof. In the end, it's about companies defining themselves what they believe is "good enough" for their customers, employees, communities, and the natural environment. (Makower 2009, 21–23.) In other words, defining green business is in the eye of the beholder.

Audits, a few green products, and environmental evaluation are good, but not sufficient enough for overall sustainability of a company. According to David Brower, former director of the Sierra Club, there are three possibilities for making company even greener. First, CEOs should be able to be free to refrain from environmentally unacceptable activities, even if it results in profits losses, without being sued or otherwise threatened by shareholders. Second, all investment offerings should come with environmental impact statement. This way investment decisions could be based on both profitability and environmental considerations. Third, environmental impact statements should also be required for all takeovers since they often tend to be environmentally destructive. (Chiras 1992, 90–91.)

By mixing the forgoing definitions together green business can be defined as combination of green values and green practices. Green values consist of green policies (environmental policy, business strategy, management), principles (vision, mission) and investments. Green practices include sustainable manufacturing processes and green products.

3.3.5 How does a company benefit for being green?

As it turned out earlier, green image with green products, but also services (technological innovations e.g.) can create a great deal of sales. Green image is therefore a reply for green consumerism. In addition to customers, according to some surveys, environmental image is important when choosing an employer. To be authentically pro-environmental, company needs to get the best employees, the ones who think that being green business really matters. (Turner, Pearce & Bateman 1994, 249.)

If the true costs of environmental impacts are taken into account, a company saves money. These costs include transportation, waste management and all other hidden costs, energy and water consumption for example. Being green also means that a company is not depleting natural resources it needs for manufacturing processes. Obviously this means that businesses from the same sec-

tor commit themselves to this principle as well. Especially big, multinational corporations should acknowledge their responsibility.

The limits of natural world could constrain business operations and realign markets. Also growing concern of stakeholders is setting new kind of pressures to companies. Surprisingly banks and insurance companies are new arrivals on the environmental scene. (Esty & Winston 2006, 8–9.)

Traditional elements of competitive advantage, such as access to cheaper raw materials and lower cost of capital, are starting to lose their place. In the new world of business going green offers an important new path to innovation and to creating enduring value and competitive advantage. (Esty & Winston 2006, 11.)

4 BIOMIMICRY

Biomimicry stems from the words life and imitation, bios and mimesis in Greek (Biomimicry Guild 2008–2010a). Biomimicry is an innovation method seeking sustainable solutions for problems we humans face by imitating nature's patterns and strategies that have formed during thousands of centuries. The method seeks to create earth-friendly products, processes, and policies that are sustainable in the long run. (Biomimicry Guild 2008–2010b.)

It is important to distinguish what biomimicry is not. Bioprocessing in which bacteria is used to clean wastewater for example is bio-assisted technology, not biomimicry. This is because biomimicry is learning an idea from an organism and then applying it to human purposes, not using the organism itself. (TED 2005.)

Although biomimicry is a new, emerging field of study, it is not a new invention. Leonardo da Vinci, for instance, tried to design an airplane based on the way birds fly at the turn of the 15th century (Holland, 3). Later on the Wright brothers combined pieces of knowledge on aerodynamics and gasoline engine and created the first airplane which had its first flight in 1903 (Rothschild 1990, 350).

4.1 Institutions related to biomimicry

Biomimicry 3.8 is the global leader in biomimicry curricula development for educators, innovation training for professionals, and consulting services for corporations. Its mission is to train, equip, and connect scientists, engineers, architects, educators, and other innovators to sustainably emulate nature's 3.8 billion years of brilliant designs and strategies. (Neal Forsthoefel, Biomimicry 3.8, email 22.3.2012.)

Over the past 14 years Biomimicry 3.8 has operated both as a for-profit corporation (Biomimicry Guild) and a non-profit institute (Biomimicry Institute), and has helped more than 250 clients to redesign products (from sneakers to air-

planes), manufacturing processes and even entire cities, all in nature's sustainable image. The staff of Biomimicry 3.8 and partners worldwide have reached millions through talks and trained hundreds who now practice biomimicry in their own professions. (Biomimicry 3.8.)

4.1.1 Biomimicry Guild and Biomimicry Institute

Biomimicry Guild, a for-profit innovation consultancy providing biological consulting and research, workshops and field excursions, and a speakers' bureau was founded in 1998 by Janine Benyus and Dr. Dayna Baumeister. For designers the Guild offers help to learn from and emulate natural models to develop products, processes, and policies that create conditions conducive to life. The guild is sited in Helena, Montana. (Biomimicry Guild 2008–2010c.)

The Biomimicry Institute (TBI), which was founded by Benyus in 2006, is a non-profit organization based in Missoula, Montana (Biomimicry Guild 2008–2010c). TBI promotes the study and imitation of nature's designs bringing together scientists, engineers, architects and innovators who can use those models to create sustainable technologies. TBI offers education from short-term workshops to two-year master's level certificate courses. It also helps developing and sharing biomimicry-related curricula used in a range of educational venues. (Biomimicry Institute 2007–2012a.)

AskNature – Nature as a solutions database

AskNature.org is an open source database, a project of TBI, where experts from different disciplines biology, design, architecture, engineering or chemistry for instance can share their knowledge and get inspired by nature, making bio-inspired technological breakthroughs. This is something that has never been done before. The world's biological literature is being organized to function for the very first time. (Biomimicry Institute 2007–2012b.)

