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LIFE CYCLE STRATEGY

C. Herrmann, C. Decker, M. Mansour and M. Mateika

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1. Introduction

Life cycle strategy is a strategy, which focuses on an economic and ecological optimum over the entire life cycle from the raw material extraction to the recycling. The purpose of this strategy is to avoid the suboptimization of individual life phases and to prevent the shift of problems from one life phase to another life phase. An ecological example for the necessity for a life cycle strategy is the substitution of lead free soldering pastes for printed circuit boards. Due to the change of the legislation and due to a high environment impact in the disposal phase lead will not be used for printed circuit boards anymore. But the substitute soldering pastes (e.g. zinc-copper alloy) have a higher melting point, so that the energy consumption in the production will rise [1]. Hence, an environment problem will be shifted from the end-of-life phase to the production phase. The importance of a Life Cycle Strategy was also stressed by the participants of the Ecodesign workshop during the ICED´03 conference in Stockholm. According to the opinion of the participating researchers one of the largest obstacles for the implementation of Ecodesign into enterprises is the missing consideration of all life phase in the strategy phase [2].
However, life cycle strategy does not cover ecological aspects only. In addition, life-cycle-oriented strategies are very important for economic reasons. In the past a product was successful, if development and production costs were compensated by revenues. Nowadays, the success should be evaluated after the End-of-Life phase. Service costs, cases of warranty, recycling costs, end-of-life logistic costs can endanger the economic success of a product (figure 1).

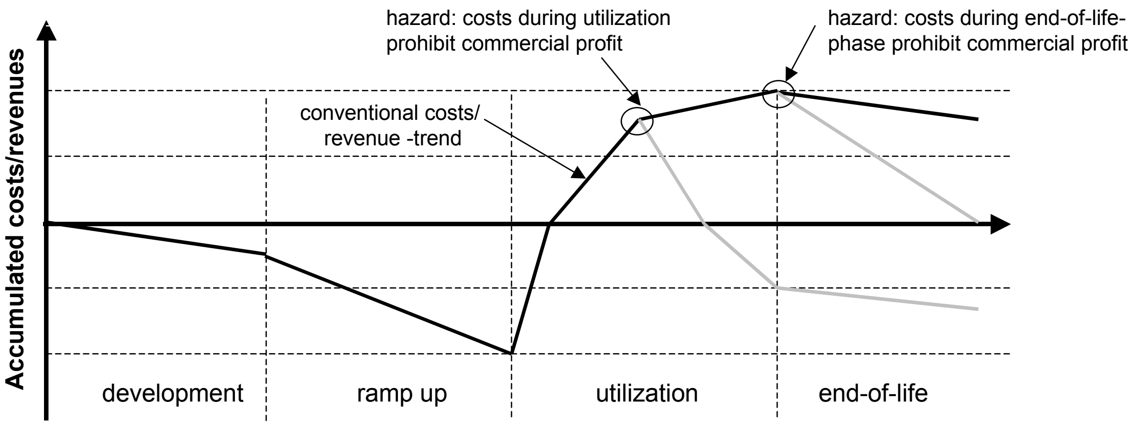

Figure 1. Accumulated cost and revenues in the product life time

For these reasons, the characteristics, the costs and the revenues of all life phases should already considered in the strategy phase. For this purpose the authors define the term life cycle strategy following Ansoff [3] as follows:

"Life Cycle Strategy is the sum of all measures to ensure the long-term success of a product over all phases of the life cycle"

The goal of the paper is the derivation of the necessity for a life cycle strategy for different products. Furthermore, methodical approaches for the life cycle oriented analysis are introduced.

2. Need for a Life Cycle Strategy

The need for a life cycle strategy derive from the life cycle costs resp. the revenues of a product. Especially the part of the costs resp. proceeds of one life phase in relation to the whole life cycle costs resp. life cycle proceeds is of interest. As presented in figure 1 the analysis of the costs and proceeds in the utilization phase and the end-of-life phase is of particular importance. The reason for that is that they can put at risk the economic success of a product. This danger is not equal for all products. A possible classification shows table 1.

