Meeting the ecological challenge by Value Chain enlargement and enrichment

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Abstract

During the past about 15 years, medium-sized and especially big companies in several branches have reduced the amount of manufacturing depth and, in this way, the Manufacturing Value Chain. This development was driven by strategic issues in the way of reduced costs and capital investment as well as increased flexibility. On the other hand, the responsibility of companies for their products has increased within that period: To meet the requirements of the new law on liability for products, changes in product design and quality management system have been implemented. Actually, the ecological responsibility of the company will increase: It is to be expected that the circulation economy and waste law passed by the German parliament in 1996 will become obligatory in the same sense at least for the EU member states. To meet this challenge, possibilities and necessities for extending the Manufacturing Value Chain are described. Finally, some results of a project on refrigerator design for easy disassembling and recycling are presented.

Keywords

Ecologically oriented corporate strategy, precaution measures, new understanding of the production system, product design for disassembling and recycling

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1 PERSISTENT ECOLOGICALLY ORIENTED CORPORATE MANAGEMENT: FROM REPAIRING TO PRECAUTION

1.1 The need for a change

Three quarters of all gases causing the greenhouse effect on Earth are produced by the industrialised states; the United States of America alone, having a share in the world population of 4 %, are blowing one quarter of the world's emission of CO₂ into the air (Lohmeyer, 1997, p. IV). Facts of this kind meanwhile form the contents of entire documentations published by national ministries of environment, the World Watch Institute (Washington), the World Bank, and other institutions. In total, around 20 % of the world population are responsible for 80 % of the consumption of natural resources and related emissions. The main cause of this is the present economic system, established a mere 100 years ago and characterised by industrial production and mass consumption without heeding ecological limitations. Adopting this kind of economic activity for China alone, with a standard of equipment comparable to that of Western Europe (e.g. number of passenger cars and household appliances per 1000 inhabitants), would result in ecological collapse.

Therefore, re-orientation of economic activities and a change in the kind, direction, and goal of innovations is required. But environmental policy, as established in some countries and companies respectively, largely based on the principle of repairing, is not sufficient. To ensure the survival of mankind with adequate quality of life, the principle of precaution has to be applied.

1.2 'Eco Audit' or more?

The concept of 'environmental management' developed in the meantime (cp., among others, Malinsky, 1996, Winter, 1997) has also led to standards (DIN ISO 14001 and 14010, 1997) as well as the EMAS Ordinance of the EC (1993), which provides for voluntary eco-auditing and certification of the individual locations of a company. Even though this certification is helpful in competition, it will not be sufficient for the required ecological re-orientation: To express it oversubtly, the manufacture of products of insufficient ecological quality (see section 1.3) is possible even in certified operating locations. This is caused, above all, by a '**strategic deficit**' (Dyllik/Hummel, 1995), as well as extensive neglecting of a **product-related** consideration (particularly with EMAS).

Reducing the strategic deficit will require **embedding of ecological orientation in the corporate strategy**, i.e. in the corporate **vision**, as an 'ambitious dream of changing the environment' and an instrument of management in order to introduce **new values** (Hinterhuber, 1996, pp. 83 & seq.) into the company. Oriented on the **normative approach** of 'Sustainable Development' (World Commission, 1987, p. 43),

- **considerate handling of natural resources** (raw materials and stocks obtained from these, energy, water, air, etc.) as 'inputs' for manufacture, utilisation, and disposal, as well as
 - **minimising or preventing emissions** (as 'outputs') in consideration of the limited absorbing capacity of the environmental media
- should be laid down as strategic guidelines for concrete action.

1.3 Product-related measures to increase ecological quality

To identify potential ecological weak points, the (relative) **ecological quality of the product** as a basis for required measures has to be determined. This may be understood as a totality of the partial qualities which have to be determined specifically for each phase of a holistic product life cycle. A possibility of graphical presentation of the result of such determination is shown in Figure 1. Obviously, it will not be possible to obtain a total quality by simple aggregation of partial qualities. As can be seen from Figure 1, a scale is used to assess the partial qualities, reaching from -5 for unacceptable ecological partial quality, e.g. due to long-term irreversible harm to nature, to +5 for very good ecological quality.

Figure 1 Ecological quality of a product as determined by its partial qualities (example) (cp. Hübner/Simon-Hübner, 1991, p. 56).