4.1.2 Biomimicry Europa

People are interested in biomimicry on the opposite coast of the Atlantic Ocean as well. Biomimicry Europa, established in Brussels in 2006, is an international non-profit association, which aims to contribute sustainability by promoting biomimicry. The association arose from the contacts with TBI founders and its team, and therefore it intends to develop a strong relationship with the “Montana base”. (Biomimicry Europa 2008a.)

Biomimicry Europa defines Biomimicry as an “innovation process encouraging the transfer of ideas, concepts and strategies inspired from the living world, with the objective of designing human applications aiming at a sustainable development” (Biomimicry Europa 2008b).

4.2 Principles

According to Janine Benyus, the founder of the Biomimicry guild and Biomimicry Institute and the author of the book Biomimicry – Innovation inspired by nature, there are three following principles that apply in biomimicry:

- ∞ Nature as a model
- ∞ Nature as a measure
- ∞ Nature as a mentor

Nature as a model

This means we would be taking our cue from natural processes using sun as energy source and simple compounds to produce goods. Our farms would be like prairies, self-fertilizing and pest-resistant with perennial and diverse varieties. We would also consult animals and insects to find new drugs or crops. Even computing, which at first sight seems to be as far from nature as possible, could take lessons from nature, since after all, computers are made to mimic the function of the brains. (Biomimicry Guild 2008–2010a.)

By learning from organisms humans can solve a variety of different problems. Nature has been solving these problems for 3.8 billion years ever since the first bacteria came along. So far living things have done everything we have done and what we only can dream of doing, without fossil fuel, polluting the planet or mortgaging their future – sustainably. As Benyus sets a question: What better models could there be? (Benyus 1997, 2–3.)

Nature as a measure

Nature provides the model but it also functions as a measure. Human innovations would be cross-checked against nature's standards. Innovations should be life promoting, they should fit in and they should last, these are the rules that apply in nature. (Biomimicry Guild 2008–2010a.)

Nature as a mentor

Perhaps the most important thing that biomimicry could offer is the way we place nature. Starting to see nature as a mentor, a source of ideas instead of source of raw materials, we would be shifting from extracting to learning. We would be obedient students rather than savages who “torture nature for its secrets”. Viewing nature as a source of ideas instead of goods, protecting biodiversity and conserving resources becomes more and more reasonable. (Biomimicry Guild 2008–2010a.) Jonathon Porritt (2007, 161) describes biomimicry as a philosophical and visionary approach bringing together humankind's model of progress and growth and nature's systems and processes.

4.3 The three levels of biomimicry – from shallow to deep

Biomimicry can be implemented in three different levels. The first and shallowest level is mimicking natural form. Copying nature's design is only the tip of the iceberg. For achieving deeper biomimicry, one must mimic natural process, the way the thing at issue is made. The third and the deepest level come true by mimicking natural ecosystems. (Biomimicry Guild 2008–2010a) This level of biomimicry is presented in chapter 4.4.

Organisms evolve and learn through genetic information over long periods of time. People do to (being living organisms as well), but there is another much faster way to learn: communication and technology. People speak, read and write and transfer knowledge between individuals, communities, nations, business life etc. We can use our wit and technology, man-made capabilities, to copy nature's designs and processes. While some nature's functions can be copied in detail, others are better serving as an inspiration for more sustainable activities. At least until the technology needed is available. Combining all these levels together with the principles of biomimicry our actions will gradually start to be life promoting instead of destructive to life.

4.4 The deepest level of biomimicry – learning from ecosystems

In chapter three the flaws of current economic model and the way we have been conducting business till today was presented. In the future green business hopefully becomes established among companies' worldwide. Emulating biological ecosystems makes sense because ecosystems are without a doubt time-tested and they function perfectly on the behalf of all organisms in it.

Biology attained the status of a science worth emulating around 1950s, after DNA was discovered. Numerous breakthroughs happened in the field of biology, in ecology, cellular and molecular biology for instance, and in the 1970s biology was at the top of sciences. The thought of emulating biology made it possible to question the paradigm of the human economy as a cyclical machine. The idea of economy as an evolving ecosystem came to being. (Rothschild 1990, 335.)

More specifically, this idea has been applied to industrial activities. The industrial ecosystem functions as an analogue of biological ecosystems. Efficiency, recycling, renewable resources and restoration are the cornerstones of manufacturing in an industrial ecosystem. (Chiras 1992, 94.)

A good way to start making human economy function more like natural world is to take a look at mature ecosystems like forests. In mature ecosystem where organisms have reached the most efficient and specialized level they:

1. Use waste as a recourse
2. Diversify and cooperate to fully use the habitat
3. Gather and use energy efficiently
4. Optimize rather than maximize
5. Use materials sparingly
6. Don't foul their nests
7. Don't draw dawn recourses
8. Remain in balance with the biosphere
9. Run on information
10. Shop locally

(Benyus 1997, 248–253.)

4.4.1 Cycle of life

Mature community circulates nutrients and minerals. This circle of life and death consists of sprouting, dying and decaying of organic matter. Every organism has their place: producers, consumers and decomposers are playing their parts in closing the loops to make sure resources won't be lost. Organisms are masters of *using waste as a resource*. (Benyus 1997, 254–255.) In biosphere *materials stay in balance*. Whatever is removed from the resource reservoirs is replaced in equal amounts. Nothing is imported or exported because biosphere is a closed system. (Benyus 1997, 271–273.)

Since nature's processes are cyclical waste doesn't actually exist. The only thing that is taken from outside the system is energy. Our current economic systems on the other hand, as it turned out in chapter three, are mostly linear and open input-output –systems (Figure 1) in which energy and raw materials are

put into the system and the output results in goods but also in wastes and emissions that are led back into nature. In human economy the problem is that consumers don't consume, they dispose.