Table 1. Classification of products

examples of products	costs in later lifetimes (examples)	revenue in later lifetimes (examples)
screw, bread	none	None
software	none	Royalties
consumer goods (e.g. electronic appliances)	warranty costs, end-of-life logistic, demounting, recycling	None
investment goods (e.g. machines)	costs of service, demounting, recycling	revenue of upgrading, sales of spare parts

A life cycle strategy is not very important at consumer goods (e.g. screws) because there will not be any costs and proceeds in later lifetimes. At software products the revenues phases (license proceeds) decide economic success.

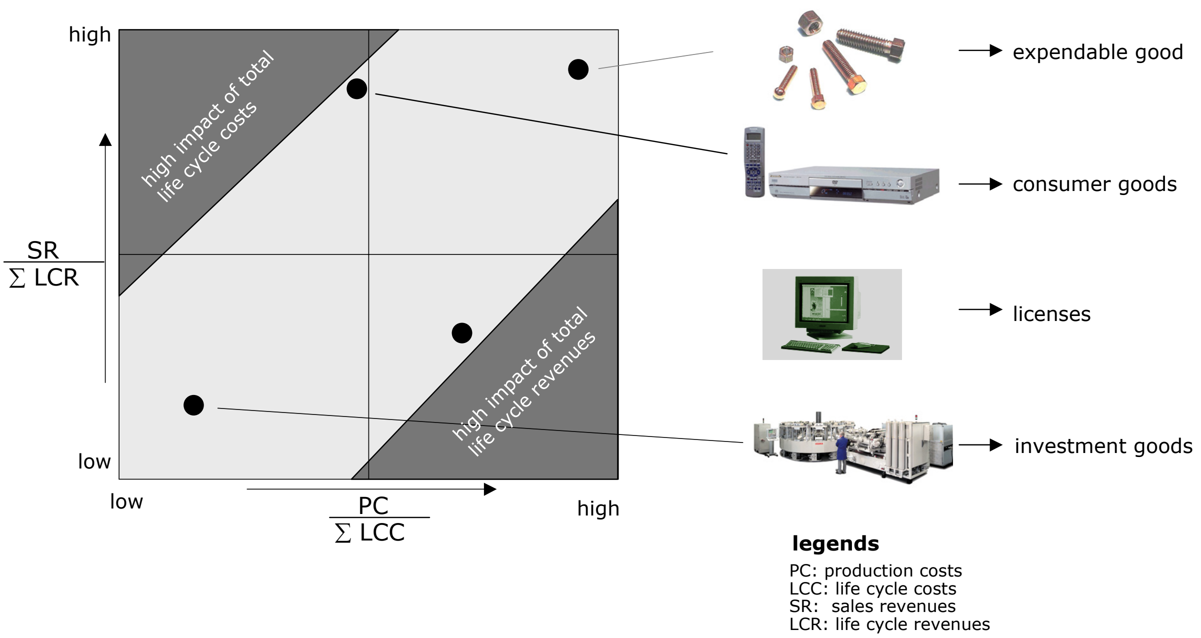

Figure 2. Life cycle costs/ lice cycle revenues portfolio

At consumer goods (e.g. electronic home appliances) the costs in later life cycle phases (e.g. guaranty costs, recycling costs) can put at risk the economic success of the product. At investment goods the economic success is often decided only by the proceeds and costs of the product in the late life cycle phases (e.g. proceeds: sale of spare parts, upgrading proceeds/costs: service costs). The formulation of a life cycle strategy is of particular importance at these products.
For the classification of products concerning their life cycle costs and revenues a portfolio was developed, as it shows the table 2. The first demension of the portfolio is described by the quotient from the production costs (which means the development and production costs) and the total life cycle costs. This quotient inclines towards 1 if there are no substantial costs (e.g. service costs, recycling costs) for the producer of the product after the sale of the product. The second dimension of the portfolio is described by the quotient from sales revenue to the life cycle revenues (e.g. service revenues, recycling revenues). If further revenues can`t be achieved after the sale of the product this quotient inclines towards 1. How the portfolio shows in figure 2 ranges can be identified in which the containment of the life cycle costs resp. the revenues for the economic success of the product are of particular importance. The examples from table1 are registered in the portfolio.

