BACKCASTING THE FUTURE

Niko Roorda

Brabant University for Professional Education
Delft University of Technology, Design for Sustainability Programme

Hogeschool Brabant / Brabant University for Professional Education
Faculty of Polytechnics
Prof. Cobbenhagenlaan 13
P.O. box 1097
5004 BB Tilburg
The Netherlands
tel. +31 13 4635250
fax +31 13 4637942
E-mail: n.roorda@projectcirrus.net
E-mail (private): nroorda@planet.nl

Biographic note
Niko Roorda is the manager of Project Cirrus at the Brabant University for Professional Education (Hogeschool Brabant) in Tilburg, the Netherlands.
He studied astronomy and physics at the Universities of Leiden and Utrecht. From 1981, he worked as a teacher in mathematics, physics and information sciences. In 1991, together with two others he developed and implemented a new university course called Milieugerichte Materiaaltechnologie ("M2": Environmentally Oriented Materials Technology) at the Hogeschool Brabant, a course in which students are educated to be specialists in sustainable technology, a kind of engineer that didn't exist before. He was head of the M2 department from 1994 till 1998. In 1998 he designed the Cirrus Project, which aims at integrating sustainability in engineering education, as a pioneering project in Dutch Higher Education.
He is also the designer of AISHE, Auditing Instrument for Sustainability in Higher Education.

Abstract
In this article, sustainable development will be discussed, and it will be explained why the eco efficiency will have to be raised with a factor of 20. This can be realised through three trajectories: product improvement, product innovation and system innovation.
The relation with strategic decision making will be shown, and the concept of “consequence period” will be introduced. As an example, a transportation system in a large city will be discussed.
The method of “backcasting” will be explained, and the consequences of long term sustainable development for the mission definition of companies.

Keywords:
backcasting, company mission, consequence period, eco efficiency, innovation, transportation.

1. Sustainable development

1.1. Factor 20

The control challenge of the 21st century - the theme of the session – is primarily a matter of making the right decisions. The 21st century will be a crucial era in the history of mankind: if we succeed in taking the right decisions, we will be able to create a world in which the inhabitants – *all* inhabitants - can live on a fairly high standard of living (see WCED, 1972).
In order to show how enormous the challenge is that lies ahead, let's have a look at some major developments that will come about in the new century.
In the first place: no doubt, the world population will about double, in the next 40 years. At the same time, it will be necessary to reduce the global environmental strain; it is estimated that this strain should be halved. So, the efficiency with which we make use of the environment and of our resources, the *"eco efficiency"*, will have to be improved by a factor of four. A description of this can be found in Weizsäcker (1997).
If you take another aspect in consideration, things are even more complicated. If we want to reach real sustainable development, the countries in the third world will need a rather large economical growth, in order to reach an acceptable standard of living. In the meanwhile, the developed countries will probably have an annual economical growth of a few percents. Together, this implies that the environmental impact will grow about fivefold.
The situation can be shown in a formula designed by Barry Commoner:

$$ee = \frac{N \times P}{S}$$

In this formula, the *N* stands for the world population; *P* is the average *Prosperity* per person (a measure for the global economical growth); and *S* means the global environmental *Strain*. *ee* is the *eco efficiency*.

Now, look at the period of 2000 till 2040. In this period, N will double and P will probably grow fivefold. If we want to succeed in halving the environmental strain, it means that we have to improve the eco efficiency by a factor of 20 (see: Jansen, 1997).

1.2. Product improvement

Certainly, this will not be an easy task. Much of it will have to be achieved by technological means.
Up till now, sustainable development through technological means usually consists of product improvements. To name only a few: the car catalyser is an example, as well as heat isolation of buildings and reduced energy usage of household equipment. In industrial processes, such improvements may be achieved by recycling waste and by an improved energy management.
In fact, these improvements can all be realised with existing technology, so nothing revolutionary will be needed. It is mainly a matter of good housekeeping and of using common sense.
Improvements like these will certainly enable us to raise the eco efficiency. It won't even take much time: the typical period in which good results can be made are 3 to 5 years. However, the effect is not enough: the efficiency will be raised by 30%, 50% or even be doubled: interesting, but in no way enough.

