

REDUCING PRODUCT COSTS BY EFFICIENT PRODUCT DEVELOPMENT

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1. Introduction

The challenges of the marketplace are met by product developers in two ways: development of innovative products and reducing product costs. Cost reduction alone is not a substitute for innovation. Cost-oriented product development is systematic engineering work, which requires an interdisciplinary approach, and needs to be efficient and effective. The costs that are of interest here are those incurred by the products.

Product development has some important influences on the total costs of the company, see Figure 1. Among costs, the greatest importance is attributed to lowering manufacturing costs, usually within the framework of the most cost-efficient possible product development. The lowering of costs is only one aspect of the problem; it is just as important to mold the company structure so that market changes can be reacted to quickly and flexibly, and that innovation is encouraged.

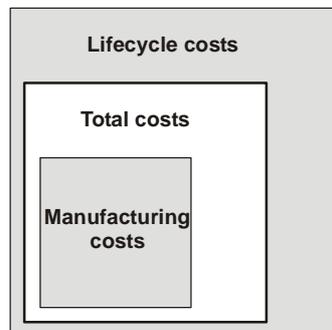


Figure 1. Manufacturing, total and lifecycle costs

2. Product cost reduction

Principles of cost reduction are well established. These begin with a classification of costs: manufacturing costs, total costs and lifecycle costs. We then proceed with the methods of cost reduction in each of the areas. Cost management is necessary in the development of innovative and high performance products - products about which customers would be enthusiastic, and which fulfil the market requirements. It makes more sense to lower the costs right at the beginning of product development, rather than afterwards by the usual steps of personnel reduction when the costs are found too high.

Management's primary goal in cost reduction is to lower the fixed costs. On one hand, their goal is to improve the company's earning power, since a considerable part of a company's reserves are in its fixed costs (frequently more than 50% of its total costs). Concurrently, the breakeven quantity with which the company can generate profits is lowered, so there is more flexibility. By doing so, the company gains product development freedom in the market and becomes more resistant to market fluctuations, Figure 2.

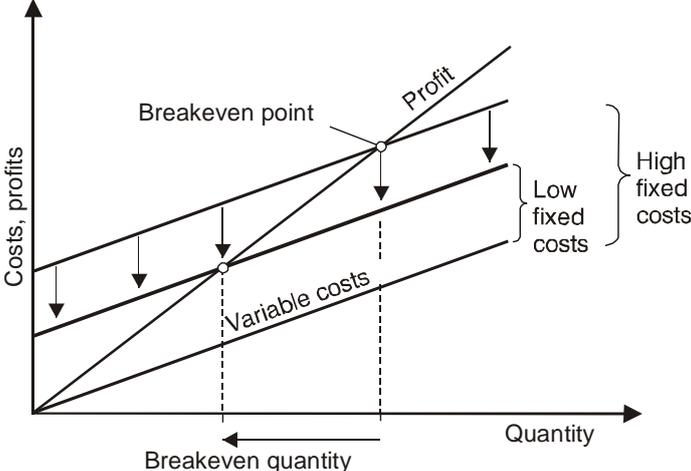


Figure 2. Shifting of the breakeven quantity in lowering of the fixed cost portion

Product development has an influence on cost generation in a series of other company processes that should not be underestimated. First, there is the production process. The logistics and service processes in the company are also cost-relevant, the costs of which also depend considerably on decisions during product development.

2.1 Reducing product development costs

The costs of product development consist of a number of different components. Whatever the models for assigning costs might be, personnel costs are the decisive portion of the product development costs, depending on the company's strengths in design and development. Therefore, personnel performance is a defining factor. These costs must be seen as fixed costs in the company because in the short run it is hardly feasible to reduce personnel simply in response to market changes. Besides the pure cost considerations, the strategic importance of innovative in-house product development is also to be taken into account when thinking about product development costs.

It is necessary to carefully select projects and tasks to be worked on and to focus on projects important for the company.

2.2 Establishing focal points of product development activities

In many companies, too many tasks and too many projects are regarded as urgent and necessary, and are pursued more or less simultaneously. The results thus do not satisfy expectations because the company's capacities are overwhelmed by too many projects; high-priority problems dominate the daily agenda. The company needs to develop a system for prioritizing projects, bearing in mind the requirements of the market as well as questions of profit and return on investment.