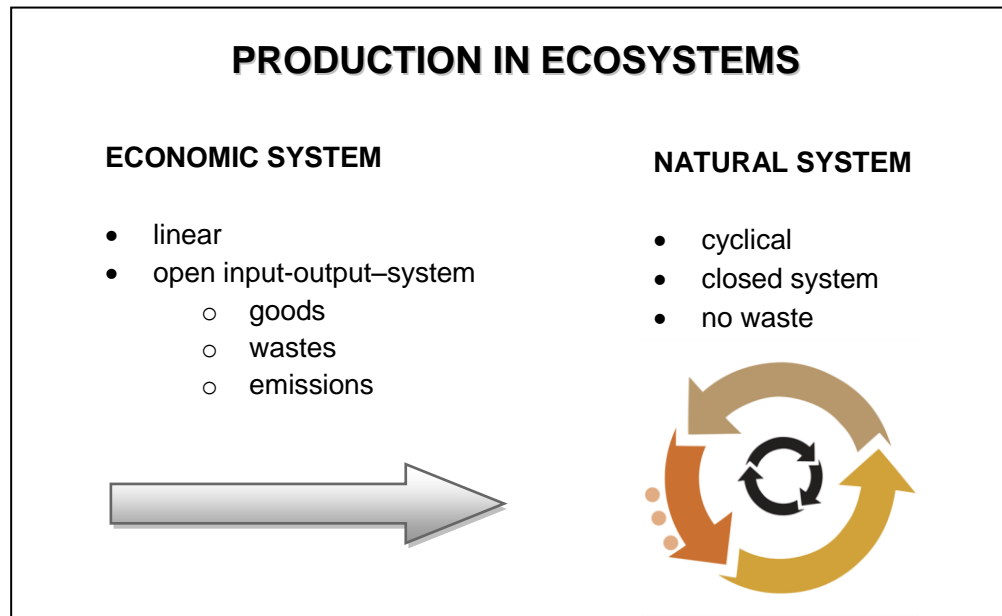


Figure1. Production in ecosystems.

4.4.2 Moderation

Organisms make sure they don't mess up with their growing stock. This means that they don't completely eliminate their prey, kill their hosts or over-consume the vegetation they're eating. What comes to nonrenewable resources like metals or minerals, organisms are not great fan of those to begin with. (Benyus 1997, 269–270.) To not *draw down resources* humans should keep in mind two simple but very essential lessons Benyus (1997, 270) has brought up:

1. Don't use nonrenewable resources faster than you can develop substitutes.
2. Don't use renewable resources faster than they can regenerate themselves.

A good example of the second lesson learned is sustained yield in forestry. The idea of sustained yield is to harvest only what has grown during the year yield is harvested. In terms of economy, you are living on interest, not depleting the capital. (Benyus 1997, 271.)

Organisms also make sure that they *don't pollute their living environment*. They don't use the "heat, beat and treat –method" which is referring to human manufacturing including high heat, strong chemicals and high pressure. By moderating energy and material use and not stressing the supply lines or cleanup mechanisms, organisms maintain their lifelines. (Benyus 1997, 265–267.) People must respect the fact that pollution rates should not exceed nature's ability to receive and process them (Gustafsson 2005, 128).

4.4.3 Efficiency

In natural communities organisms taking care of photosynthesis – green plants, blue-green algae and some bacteria – are the ones fixing the energy coming from the sun. They achieve astonishing 95 percent quantum *efficiency*. Animals strive for timing their activities so that they can maximize their rewards and *minimize energy costs*. They also travel only as far as necessary to save energy. To act effectively, organisms have evolved ways to work smarter, not harder. (Benyus 1997, 260–261.) One may consider humans being smart using fossil energy sources. A few table spoons of crude oil contain the same amount of energy that releases from eight hours of human work. Smart and efficient? Yes, but not sustainable. To harness the power coming directly from the sun is a technological challenge of our generation or the generations to come.

Humans definitely are not the only species that build. The difference between humans and other organisms is that organisms don't overbuild. They are building for durability, fitting form to function with the *minimum material input*, material efficiency that is. If thinking about the examples brought up in the Light Bulb Conspiracy documentary, one can only wonder the perversion of our economic

activities. Changes in the mindset of consumers, business men and politicians are crucial to enable designers and engineers to design for durability not for disposability.

In human world a lot of things are maximized, profits, prosperity, success, indulgence, just to name a few. The aim is to gain as much volume as possible. In a mature ecosystem emphasis is on *optimizing*, doing things in most favorable way. Being efficient and learning to do more with less is rewarded (Benyus 1997, 263). That is being eco-efficient. Many businesses however pay more attention to labor and capital costs than implementing eco-efficiency (Turner et al. 1994, 248). This phenomenon is well-known in paper industry for example. The factories are shut down in welfare states, like Finland, and shifted into countries where there is lack of environmental and labor laws.

Of course in some cases nature splurges. For example in spring or summer time when flowers are blossoming in the meadow nature doesn't seem to optimize. This is not a mature, type III ecosystem though, it is type I ecosystem, a developing ecosystem, where species' life spans are short, growth is rapid, and production method is based on quantity to insure offspring's survival (Benyus 1997, 252).