1.3. Product innovation

Better results can be reached by completely redesigning and replacing existing products. Examples of such product innovations are: heat storage in factories; and the so-called “hypercar”, which is now being developed. Success depends on the development of the necessary new technologies. Since large investments are needed, it will take more time: something in the order of 10 years.

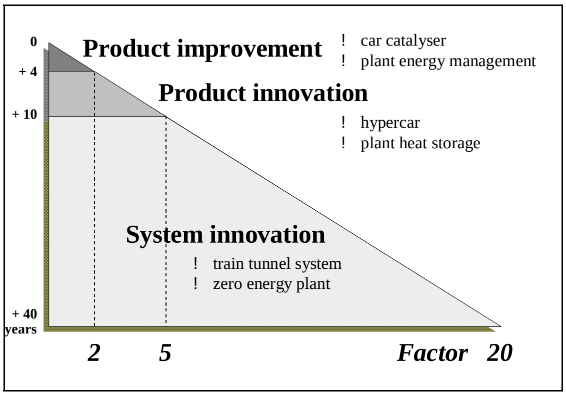

Fig. 1. The three trajectories towards factor 20

Innovations like these will enable us to raise the eco-efficiency with a factor of about 3 to 5. Although much better than mere improvement of existing products, this is still not good enough.

1.4. System innovation

If we really are to get to the factor 20, then something more drastically is needed. It is not only products and processes that have to be redesigned; in fact, the whole structure which those products and processes are part of, will have to be redesigned (see fig. 1).
For instance, the traffic system of goods nowadays depends considerably on transport by trucks. The eco-efficiency of this is very low. Much better already is the transportation by railroad. However, replacing trucks by railroads doesn’t realise a factor of 20.

This transportation problem has been investigated in a number of projects. One of them is the Dutch STD programme (“Sustainable Technological Development”: see Jansen, 1997). One of the conclusions of this investigation was, that the desired factor 20 in transportation can be reached by making a network of tunnels, in which small trains transport goods (together with other alterations of the system). Of course, this system will be completely automated.

Another example of a goal that can be reached is the development of industrial plants that don’t take any energy from outside: the so-called “zero energy plants”.

Of course, for developments like these a lot of new technologies are necessary. Because of this, and because of the large investments that are needed, the time scale for this changes is in the order of several decades.

2. Consequence periods

Back to the control challenge of the 21st century. In order to make sound decisions meeting the needs of the 21st century, it is essential to keep the three trajectories towards sustainable development in mind:

short term:	product improvement
middle long term:	product innovation
long term:	system innovation

Unfortunately, it is all too easy to forget this. As an example, the situation in a large Dutch city will be discussed. In this city, in 1999 the local government decided it wanted to develop a Sustainable Development Policy Plan. One of the items that was investigated was the transportation of goods through the city. In this city, there are several industrial areas; there is a harbour and a train station. All of the goods traffic takes place by trucks.

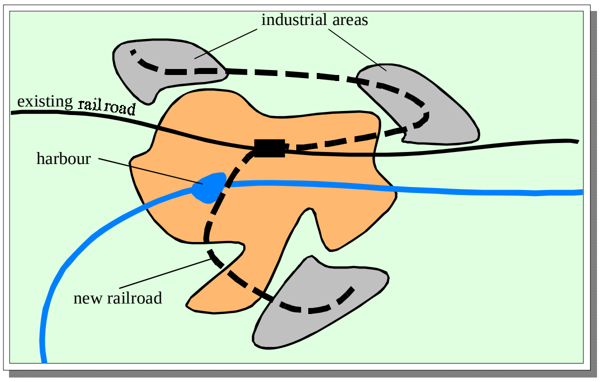

Fig. 2. The city map with the planned new railroad

Aiming at improving the environmental impact, it was decided that a railroad was to be constructed linking the industrial areas, the harbour and the station. (see fig. 2).

Superficially, this seems a good decision. However, something crucially important went wrong.

What this local government didn't take into consideration was the **consequence period** of the decision. A railroad is not to be constructed for a period of only five or ten years. A new railroad takes a lot of investments. Besides, it has many other consequences, for instance: destruction of houses; alteration of the road structure. So, the decision to construct a railroad has consequences for at least 50 years, perhaps even 100.