The company's strategic direction should be the primary criterion in decisions about prioritizing projects. Therefore, integrated considerations are called for, not just the isolated viewpoints of product development, marketing, or customer service. The profit orientation of project work must not be considered a constraint but, rather, as the condition that creates the necessary room for basic product development and innovations. The entire company, not only the product developers, must consider setting and prioritizing the goals for product development.

2.3 Increasing the efficiency of product development

2.3.1 Personnel

Personnel qualification and motivation has the most significant influence on the efficiency of product development [Frankenberger 1997]. This is true both for the personnel in the company as well as for the personnel of associated external partners. What are the essential criteria here? On one hand, increasingly rapid changes in technology place continual demands on personnel training. Thus, the initial qualifications as well as ongoing training of the employees are decisive parameters. Not only are the technical and technology-related topics of great importance here, but also the so-called "soft" factors related to collaboration; integrated and networked thinking and working; and questions of conflict resolution, etc.

2.3.2 Motivation

Motivation is another decisive success factor [Frankenberger 1997]. Motivated employees who are focused on the total goal of a successful company will be more successful in shaping the many processes of product development. Employees who are less motivated or who see only their specific limited subject, or who are more concerned about their personal sphere of influence or their professional future, will generate only average output, at best.

2.3.3 Organization

There is no one type of organization that satisfies all requirements. Decisions about the form of organization must be grounded in the personnel situation, the product requirements, the history of the company, as well as the market demands. Whether the organization will be functional-, matrix-, or process-based must be decided on a case-by-case basis.

2.3.4 Project management

The structure of project management is decisive for success or failure in a company. With more complex products (large number of parts, many functions, etc.) or products with high process complexity (for example, a difficult production process sequence), it is necessary to execute operation steps as in Concurrent Engineering. In other words, the steps are executed in parallel to satisfy, on one hand, the requirements of the system complexity and, on the other hand, the demands of time and process sequence optimization. With complex products such as cars, it is apparent that many project teams must function in parallel. Concerning decision competence and responsibility, the decision on hierarchies is replaced increasingly by the subsidiarity principle: Decisions are made where the highest professional competence is available, and complexity should be held to a minimum.

2.3.5 Time scheduling and capacity planning

Time scheduling and capacity planning have overtaxed design and development for decades and recent investigations show need for improving these activities. Dramatically shortening product development times (by as much as 50% in many industries [Hundal 1993]), requires carrying out activities strongly in parallel, and the elimination of unnecessary work.

Investigations of product development methodology have shown repeatedly that considerable time and expense can be saved by making the correct decisions in the early product development stages (during clarification of the task and the first concept development). If more emphasis is placed on "up-front" efforts, fewer iterations and improvements are needed later. Shortening product development times requires investing more time and capacity in the early stages of product development than was done previously. Therefore, preplanning and early identification of critical properties of future products are needed for avoiding iterative loops (Figure 3). This also enables product planners to react quickly to market changes.

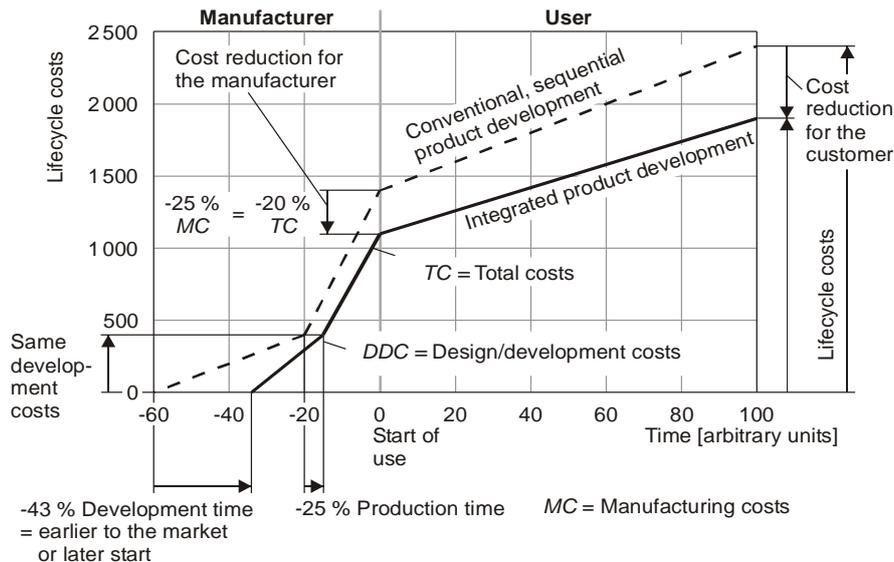


Figure 3. Cost and time saving with more intensive product development in the early stages