4.4.4 Cooperation and communication

Competition makes sense from evolutionary point of view: the best and the strongest individuals can transfer their genes to the next generations. In an ecosystem, whether it is natural or economical, competition and cooperation go hand in hand. Together they create diversity and abundance to the Earth's ecosystem as well as to the global market economy. Competition leads to specialization which prevents extinction and makes use of resources efficient. (Rothschild 1990, 336; Porritt 2007, 103.) Good examples of *cooperation* in biological ecosystem are mutualism and symbiosis. Species work together to gain mutual benefit without competing with each other. (Benyus 1997, 258.) This kind of

positive synergy is also useful for business. In closed-loop manufacturing systems companies can utilize each other, especially if sited in close range. A company can sell its output to the other, who can use it as an input. It's a win-win situation from economical point of view but also from the viewpoint of the environment.

Rich *communication channels* help carrying feedback to all members in a system and helping the community (whether it is a mature ecosystem or a company) towards sustainability. To fix the problem we have in the economy at the moment, the fact that we take more than the world can replace and release more it can handle, feedback links among and within businesses has to be established as well as feedback from the environment to businesses. (Benyus 1997, 274.)

4.4.5 Localization

Biological communities are localized or relatively closely connected to time and space. Organisms don't commute, instead they shop locally and become *local experts* in their own living environment. This saves energy and enables making most of organism's abilities. Unfortunately local expertise, or bioregional attunement, is a lesson we seem to be ignoring completely. (Benyus 1997, 276.)

The order for today is global, borderless economy, where a final product has seen fistful of different countries and travelled thousands of miles. Also foods that could be grown and sold inside the country's borders are trucked, flown or shipped from foreign soils of different countries. (Benyus 1997, 276.) Current model of globalization tries to standardize practices and fit them where they don't belong. By not mimicking this special feature of nature, corporations rule out regional preferences and cultural histories. To gain maximum or nature's style optimum benefit and wellbeing, ownership should be kept close to local conditions. When ownership is too far removed from local circumstances, decision making often obscures and results in non-optimal economic evolution. (Poletti & Ogilvy 2003, 620.)

Jonathon Porritt (2007, 97–98) cites John Keynes in his book *Capitalism as if The World Matters* bringing up a logical, yet nowadays unfashionable idea. Things like travel, knowledge and art should be international because of their nature. Goods on the other hand should be produced inside nations' borders whenever possible and reasonable.

Green economy encourages to exports which is a bit contradictory to this nature's instruction. The aim is still the same. Improving the wellbeing in developing countries promotes the sustainability in a larger scale. Multinational corporations could take a lesson from nature and rather than going and exploit natural resources and local communities they could invest on green technology in the specific location.

4.5 Case studies

There are more and more examples in business life on how to mimic nature to make human actions more sustainable, in a profitable way even. In the next chapter some case studies are shortly presented to give an idea how biomimicry can be realized and how all-around method it is.

4.5.1 Curbing CO₂ emissions - Carbon Dioxide Technology by CALERA

Calera is a Californian company aiming at developing technologies that reduce industrial CO₂ emissions by capturing and converting industrial CO₂ emissions into stable solid minerals or other usable materials. These technologies could be used in power plants, chemical plants or cement plants for example. (Calera a).

Inspiration for technology stems from natural chemical processes in the world's oceans, which have helped to balance the world's carbon cycle and created massive formations of carbonate deposits. Over geologic time CO₂ absorbs into the oceans and converts into stable minerals, for instance limestone. (Calera b.)

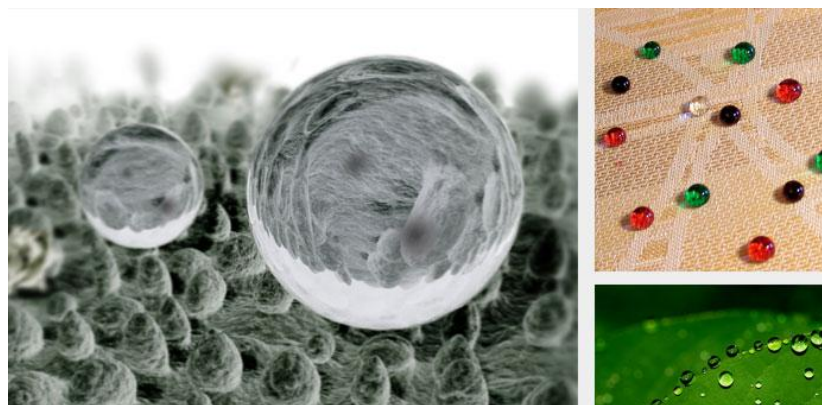
4.5.2 Sustainable buildings: Eastgate Building in Harare

An office building in Harare Zimbabwe designed by architect Mick Pearce can be considered as an architectural marvel. Biomimicry principles are used innovatively to construct a sustainable building. Eastgate Building has no conventional air-conditioning or heating, instead it uses technology adopted from the self-cooling mounds of African termites.

Eastgate uses 90% less energy than a conventional building of its size. Saving energy means saving money. 3.5 million dollars alone has been saved because there wasn't no need to implement separate air-conditioning system. (Inhabitat 2012.)

4.5.3 Water repellency of fabrics: GreenShield

BigSky Technologies has developed a green nano-particle-based innovation, a fabric finish called GreenShield, which reduces health and environmental impact of stain resistant finishes since it dramatically lowers the amount of fluorochemicals used. Microscopic roughness on the surface of leaves (Picture 1), which prevents leaves from getting wet, is the inspiration behind GreenShield.(GreenShield.)



Picture 1. Water repellency. (Biomimicry Institute 2007-2012).