3. Developing a Life Cycle Strategy

There are already instruments where a comprehensive consideration of the life cycle is focussed (e.g. life cycle analysis (LCA) or life cycle costing (LCC). These instruments as instruments for the design process are discussed in literature because the availability of the necessary information is very low and the expenditure for the application of these instruments is too high [4]. Approaches for life cycle strategies focus on the environmental impact of a product [5,6,7]. This paper focus more on the economic impact of a product. Therefore, it presents a combination of instruments (procedure model) which is suitable to recognize the demands on future products and the supply for a life cycle strategy as well as to deduce action recommendation for the product development (figure 3).

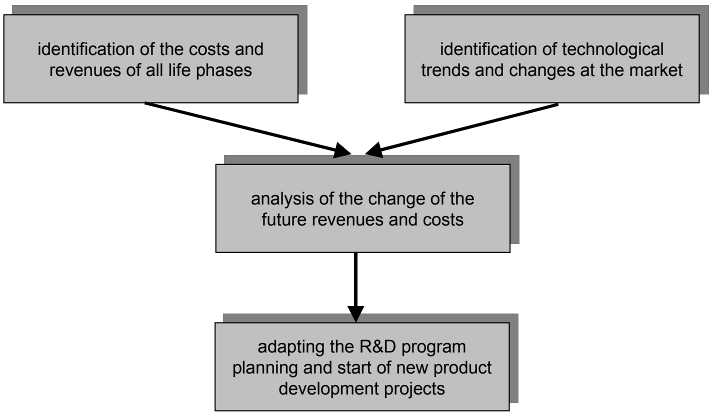

Figure 3. Procedure model for a life cycle strategy

The purpose of a life cycle strategy is to optimise the economic success of future products over all phases of the product life cycle. In addition all future changes have to be recognized in the phases of the product life cycle and they have to be translated in demands of the product design. The formulation of a life cycle strategy dates temporary before the start of the product development.
A cycle model for the formulation of a life cycle strategy was developed at the TU Braunschweig. According to this model all costs and revenues of a product over its life cycle are calculated in the first step. Only costs and proceeds are to be determined thereby incurred at producer`s oft the product. Costs thereby incurred at customer`s, e.g. producing costs, service costs, sales revenue etc. are not relevant for the purpose of such a model. With the determination of these costs and revenues statistical dates of the controlling (e.g. producing costs, service costs, sales revenue etc.) normally fit in very well. In the second step changes in the phases of the product life cycle have to be identified. Thereby technological trends (e.g. the application of a new product or process technology) as well as changes at the market (e.g. changes of the regional customer structure, new laws for waste management of the

product) are of particular interest. Among systematic technology and market watching expert talks (Delphi-method) or the scenario analysis is a great convenience in identification of these trends. The next step consists of the evaluation oft the identified technological trends and changes at the market on life cycle costs and revenues. Thereby it is important to identify the cost and revenue elements that will change in the future.
Figure 4 shows a simplified personated analysis result which was acquired in the course of a research project with a german engineering business. The left pillar shows the percentage distribution of the costs and revenues of a product over the product life cycle concerning the producer of the machine. Revenues are represented in the upper half of the beam, costs underpart. The maximum share of revenues is achieved by sales. A wide percentage of revenues (ca. 30%) can be achieved only after the sale of the product, i.e. in the later phases of the product life cycle (e.g. revenues from spare parts, service, upgrading). The highest portion of costs is on the side of the product development, raw materials and production. But there are great expenses for service and deconstruction as well. The right pillar shows the expected future costs and revenue strucure of the product. The percentage revenues from the sales will continue to decrease and the percentage revenues frome the service and the upgrade of a machine will rise. The change on the side of the costs especially concern the production and development costs which will be increasing.

