Backcasting - What is a sustainable future and how do we reach it?

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5 BACKCASTING – WHAT IS A SUSTAINABLE FUTURE AND HOW DO WE REACH IT?

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This chapter is about ways of defining sustainability in an actionable way, in order to innovate and change the way products and services are being developed. The starting point is the four system conditions for sustainability developed by Holmberg (1995) and the Natural Step (a non-governmental organization). The second part of the chapter proceeds to introduce one particular proven way to introduce sustainable strategies in organizations, the 'backcasting approach' (Holmberg 1998; Holmberg & Robèrt 2000). The chapter ends by suggesting a combined backcasting/scenario planning approach (Alänge et al. 2007).

DEFINING SUSTAINABILITY

There are many definitions of sustainability, but a common starting point is the Brundtland Commission's report 'Our Common Future' which defined sustainable development in the following way (UN Brundtland Commission 1987, chapter II):

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

> "At a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings."

This broad definition has inspired many followers, both policy makers and academicians. When it comes to the company world, the question is how to make the sustainability concept useful for decision-making and action. There have been many attempts, more or less successful, to understand and act in a sustainable way.

There are some areas which are relatively easy to grasp, e.g. that it is no good to let dangerous by-products from production out directly into nature or into the sewage system. Sometimes sustainability is focused only on environmentally friendly products. Usually however, sustainability is seen as a multidimensional concept of supporting life on earth, which entails more than using environmentally friendly technologies and products to achieve economic growth (Sotoudeh 2005).

Many times, decisions need to be made concerning new products where it can be extremely hard to analyze any possible negative impact, especially if these impacts would show up sometime in the future and perhaps only if linked to some other changes in the environment. This means that the complexity sometimes is too large for companies to grasp the full picture, or the data or the knowledge needed may simply not yet exist. This refers to the 'dilemma of deciding under ignorance' which was discussed by Croy (1996).

> "In 1908 changes in the design and use of the automobile were easily implemented, but accurate prediction of its eventual social consequences was impossible. It was not possible to anticipate future problems with air pollution, lead in gasoline, non-renewable resources, social dynamics, etc.
>
> Today the undesired effects of automobiles use are easily determined, but change is difficult to implement" (Croy 1996 in Sotoudeh 2005).

Researchers have followed two tracks in order to deal with this complexity of sustainability. One way has been to try to list all substances and practices that were considered non-sustainable, and advise companies to avoid what was listed. Of course, this will work like a list of doping substances; it will omit the ones that were not yet known when the list was made. Furthermore, a list mainly contains individual components, while we realize that sustainability is a complex concept where one component is linked to several others and negative effects may only occur in combination with other factors. Even if only renewable resources are considered, there is a complexity because "…most renewable resources are part of a complex and interlinked ecosystem, and maximum sustainable yield must be defined after taking into account system-wide effects of exploitation." (UN Brundtland Commission 1987.) Hence, an alternative approach followed is to try to reduce the complexity and develop general principles which can be used to guide decision-making.

This is the case for the approach of defining what is sustainable, developed by Holmberg and Robèrt (Holmberg 1995, 1998; Holmberg & Robèrt 2000). The starting point is to identify what scientists can agree upon regarding sustainability and use this as a common base for the analysis, instead of including all those issues where they disagree. This led to the formulation of four non over-lapping basic principles for sustainability, which are being used as a non-prescriptive starting point for systems thinking about sustainability.

THE FOUR SYSTEM CONDITIONS

The starting point for identifying system conditions is the observation that humans can destroy the functions and biodiversity of the ecosphere by a systematic increase in concentration of matter that is net-introduced into the ecosphere from the outside (Earth's crust or Space), or a systematic increase in concentration of matter that is produced within the ecosphere, or a systematic physical deterioration within the ecosphere by over-harvesting or some other form of ecosystem manipulation which is not reversible (Holmberg & Robért 2000).

The *ecosphere* is that part of the Earth which directly or indirectly maintains its structure and flow using the energy (ordered energy, available work) flow from the 'sun/space battery'. With this definition the ecosphere contains the *biosphere*, the *atmosphere* (including the protective stratospheric ozone layer), the *hydrosphere* (water) and the *pedosphere* (the free layers of soil above the bedrock).

The *lithosphere* is the rest of the Earth, i.e. its core, mantle and crust. Processes in the lithosphere are primarily driven by radioactive decay of its heavy elements. The formation and concentration of minerals in the lithosphere are so slow that these resources, as viewed by society, can be considered as finite stocks.

There is a natural flow from the lithosphere to the ecosphere through volcanoes and through weathering processes, and there are reverse flows through sedimentation. However, compared to the turnover within the ecosphere, the exchange of energy and matter between the ecosphere and the lithosphere is often much smaller.