4.5.4 Quieter energy saving commuting - The Shinkansen Bullet Train

The problem with fast trains is noise generated from air pressure changes. A solution for this problem in one of the Shinkansen Bullet Trains in Japan was inspired by kingfisher (Picture 2), whose beak is perfect for the job: a fast dive into water with very little splash guarantees a catch. The front-end of the train was designed mimicking kingfishers beak, which resulted in a quieter and faster train with 15% less energy consumption. (Biomimicry Institute 2007–2012c.)



Picture 2. Kingfisher and bullet train. (Biomimicry Institute 2007–2012.)

5 THE BRIDGE BETWEEN

5.1 Biomimicry, green economy and green business

There are clear similarities in the principles and goals of biomimicry and green economy (Appendix 1). Biomimicry is aiming at sustainability in the long run, just like green economy. Both are related to production and consumption of goods. Biomimicry is about innovating new technologies and practices and green economy stresses the importance of technology transfer to developing countries. Biomimetic technology transfer could be implemented in a way that expensive investments and prototypes are developed in richest countries and solutions are taken into developing countries after becoming established.

Biomimetic innovations can help companies to be competitive and biomimicry can be applied exactly on the same sectors of economy which have most export potential: in primary and secondary industry and in energy sector. Design with the form and function in mind will be emphasized in manufacturing and energy sectors and mimicking ecosystems in primary industry, although mimicking natural ecosystems can be adopted almost everywhere.

In biological ecosystems localization and specialization are important, every organism have their role to play, they are not doing what they are not supposed to do. Since there are vast differences in natural, human and economic resources between countries the rule applies in green economy too: it's important to realize and accept the boundaries of production in a specific country. For example, if there is not enough water, then maybe it's not the best solution to grow cotton. Products manufactured and energy produced depends on the circumstances of the country. Extraction of raw-materials and manufacturing should happen in the same place wherever possible. Mining in Africa is a cautionary example.

If we can change our mindsets concerning consumption it would help in transition from overconsumption to appropriate consumption, in shifting from max-

imizing to optimizing. The change in our mindset gives room for sustainable design, i.e. design for durability, which can be realized with the help of biomimicry.

If green business is defined as a combination of practices and values, biomimicry fits in the picture with flying colors due to the coverage of the method. The connections are summarized in the table below (Table 1), which is based on the definitions brought up earlier.

Table 1. Green business and biomimicry.

Green business	Biomimicry
Green practises <ul style="list-style-type: none"> • product design • manufacturing processes 	Design inspired by nature <ul style="list-style-type: none"> • fitting form to function • mimicking natural processes
Green values <ul style="list-style-type: none"> • policies • principles • investments 	Nature as mentor <ul style="list-style-type: none"> • mimicking natural ecosystems • nature as source of ideas, not raw materials

A clear green image will satisfy environmentally conscious clients, consumers and employees, and at the end of the day company can benefit from the investments put in biomimicry.

5.2 Production and biomimicry

Efficiency, both in material and energy consumption apply in the mature ecosystem. Doing more with less is also what companies can pretty easily do to make their ecological footprints smaller. Ilpo Penttinen (2010, 32–33) has put together four main possibilities to execute eco-efficiency:

- 1) Companies should start selling services instead of products.

- 2) Re-engineering processes and disposal or delivery and supplier operations for example.
- 3) Co-operating with other companies to make the most of the by-products. One company's waste is other company's raw material.
- 4) Redesigning products according to ecological design rules.

Penttinen states that biomimicry is a good tool for implementing eco-efficiency. On the basis of the theory presented earlier his statement can be supported. All possibilities excluding the first one are realizable with the help of biomimicry.

Despite of the emergence of cradle to cradle approach, make-use-dispose – thinking (linear input-output) is still dominant (Porritt2007, 191). By mimicking nature's designs and processes and mature ecosystems, especially the cycle of life, companies can learn to close the loops and make the word waste disappear. This means that production residue is utilized again and again in the manufacturing processes and the goods that are disposed of by consumers can efficiently be collected and re-used or recycled.

The process starts from the design table. The products should be designed in a way that the whole lifespan of the product is taken into account. The attention should be paid on energy consumption, raw materials extracted, transportation need and recyclability. But first of all, an important questions to ask and answer: is the product necessary and is it part of a larger economy that works on the behalf of nature and people (Biomimicry Guild 2008–2010a). Thinking about necessity is really important since it screens out the products that are not needed. There are hundreds of thousands of products produced every day that have no significance whatsoever.

Profits are basically the main reason business is done at the first place. Therefore it is important to find out if the product has an economically viable role (Biomimicry Guild 2008–2010a). When designing using nature as an inspiration, it may turn out to be an expensive and long lasting project. Learning how nature's processes could be applied to the production of a specific product, could

take years of studying. Of course the viability should be considered always when creating something totally new and innovative.

No matter how green the manufacturing process or the products are, if the trade is global, there are some negative impacts because of transportation needs. The most severe environmental impacts of transportation will be history after we figure out how to satisfy the energy need with power coming directly from the sun. Here too biomimicry can be of assistance. Producing hydrogen gas from sunlight and water are under examination, unfortunately nothing groundbreaking hasn't happened yet (Benyus 1997, 84). We just have to wait and see.

5.3 SWOT-analysis

In the following simplified SWOT-analysis on biomimicry and its relations to economic activities the discussion of further measures to be taken is ruled out. The aim is to clarify the pros and cons of biomimicry as a tool for implementing green economy and business. There is a figure (Figure 2) in the end of the chapter to summarize the SWOT.