Applying the holistic product life cycle, the **ecological quality of production**, including materials management, is considered as a **partial quality of the product**. This approach ensures to consider not only ecological impacts of production processes of the individual company, but also the amount of production-related waste - which may be 10 to 50 times higher than the weight of the product - and all resources required for getting materials, beginning with their extraction from raw materials.

All these resources are burdening the product as an ecological 'Rucksack'. The aim of measures following the principle of precaution is to reduce the use of new resources along with unchanged benefit of the product to the customer. This reduction of resource input involves a reduction of emissions and

production-related waste and will, in this way, lead to an increase of resource efficiency. Further statements are concentrating on the respective possibilities and consequences for (the strategic management of) the Manufacturing Value Chain.

2 MEASURES FOR INCREASING RESOURCE EFFICIENCY AND CONSEQUENCES FOR THE STRATEGIC MANAGEMENT OF THE MANUFACTURING VALUE CHAIN

Preoccupation with the 'input' side for the phases of production, utilisation, and 'decommissioning' of products under ecological aspects has been coming up only in recent years with a view to restricted dumping capacity for 'old' products, increased resistance in the population against further dumping sites and refuse incineration plants, and also to international agreements on reduction of greenhouse gas emissions. These latter directly depend on the volume of materials used, energy input for obtaining raw materials, transport, etc. Estimates for increasing resource efficiency without losses in quality of life range between a factor of 4 (Weizsäcker/Lovins, 1995) and 10 (Schmidt-Bleek, 1994). Since examples of greater factors meanwhile exist, the TWI Product Workshop bears the designation 'Factor x'.

2.1 Measures for increasing resource efficiency

Possible measures for increasing resource efficiency are concerning the **quantity** as well as the **speed** of resource flows.

Measures for reduction of quantity are concerning, above all, the substitution of resource-intensive technologies. Several tools have meanwhile been developed for recording of resource intensity; as examples, MIPS (Material Intensity Per Service Unit, cp. Schmidt-Bleek, 1993) and Cumulative Energy Demand (VDI 4600) may be named.

However, **measures for reduction of speed** are also linked to quantity reduction. Dealing with speed, attention will be directed to the factor of **time**: Measures for reduction of speed are based on the '**Longevity Approach**' (LA), which may be applied to products and product components.

The aim of LA application for products is to increase the duration of product utilisation by means of product-related services ranging from maintenance and repair to technical updating and upgrading. This extension of the traditional Manufacturing Value Chain may be designated as '**value adding for value preservation**' of the product. A more detailed description of the LA and a case study demonstrating the economic reasonability of product reconditioning, too, is described by Hübner (1998).

By application of the LA, the phase 'after the end of utilisation' will be reached later. Since the company will be responsible also for that phase in

future (Kreislaufwirtschafts- und Abfallgesetz, 1996), it will have to deal with the respective measures, irrespective of whether these will be carried out in the company itself or outside of it. Additional value adding concerns **re-utilisation of components (LA)** and various forms of **recycling**.

Product design providing for easy disassembly will be a prerequisite. The results of a related project are presented in chapter 3.

2.2 Consequences for strategic management of the Manufacturing Value Chain

Summing up, Figure 2 shows possibilities and necessities respectively for extending the Manufacturing Value Chain to meet ecological requirements, leading to a new understanding of the production system.

Figure 2 New understanding of production system meeting ecological requirements.

3 REFRIGERATOR DESIGN FOR DISASSEMBLING, SEPARATING AND RECYCLING

Selected results of a project worked out together with a company (cp. Hübner et al., 1997) are being presented below (Figures 3 to 5). Units of various makes as

well as of different manufacturing years from one manufacturer were examined as to their suitability for disassembling, separability of material fractions, and recyclability. The products were disassembled completely in the 'Factor x' TWI Product Workshop and compared in respect of product characteristics (weight, number of parts, kind and number of different materials used), disassembling time, time-weight diagrams (which handling equipment is necessary for disassembling?), kind and number of different connecting techniques, total number of connecting points, portion of components that may be disassembled without destruction, and other criteria.

The aim was to derive concrete requirements for new product development in order to meet ecological requirements as well.

Figure 4 Weight shares per mat. fraction and disassembling level for Unit 1.

Disassembly	Unit 1	Unit 2	Unit 3
Number of components	153	191	131
Time for disassembling (sec)	2797	2937	4098
Time for cleaning (sec)	2118	1405	1650
Total weight (grams)	36844	41062	35651
Number of joints	153	182	102
Number of joining points	258	203	182

Figure 3 Comparison of three units by means of selected criteria

Figure 5 Joining techniques of Unit 1.

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