In order to visualize these correlations, the following assumptions were used in Figure 3 for product development, manufacturing, and operating costs that are based on practical experience (other costs are not considered):

- Through better planning, more thorough use of personnel and methods, the product development time during the integrated product realization (thick line) compared to the conventional product realization (dashed line) is reduced to one-half (with new developments in single-unit production to even 40%! [VDMA 1998]). The product development costs remain constant at 30% of the former manufacturing costs.
- The manufacturing costs are lowered by around 25% through integrated product development. That also results in a production time reduction of 25%.
- Furthermore, it is assumed that the operating costs decrease by around 20%.

We achieve the following advantages:

- With these hypotheses, the total product-development time for the manufacturer is reduced by about 43%. Either the result is a shorter time to market, or the company can begin product-development work later and react faster to market changes. The total costs fall by around 20%. It is assumed that this reduction is passed directly on to the customer in the form of a lower price.
- For the customer there is a reduction in price of around 20% and, depending on the operating life, a considerable reduction in the lifecycle costs.

2.3.6 Changes

Every product-development goes through iterations or optimization processes, which lead automatically to changes. Changes incur costs, use up time, and influence the resulting quality. They involve both chances and risks.

2.3.7 Computer support

Application of computer technology is an important means of increasing product-development efficiency. CAD, FEM, company intranets, and many computer applications characterize contemporary product-development work. The expected future performance improvements of computers and computer networks will expand possibilities for simulation, visualization, and providing information and communication. Unfortunately, many of these advantages are sometimes cancelled out by negative effects, including software version changes that require constant updating and retraining. Exchanging data with product development partners becomes difficult if everyone's software changes are not done simultaneously.

2.3.8 Methods

While product development engineers often use as many as 20 different computer tools, they are often not truly qualified with regard to the application of design and development methods. However, if a very specific method application is considered necessary, personnel are frequently trained in very complex methods, for example FMEA, QFD or TRIZ [Hundal 1997]. Engineers often fail to understand the basics of the methodical procedure, or lack the ability to judge in the given situation which methods should be deployed, in which form, and to what depth.

2.4 Capabilities regarding in-house product development

Personnel costs comprise the major portion of product development costs (about 60-80%). That leads to the question of the proper staffing level of, and the strengths and weaknesses of, the in-house product-development group when deciding whether to award product development work to outside sources. In combination with the issues pertaining to in-house versus external production, this question often leads to emotional rather than impartial decisions.

Product development engineers have always relied on the development work of their partners (suppliers, design and development offices, etc.) in their own performance results. After decisions about which parts and assemblies are to be developed in-house are made, engineers must decide whether outside capacity is to be used (a) to meet deadlines, or (b) for financial reasons, or (c) when supplementary external qualified personnel must be called in. Along with the question of in-house versus outside product development comes the question of in-house versus external production. There is no universal rule about this, and every company should develop a clear strategy and repeatedly check to what extent in-house product development is appropriate. An increase in product development outside the company can lead to a series of perspectives that can have a positive effect on company output. For example, the fixed costs of product development will be reduced in the company, and using external capacity will speed up the development process. One can take advantage of the particular qualifications and expertise in other companies, and build up and maintain strategic alliances with partner companies.

However, combined with that are also expenses and risks including the possible loss of technological competence, dependence on product development partners, and increased coordination expense.

3 Effects of product development on complexity

Product development activities influence not only the direct costs of product development, but also the complexity of all processes in the company. This influence can be substantial ("complex products usually engender complex processes"). The problem lies in that this complexity is not apparent in its essential nature and cannot be recognized by the usual control methods either.

Complexity in a company is determined by many things, but from a product development viewpoint, the following should be mentioned: (a) The number of different parts in the products; (b) the number of the technologies used; (c) the number of the participating designers and development partners; and (d) the extent of networking among all these entities. Additional influences certainly come from the markets (which differ according to product), as well as from the organization of the company and other functions.