This period is at least as long as the time scale available to realise the factor 20. The construction of the railroad by no way realises this factor; so the decision simply can't be good.
During those 50 years, probably other cities will start drilling the tunnels for an underground goods traffic system. So, within 20 or 30 years the city will lag behind, having a railroad which hasn't yet been paid off; which doesn't contribute enough to sustainable development; and which cannot be removed in the next decades, because there won't be investment money for a whole new transportation system.

It wouldn't have been difficult for this city to make a better decision. Instead of the railroad, a tunnel with the same track could have been planned and realised by the year 2010. After that, new lines could have been realised in the next decade (see fig. 3), followed by even more tunnels – reaching individual shopping malls, hospitals, hotels etc. – and intercity connections, somewhere around 2040 (see fig. 4).

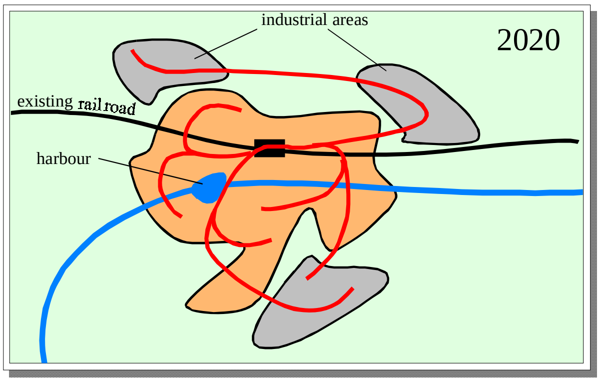

Fig. 3. A tunnel system in 2020

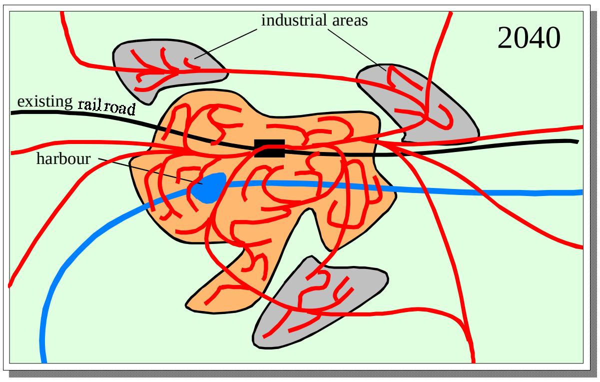

Fig. 4. The same tunnel system in 2040: many more lines; and intercity connections.

The error made by the local government is: on the short term the decision seems to be a good one, since an improvement of the eco-efficiency is realised. The impact of the decision, however, is much larger than the local government is aware of: they didn't ask themselves what the value of the decision would be after several decades.

So, the conclusion must be:

> *A decision can only be a good one*
> *If it is to be expected that*
> *People will still be happy with it*
> *At the end of it's consequence period.*

3. Backcasting

This decision making principle is quite easy to understand; but it is not so easy to realise it in practice. How does one decide whether people after 40 years or more will be happy with decisions we take now?
Of course, it is impossible to be certain about that. But still, it is possible to make a sound guess. The way in which this can be done has become known as "backcasting" (see fig. 5).

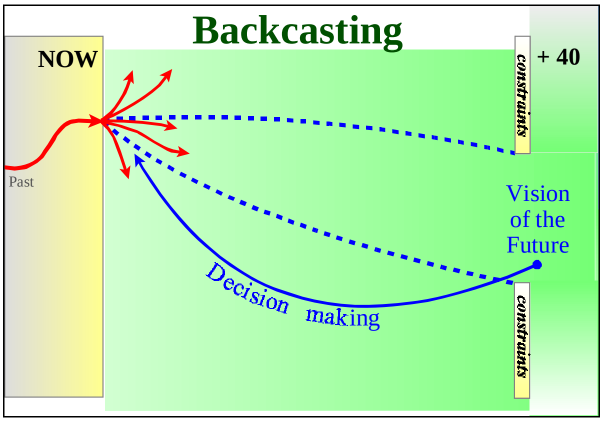

Fig. 5. Backcasting as a way of making decisions

In contrast with "forecasting", backcasting doesn't have the intention of trying to tell what the future will look like: backcasting is *not* prophesying.
Instead, using the information now available, a vision is developed about what the future (in, say, 40 years), would have to look like in order to consider it (now) as a desirable world (then). This vision can be worked out in detail, including technological aspects, based upon the thought of sustainable development. For instance, elements could be: chemical industry based on renewable materials (plants, not oil); an agricultural and food system that doesn't deplete the soil; no atmospheric disturbance; 100% reuse or recycling of metals; no landfill; etcetera. And of course, a transportation system that doesn't cause traffic jam, noise, disturbance of the landscape and emissions to the atmosphere.