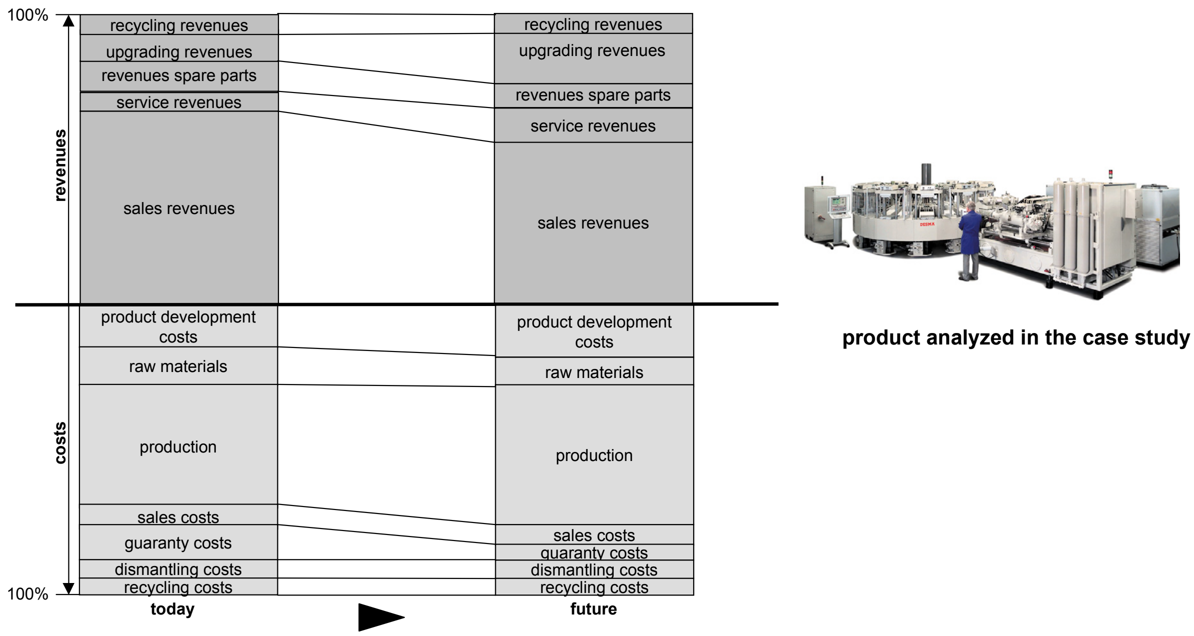

Figure 4. Producers life cycle costs and revenues of a shoe machine

4. Life Cycle Strategy for a Shoe Machine

The represented procedure to the analysis of life cycle revenues and costs were accomplished considering as example of a shoe machine. Based on the analysis results sanctions for the securing of the long-dated economic success could be derived over the whole product life cycle (=Life Cycle Strategy).

4.1 Technological trends and Market Changes

The analysis of trends shows a strong development to more and more customer orientated products. This causes in a higher variety and smaller lots in the production in connection with higher costs. The trend for a really mass customization is aware in many different markets. This starts in the electronic industry and is not ending in the textile business. But in this area there are special requirements related to same products but different sizes. This is in addition a further variant and cost driver. The solution is seen in a more flexible and dynamic production equipment which delivers a wide range of production possibilities.

The development of the different global areas was concentrated in the past on low wages and lowest costs of production. The last two decades especially in the textile industry were signed by a movement to Asia. The main production market today is china with a part of more than 56% and together with the other Asia countries of about 80% of the world shoe production for example. But there are basic trends back to the consumer markets. The production of individual configured products only makes sense if the delivery time is as short as possible so short ways to the consumer markets are obvious. Special products which are configured individually will be produced in or near the endcustomer. The requirements of this production will be most flexible plants with highest automation levels for high quality in single order production.

The today existing areas of mass production will remain there or will move to other areas with lowest wages.