The above observations led to the formulation of the system conditions phrased as not allowing the destruction of the ecosphere, by adding a negation to the above principles for destruction. Hence, in order for a society to be sustainable, nature's functions and diversity **cannot** be subject to:

1. Systematically increasing concentrations of substances extracted from the Earth's crust
2. Systematically increasing concentrations of substances produced by society
3. Systematic impoverishment by over-harvesting or other forms of ecosystem manipulation

The first three system conditions provide a framework for ecological sustainability. In addition, a fourth system condition was added which is a principle for the distribution of society's resources. This system condition links directly back to the sustainability definition in UN Brundtland (1987):

4. Resources are used fairly and efficiently in order to meet basic human needs worldwide.

The Four System Conditions can be used in different ways:

- Provide input for strategy processes, e.g. through a backcasting exercise with the leaders of an organization accepting the principles for a sustainable society and envisioning their own organization's role in such society. The system conditions can serve as a guide to ask the 'right' questions and to reduce the perceived complexity, which can contribute to avoiding investments in dead-ends (Holmberg 1998).

- Can contribute to a shared mental model, facilitate communication, trigger creativity and make individual efforts align in a coordinated and effective way.

    - "…when humans become aware of problems, and perceive them from a shared systems perspective, we often have an ability to turn them into challenges and to find possibilities and creative solutions." (Holmberg & Robert 2000, p. 293)

- Can be used to guide specific tools for sustainable development, such as LCA, ecological footprint, or environmental management systems (e.g. Robèrt 2000; Robèrt et al. 2002).

- Can support individuals' decision-making in their daily work. For example, in the early concept development phase of product development, the system conditions can assist individual product development engineers selecting alternatives that do not systematically increase the number of new substances in the ecosphere. If the concept alternatives also are in line with the other three system conditions, then all concept alternatives could be sustainable from the start (Alänge et al. 2007).

BACKCASTING

The most common way that the system conditions for sustainability have been introduced into organizations is through a backcasting approach (Holmberg 1998), which has also been the approach communicated and used by the Natural Step (Nattrass & Altomare 1999). Through backcasting, organizations have a possibility to analyze their own position in relation to the demands of a future sustainable society and to develop strategies of how to move forward in line with sustainability demands.

The backcasting approach has also been shown to bring advantages for innovation, as the backcasting exercise supports managers in thinking 'out-of-the-box' and in avoiding lock-ins. One early example of this was when Electrolux succeeded in taking one step ahead of all competitors and launching the first CFE-free refrigerators and freezers, after having used backcasting to analyze its products and technologies in a sustainability perspective (Holmberg 1998).

Backcasting is normally done in four steps:

1. **What is a future sustainable society?**
   - ⇨ The first step is to define and agree upon the criteria for sustainability and then use them as a framework for the following steps
   - ⇨ Development of a vision of a future sustainable society, within the framework for sustainability
   - ⇨ The company elaborates on the implications of the principles for its specific company context – 'makes the principles its own' – through a discussion of sustainability
2. **The company describes its current situation in relation to the criteria for sustainability**
   - ⇨ Mission, markets, products, environmental impact, human resources, etc.
3. **The company develops a future vision**
   - ⇨ within the agreed framework for sustainability
   - ⇨ based on its knowledge about the company and the market, etc.
4. **Strategies are developed towards the company's future vision**
   - ⇨ Development of a plan of goals and activities to move in the direction of the vision – including follow-up and reflection
   - ⇨ Here, a possibility exists to use scenario planning technique in order to develop robust strategies in relation to some dimensions that are important but unpredictable

SYSTEM CONDITIONS FOR SUSTAINABILITY IN COMBINATION WITH SCENARIO PLANNING

It is possible to use the four system conditions for sustainability (Holmberg 1995) as the guiding frame for strategy development in combination with a scenario planning process in order to make the strategy robust (Alänge et al. 2007). The four system conditions are timeless in the sense that they are applicable both in a very long-term perspective and as a guiding principle for decision-making today. The scenario planning process adds an increased awareness of the multitude of factors that could possibly affect a company's development during a selected time period, usually 10-15 years (see Figure 1).

The strength of the system-conditions approach is that instead of providing restrictions in terms of absolute numbers, e.g. for pollution by specific substances, it provides guidelines in a relative and system-related sense. Hence, the first three system conditions provide guidelines concerning ecological sustainability through their focus on the potentially damaging effect of *systematic increases* of substances or *systematic degradation* of the environment. This includes a systematic increase of substances extracted from the lithosphere, a systematic increase of new substances created by society and a systematic degradation by physical means of the resource base, including the biodiversity. Hence, these three system conditions provide a set of guidelines within which companies' and other societal actors' activities must be incorporated in order to be sustainable. Based on these guidelines, a fourth (and first-order) principle for the society's internal turnover of resources has been formulated, i.e. that resources should be used *fairly and efficiently* in order to meet basic human needs worldwide (Holmberg & Robért 2000, p.298).

The system conditions' focus on 'systematic increases' means that they can be used as an input for decision-making concerning very specific decisions, such as what material to select for a new product, or for more general strategy questions, such as what markets to target and how. Although the decisions may concern activities today and in the near future, the system conditions ensure that these decisions are made in the more long-term context of a sustainable society.