STRENGTHS

There are strong institutions built around biomimicry. Biomimicry 3.8 is providing educational and consultation services all over the globe. Companies in Finland for example have an opportunity to contact Biomimicry Guild and get inspired by nature. There is a Biomimicry& Innovation Group on LinkedIn forum where interested and engaged people across different disciplines can exchange ideas, thoughts and best practices on biomimicry.

Biomimicry can be applied in different sectors of economy. Biomimicry Guild focuses giving consultation in three main areas: Built Environment, Materials & Products, and Organizational Development. Biomimicry is suitable for organizations of all sizes, but the larger the company is the larger the investments can be, naturally. (Neal Forsthoefel, Biomimicry 3.8, email 22.3.2012.)

Deeply green products and technologies have markets in the future, especially if the transition towards green economy takes place. Biomimicry cuts costs in the long run and makes products desirable, which means profits.

Nature's principles can also be used as guidance, and there is no need for technological innovations necessarily. Implementing eco-efficiency for instance is possible without big investments and therefore available even for smaller companies. If mimicking only natural forms can be called biomimicry, why not mimicking nature's principles either?

A great strength of biomimicry is that it is really comprehensive: it provides innovative solutions to environmental problems and answers to sustainability dilemma, but it is an ideology, too. By studying nature people learn to respect it and understand the importance of conservation, in other words, the more people, especially business people, are aware of the potential of biomimicry, the more they want to protect biodiversity – every loss of species is a potential loss for new sustainable and profitable innovation. Adopting this ideology may affect on the way we see ourselves in the world's order. For the time being we convince ourselves to be the rulers of the Earth. The problems we are facing today spring from this mindset, which is definitely not a basis for sustainability.

WEAKNESSES

For biomimicry to really help any organization requires a substantial investment in both time and money (especially if mimicking processes and systems). The larger the organization, the bigger the investment usually is. (Neal Forsthoefer, Biomimicry 3.8, email 22.3.2012.) This raises a question: is design innovated by nature only for those companies that can afford to experiment new ways of doing their business? Not only the potential high price tag for product design gone wrong, meaning that the product won't sell, but also the fact that using biomimicry in design requires know-how and advanced technology may turn out to be a stumbling stone. Smaller companies don't have their own designer or engineer sections where they could develop new innovations. Sure they can always hire someone to do that, but again, it costs money.

Being strongly cross-disciplinary, biomimicry requires a lot of cooperation between biologists, engineers, managers, designers and scientist, lots of networks and contacts.

If only the shallowest level of biomimicry (mimicking natural form) is implemented, it's not going to contribute to green business. Also if a company has only one biomimetic product in its wide range of goods, the positive effects will stay close to nothing. Businesses can also use nature's knowledge for purely making money. Thinking only about the economical or individual interests excluding the natural world can result in technological innovations that could be in the worst case used against nature, not on behalf of it. Without an ideology biomimicry could end up being only a technological tool for solving environmental problems. The approach is therefore technocratic and doesn't really go into the heart of the problems. It's like medicine that takes away the pain but not the illness itself. On the other hand, does it matter why biomimicry is used as long as it contributes to the state of the environment?

THREATS

Using biomimicry, like any other design method, includes a risk of not reaching the desired market success. Nike for example had to face this with Goatek shoes, which were designed after the hoof of a goat (Vella 2008).

Before entering to green economy global economic crises may hinder companies' interest towards biomimicry. In situations like that long term decisions cannot be made.

OPPORTUNITIES

Nature's 100 Best (published 2009) is a book written in collaboration with the Biomimicry Guild, Zero Emission Research and Initiatives, UN Environment Programme and International Union for the Conservation of Nature. The book was written to show the versatility of biomimicry in solving technological and sustainability problems. Over 2000 technologies were analyzed, and 100 were chosen as priorities. The 100 best solutions are said to be preliminary findings

on how to green the global economy. (UNEP News Centre.) For this study-wise it would have been good to get a hold of this book but it turned out to be a complicated task. Maybe this book should be republished since green economy is topical in the becoming UNCSD meeting.

Eco-labels and certificates help selling pro-environment goods. If biomimicry had its own eco-label, it could be easier for companies to approach biomimicry in search for greener business activities.

The change in company's practices can start from innovation in product design and be widened to the whole strategy of a company. In business life environmental issues are connected to strategic management nowadays. Especially the ecological dimension of sustainable development has become an important part of the global business environment and that is why the natural environment should be taken into account in strategic management. (Penttinen 2010, 36; 129–130.)