4.2 Evaluation of life cycle costs and revenues

The structure of the life cycle costs and revenues of the researched machine is simplified presented in table 4. The distance to the customer increases with the shifting of the world shoe production from europe to asia. The effort for the build up of new marketing and service structures in asia will leads to an increase of marketing and service costs. At customer`s option for an extension of the product life cycle and a better integration of new technologies in an existing machine will increase the revenues for the upgrading. The trend of highly flexible machines that are adapted for customized mass production will increase the variability of the product structure and the effort for the development and production for the several machines.

4.3 Requirements on the Product Design

Based on the described analysis strategic demands on the future sole machines could be developed. The most important demands are:

1. The customer wish for machines in which machine technologies can easily be integrated will lead to advanced upgrade revenues. For this purpose the technological relevant sub-assembly have to be created more modular. The interfaces between the devices must be standardized further.
2. Similar demands can be derived from increasing service revenues and the spare part business. To make possible the fast exchange important spare parts must be created modular. To minimise the service effort already with the machine construction remote maintenance systems (teleservice) should be integrated in the future.
3. The containment of the high alternative variety will be one of the biggest defiances for the producer of the machine in the future. Solutions must be found to prevent the explosion of poduction and development costs. There is already a need fot the securing of the variation robustness in the devices and function structure of the future machines. In addition there is a need for constructive measures that result a standardisation of devices and parts.
4. Further measures in terms of a life cycle strategy concern production and marketing. But they are unimplemented in this publication.

5. Benefit for the product development and conclusion

The analysis of the change of the life cycle costs and revenues suit the deduction of demands on the product design and the business planning. If the costs for recycling rise in the future a recycling compatible design will be necessary. If the future spare part business will have a superior share the product structure of potential spare parts should be created as modular as possible to provide a simple and a fast exchange of the spare part. Consequently future demands on products can be weighted among each other with the help of the represented product model. Goal conflicts that arise from the creation of the requirements list can be solved much easier. The big advantage is situated in the systematic consideration of all life phases in the early phases of the product development. The important changes are recognized in time and evaluated concerning their meaning. The probability to create a life cycle compatible product is increased. Further on the analysis results of the life cycle costs and revenues can be an input in using the QFD-method [8].

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References

[1] Commission of the Lower Saxony government: Final report of the working group 13 (electronic scrap), Hannover, 2002

[2] McAllonee, T.: Results of the Ecodesign-Workshop of the ICED conference, Stockholm, 2003

[3] Ansoff, H. I.: Corporate Strategy: an analytic approach to business for growth and expansion, Mc-Crawn Hill, New York, 1965

[4] Ernzer, M.; Birkhofer, "Enviromental Impact Assessment in Design or is it Worth it to Carry Out a Full LCA?", Proceeding ICED 2003, Stockholm, 2003

[5] Takayuki Daimon, Shinsuke Kondoh, Yasushi Umeda, "Proposal of Dicision Support Method for Life Cycle startegy by Estimating Value and Physical Lifetimes", Proceedings Ecodesign 2003, Tokoy, 2003

[6]Giudice, F., La Rosa, G.; Risitano, A., "An Ecodesign Metho for Product Arcitecture Definition Based on Optimal Life-Cycle Strategies", Proceeding Design 2002, Dubrovnik, 2002, pp. 1311-1322

[7] Hallander, I.,"Life Cycle Value in Product Developemt: A Case Study in the Transportation Industry", Proceedings ICED2003, Stockholm, 2003

[8] Masui, K., Sakao, T., Kobayashi, M. and Inaba, A., "applying Quality Function Deployment to Environmentally Conscious Design", Internations Journal of Quality and Reliability Management, Vol. 20, No1, 2003, pp.90-106

Dipl.-Wirtsch.-Ing. Marc Mateika
Institute of Machine Tools and Production Technology (IWF), Technical University Braunschweig
PO Box 3329, D - 38023 Braunschweig, Germany
Telephone: ++49-531-391-7601, Telefax: ++49-531-391-5842
E-mail: m.mateika@tu-bs.de