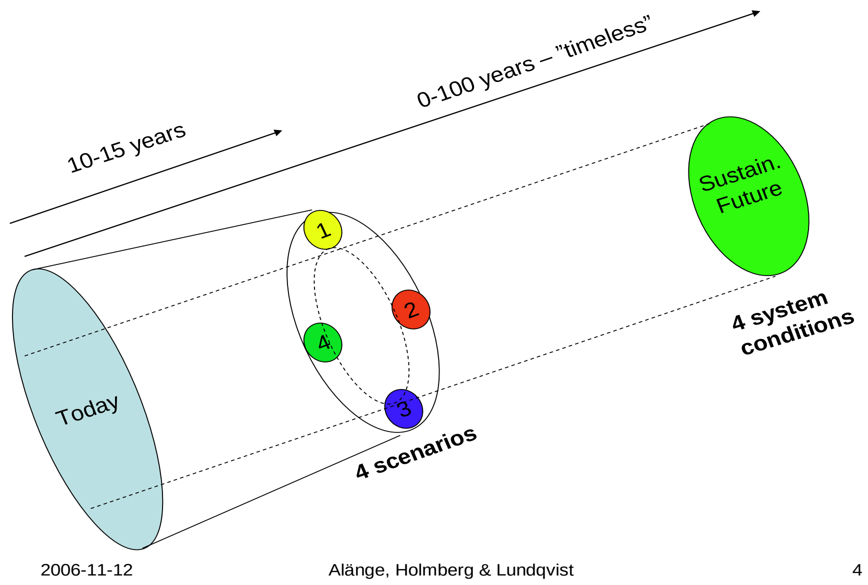

Figure 1: The relationship between the four system conditions and scenario planning

However, while the system conditions provide the frame needed for development towards a sustainable future, they do not directly provide guidance for all factors that could possibly influence a firm's development towards a sustainable future. The scenario planning can be seen as a complementary process aimed both at considering identifiable trends and at exposing less clear and more uncertain factors (critical factors) which may have a considerable impact on a firm's development as well as on its survival (Van der Heijden 1996).

The two (or three) most important mutually independent critical factors are being selected as a basis for generating scenarios. First, possible future developments (reasonable end values) along these dimensions (critical factors) are being generated. Second, these critical factors are being used as axes for a matrix, where four (several) equally possible futures or scenarios can be described. If the relevant critical factors have been identified, these four scenarios can provide vivid pictures of equally probable future developments that cover an area of possible developments. (See Figure 1.) The circled area in the middle indicates equally possible developments, and the scenarios 1-4 are points describing this area. The scenarios' function is to expand the basis for decision-making to include important but uncertain factors which often remain hidden in traditional strategy processes. The aim is to create a robust strategy which makes it possible for a firm to succeed within "the circled area", regardless of which development will occur in reality. By thinking through and discussing possible developments, there is also a possibility to create "early warning systems" along the alternative development paths, which can provide essential input for modifying the strategy selected.

REFERENCES

Alänge, S, J. Holmberg and U. Lundqvist 2007. Strategies and practices for sustainability: Experiences from firm level, *Proceedings from the International QMOD Conference*, Helsingborg

Carlsson-Kanyama, A. et al. 2003. Images of everyday life in the future sustainable city: Experiences of back-casting with stakeholders in five European cities, *FOI Memo*, D.nr. 03-2849, Forskningsgruppen för Miljöstrategiska Studier and Swedish Defence Research Agency

Holmberg, J. 1995. *Socio-Ecological Principles and Indicators for Sustainability*, Ph.D. thesis, Physical Resource Theory, Chalmers University of Technology and Göteborg University

Holmberg, J. 1998. Backcasting – a natural step when making sustainable development operational for companies. *Greener Management International*, **23,** pp. 30-51

Holmberg, J. and K.-H. Robèrt 2000. Backcasting – a framework for strategic planning. *International Journal of Sustainable Development and World Ecology*, 7, pp. 291-308

Lundqvist, U., S. Alänge and J. Holmberg 2006. Strategic Planning Towards Sustainability: Experiences of Applying a Method on Firm Level. *CPM Conference*, Nov. 22, Göteborg

Nattrass, B. and M. Altomare 1999. *The Natural Step for Business: Wealth, Ecology, and the Evolutionary Corporation.* Gabriola Island, BC, Canada: New Society Publishers

Robèrt, K.-H. 2000. Tools and concepts for sustainable development, how do they relate to a general framework for sustainable development, and to each other? *Journal of Cleaner Production*, 8, pp. 243-254

Robèrt, K.-H., et al. 2002. Strategic sustainable development – selection, design and synergies of applied tools, *Journal of Cleaner Production*, 10, pp. 197-214

Sotoudeh, M. 2005. Links Between Sustainability and Technology Development. *IEEE Technology and Society Magazine*, pp. 9-14

UN Brundtland Commission 1987. *Report of the World Commission on Environment and Development: Our Common Future*. Oxford: Oxford University Press http://www.un-documents.net/wced-ocf.htm

Van der Heijden, K. 1996. *Scenarios: The Art of Strategic Conversation*. Chichester: John Wiley

Vergragt, P.J. 2001. Back-casting for Environmental Sustainability: From STD and SusHouse towards Implementation. Paper for *International Conference: "Towards Environmental Innovation Systems*", 27-29 September 2001, Garmisch-Partenkirchen