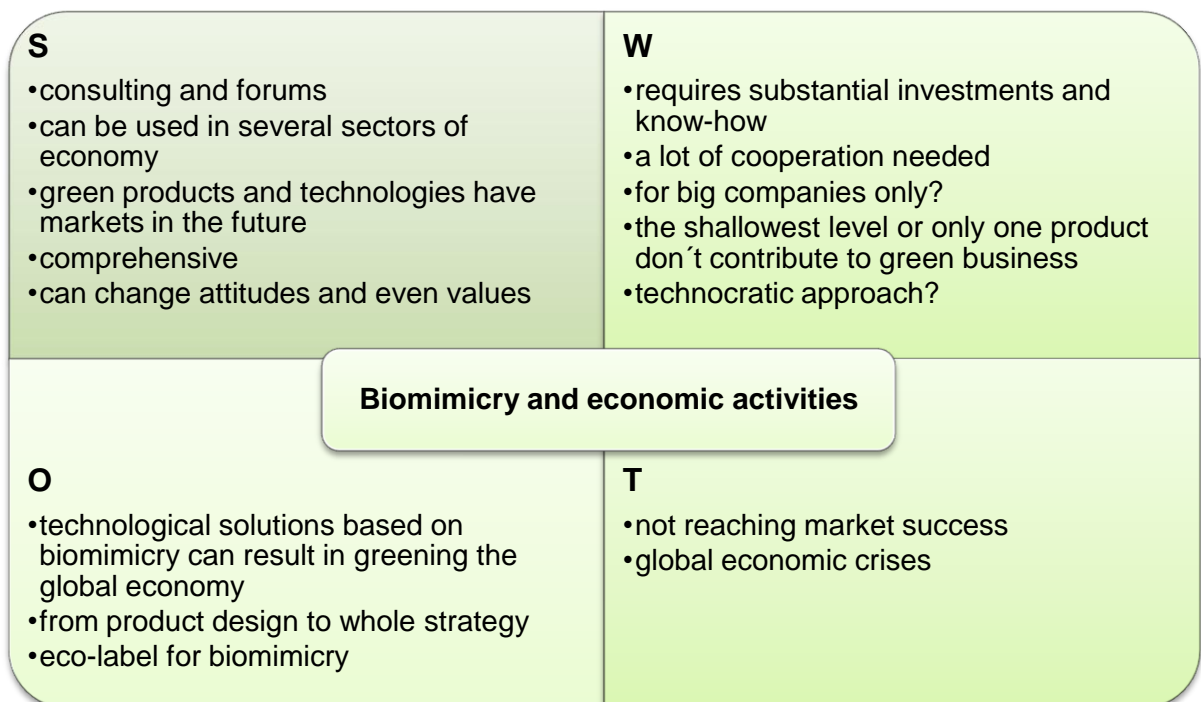


Figure2. SWOT-analysis.

6 CONCLUSIONS

After analyzing the data it can be concluded that there are clear connections between biomimicry and green economy. Connections can be found only by defining these two concepts. Biomimicry can be used in adopting green economy and also used as a tool for making business greener. In the best case biomimicry could contribute to green the economy in a global level. Not necessary alone, but as part of expansive reform.

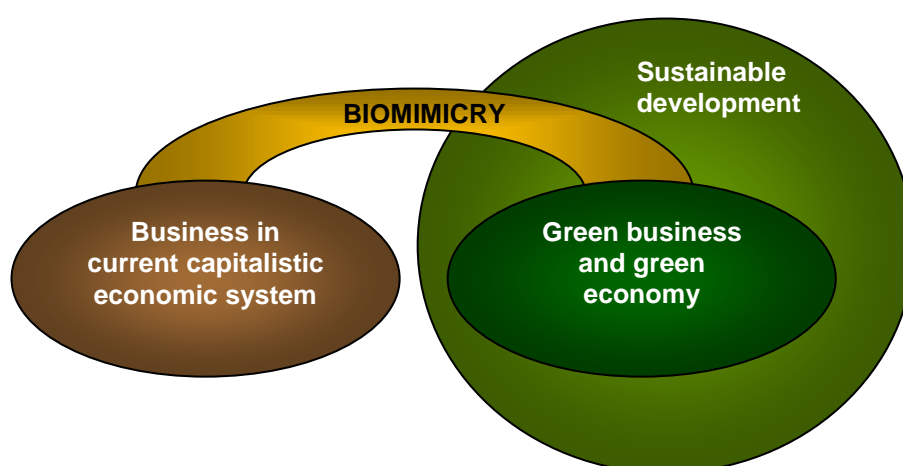


Figure 3. Biomimicry connecting current and future economic model.

Adopting biomimicry as part of sustainability practices works both ways: either biomimicry can help making business greener and hence contributing to transition towards green economy or after countries start shifting towards green economy biomimicry can help businesses to do their share. Anyway, biomimicry serves as a bridge between current and future economic model (Figure 3).

Biomimicry requires big investments, but if the innovation succeeds, investments turn out to be profitable in the long run. As the case studies show, the savings in energy costs for example are remarkable. Biomimicry reduces energy and material consumption and transportation need and improves recyclability of products and materials. Eco-efficiency is one essential form of biomimicry. There are also a number of studies which show that preventing environmental problems is more cost-effective than trying to fix the damage done. Studies on climate change and its costs, the Stern report e.g., are a good example here.

At its best biomimicry is a combination of technology, product design and ideology. Biomimetic product design and technological innovations help avoiding environmental problems and reducing already existing negative environmental impacts. Change in attitudes and values are necessary if we want to shift from the current economic model to a new green one. Biomimicry can help in opposing planned obsolescence with the durable design that fits form to function, but also with the new mindset which rises from the genuine respect for Mother Nature.

“Biomimicry is a field whose time has come.”

- Achim Steiner, UN Under-Secretary-General and UNEP Executive Director

REFERENCES

Benyus, J.M. 1997. *Biomimicry: Innovation Inspired by Nature*. New York, USA: Harper Perennial.