This vision sets boundaries to the developments in the coming decades. It also puts a challenge to designers. For instance, if designers are to develop a "clean" transportation system: how can they do that? One of the possibilities, of course, is the tunnel system as described; this system concept is a result of the backcasting approach. Follow-up questions then are: how can that be realised; what are the investments; how to control it? Much research has already been done about those and similar questions.

Based on those investigations, strategic decisions can be made. When a choice has to be made between a number of alternatives, it will appear that some alternatives fit in a desirable sustainable development, and some will not. This gives a criterion for taking decisions.

4. Redefining the reason for being

It's not only governments that have to think about consequence periods. The same is true for industrial companies.
There are many, many things that will change drastically in the coming years. To name only one: the introduction of digital paper will have an enormous impact on industry and on society (see fig. 6). It already exists, so there can be no doubt whether it will reach the market; and it will come sooner than many people think. Some companies know this and adjust: they change the definition they give of themselves, and choose a new company mission. A well known example is a large producer of copying machines: they don't call themselves "copying company" anymore, but "document company"; thus preparing themselves to move from paperwork to information handling.

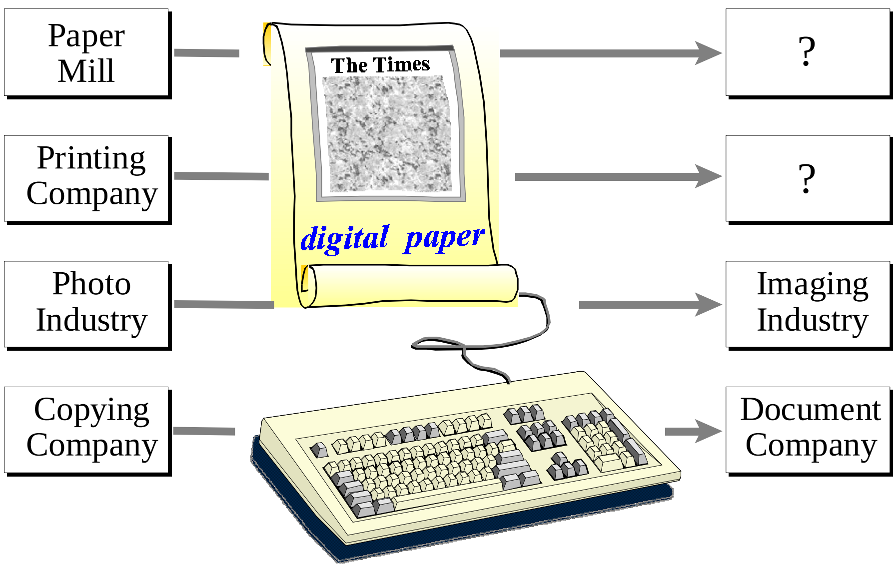

Fig. 6. Redefining a company's mission

A lot of companies aren't that far. What about a paper mill that primarily tries to improve environmentally on paper production? A good thing, on short term. On the longer term: missing a vital clue.

References

Jansen, L. (ed.) (1997). *STD Vision 2040 - 1998; technology, key to a sustainable prosperity*. Interdepartmental Research Programme on Sustainable Technological Development (STD), Delft, Netherlands.
Roorda, N. (1999): *Integrating sustainable technology into Higher Engineering Education*. Entree 1999 Proceedings, Tampere Finland EEE Network, Brussels.
Weiszäcker, E. von (1998). *Factor four - doubling wealth, halving resource use*. London.
WCED (World Commission on Environment and Development) (1972). *Our Common Future.* Stockholm.