Biomimicry Europa. 2008a. Biomimicry Europa. Referenced 1.3.2012 <http://www.biomimicryeuropa.org/>

Biomimicry Europa. 2008b. What is biomimicry? Referenced 1.3.2012 <http://www.biomimicryeuropa.org/about/what-is-biomimicry/introduction>

Biomimicry Guild 2008–2010a. A conversation with Janine Benyus. Referenced 12.1.2012 <http://biomimicryguild.com/janineinterview.html>

Biomimicry Guild 2008–2010b. What is Biomimicry? Referenced 19.3.2012 http://biomimicryguild.com/guild_biomimicry.html#

Biomimicry Guild 2008–2010c. About the Biomimicry Guild. Referenced 29.2.2012 http://www.biomimicryguild.com/guild_about_us.html

Biomimicry Institute 2007–2012a. About us. Referenced 29.2.2012 <http://www.biomimicryinstitute.org/about-us/>

Biomimicry Institute 2007–2012b. AskNature. Referenced 29.2.2012 <http://www.biomimicryinstitute.org/resources/biomimicry-design-portal.html>

Biomimicry Institute 2007–2012c. Case Studies. Referenced 5.3.2012 [http://biomimicryinstitute.org/> Case Studies > Browse](http://biomimicryinstitute.org/>Case%20Studies%20>Browse)

Biomimicry 3.8. Announcement from founders. Referenced 22.3.2012 <http://biomimicry.net/letter.html>

Business Dictionary. Referenced 26.2.2012 <http://www.businessdictionary.com/definition/green-business.html>

Calera a. About us. Referenced 4.3.2012 [http://calera.com/index.php>About us](http://calera.com/index.php>About%20us)

Calera b. Carbon Dioxide Technology. Referenced 4.3.2012 [http://calera.com/index.php> Technology > Carbon Dioxide Technology](http://calera.com/index.php>Technology%20>Carbon%20Dioxide%20Technology)

Chiras, D.D. 1992. *Lessons from nature: Learning to live sustainably on the earth*. Washington USA: Island Press.

Esty, D.C. & Winston, A.S. 2006. *Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage*. New Haven, CT, USA: Yale University Press.
<http://site.ebrary.com.ezproxy.turkuamk.fi/lib/turkuamk/docDetail.action?docID=10210221>

García-Serna J.; Pérez-Barrigón, L.; Cocero M.J. 2007. New trends for design towards sustainability in chemical engineering: Green engineering. *Chemical Engineering Journal* 133, 7–30.

Green Marketing TV. 2011. What is a Green Business?. Referenced 26.2.2012 <http://www.greenmarketing.tv/2010/03/27/what-is-a-green-business/>

GreenShield. The first and only textile finish inspired by nature. Referenced 4.3.2012 <http://greenshieldfinish.com/>

Gustafsson, J. (edit.) 2005. Maailmanlaajuiset ympäristöongelmat. Vammala, FIN: Turun yliopiston täydennyskoulutuskeskus.

Hawken, P. 2010. The Ecology of Commerce: A Declaration of Sustainability. 1st, revised edition. New York, USA: Harper Business.

Holland, Wade. Biomimicry: The Answers May Be Right in Front of Us. Referenced 19.1.2012 http://colorado.edu/pwr/occasions/articles/Holland_Biomimicry.pdf

Inhabitat 2012. Green building in Zimbabwe modeled after termite mounds. Referenced 4.3.2012 <http://inhabitat.com/building-modelled-on-termites-eastgate-centre-in-zimbabwe/>

KvaliMOTV. Sisällönanalyysi. Referenced 13.4.2012 http://www.fsd.uta.fi/menetelmaopetus/kvali/L7_3_2.html

Makower, J. 2009. Strategies for The Green Economy: Opportunities and Challenges in The New World of Business. USA: McGraw-Hill.

Penttinen, I. 2010. Adoption of Eco-efficiency in Strategic and Operational Management of Industrial Small and Medium Sized Enterprises. Tampere: Tampereen yliopistopaino – Juvenes Print Oy.

Poletti, F.; Ogilvy, J. 2003. The emergence of sustainable future: Brainstorming better ways to globalize at the Esalen Institute. World Futures, 59: 615-623.

Porritt, J. 2007. Capitalism as if the world matters. London, Sterling, VA: Earthscan.

Rio+20 Issues Briefs. 2011. Brief 1: Trade and Green Economy. Referenced 20.3.2012 <http://www.uncsd2012.org/rio20/rio20issuesbriefs.html>

Rothschild, M. 1990. Bionomics: Economy as ecosystem. Ontario, Canada: Fitzhenry & Whiteside Ltd.

TED 2005. Janine Benyus shares nature's designs. Referenced 21.3.2012 http://www.ted.com/talks/janine_benyus_shares_nature_s_designs.html

The Light Bulb Conspiracy. 2010. Dannorizer, C. Mediapro, European co-production. Eurooppalainen yhteistuotanto. Aired on YLE TV1 13.3.2011. Referenced 19.3.2012. <http://www.youtube.com/watch?v=JLsxtTYy8WA>

Turner, K.; Pearce, D.; Bateman, I. 1994. Environmental Economics. Pearson Education Limited: Harlow, Essex, England.

UNCSD 2012. Rio+20 United Nations Conference on Sustainable Development. Referenced 20.3.2012 <http://www.uncsd2012.org/rio20/index.html>

UN Documents. Our Common Future, Part I. Common concerns. Chapter 2: Towards Sustainable Development. Referenced 24.2.2012 <http://www.un-documents.net/wced-ocf.htm>

UNEP News Centre. Entrepreneurs of the natural world showcase their groundbreaking solutions to the environmental challenges of the 21st century. Referenced 14.4.2012 <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=535&ArticleID=5816&l=en>

UNEP. 2009. Background paper for the ministerial consultations. Green economy. Referenced 14.4.2012

<http://www.unep.org/civil-society/Portals/59/Documents/GMGSF12-UNEP-GCSS-XI-10-add1-background-paper-on-GE.pdf>

Vella, M. (2008, February 11). Using Nature as a Design Guide. Bloomberg Businessweek.

Referenced 7.3.2012

http://www.businessweek.com/innovate/content/feb2008/id20080211_074559.htm

Connections between green economy and biomimicry