3.1 Costs of complexity

Complexity costs are those costs that result from the complexity of the product and the production processes. They become apparent through process cost accounting. In addition, complexity produces opportunity costs that cannot be determined explicitly. Opportunity costs consist of the profit contribution that must be forgone because the limited available resources cannot be used for the most favorable procedure.

An example of opportunity costs of complexity is the commitment of valuable capacity in product development for preparation of variants and their care, which is thus unavailable for product innovation. This is similar what happens in production planning, cost control, and purchasing. A Pareto analysis may be applied here: frequently the highest amount of the sales (70-80%, is accounted for by only 20-30% of the variants designed.

If there are too many variants on the product side, secondary products will take the place of core products. Products that are produced at high costs due to their smaller quantities, and marketed without perceptible additional price, will work against the core products and thus lead to a reduction in earnings.

Other factors can also lead to high complexity in the company processes, such as an exaggerated in-house production capability, a high portion of outside designs, and procurement of material from a large number of suppliers.

3.2 Costs of part variety and technology complexity

Typical one-time complexity costs are the costs that arise in design and development for defining and testing new parts. Accordingly, production expenditures arise for planning, special production equipment, technology development as well as the costs of setting up series production. In addition, these one-time expenditures occur in other company functions, such as materials management, quality features, and service.

In the sense of the complexities described above, administrative costs for each additional part usually lie in the range of \$1500-2000 for purchased parts and \$3000-3500 or more for parts made in-house. Administrative expenditures with the supplier are not considered here, but expenditures are included for documentation, job control, planning, and production planning tasks, all logistics tasks, cost calculation and billing, as well as the entire milieu of spare parts and service. Costs for the design and development of the part are not included in these figures.

Every part must be documented by, for example, technical drawings, parts lists, technical calculations, test reports, operating and service instructions, spare parts documentation, disposition rules, incoming goods vouchers, bills, production test records, work schedules, NC programs, tool settings, etc. At times, some of these are needed in several languages. Having many parts therefore leads to needing many documents that are all in turn tied to activities.

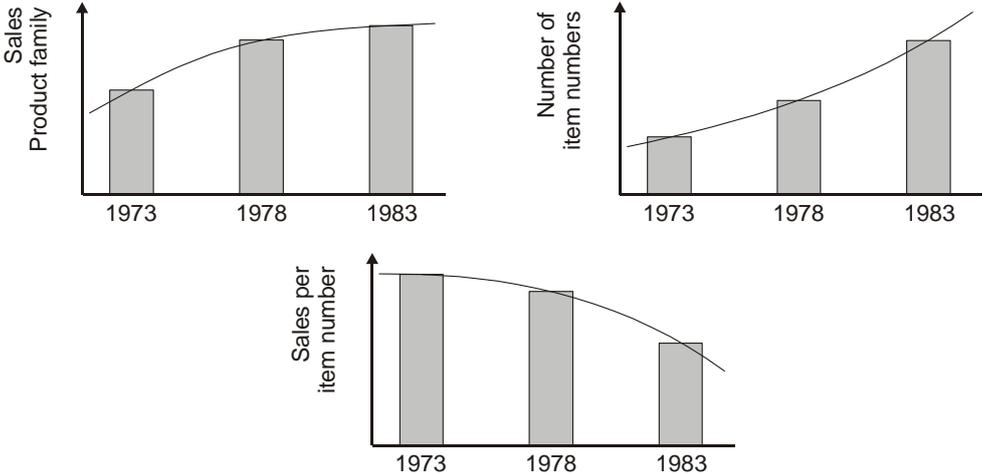


Figure 4. The part quantity in a family of electrical products increased faster than the sales

Manufacturing processes for the parts are characterized by different production technologies. High-grade, deep-drawn body panels tend to wrinkle; case-hardened parts are subject to warping and residual stresses; and mating parts with tight tolerances complicate production control.

Thus, changes to parts result in changes in the procurement and production processes that had been running smoothly, risking disorder.

An investigation by Hichert [Hichert 1985] showed how high the risk of chaos is when the number of the parts and thus the complexity increases in a company. Figure 4 shows that within 10 years the number of the items in a product line more than doubled and the sales of each part therefore reduced significantly.

3.3 Cost of product variants

Management consultants have repeatedly warned against having too many product variants. Figure 5 shows that successful companies with a specific line of products achieve positive results with fewer products and significantly fewer assemblies and parts within their products.

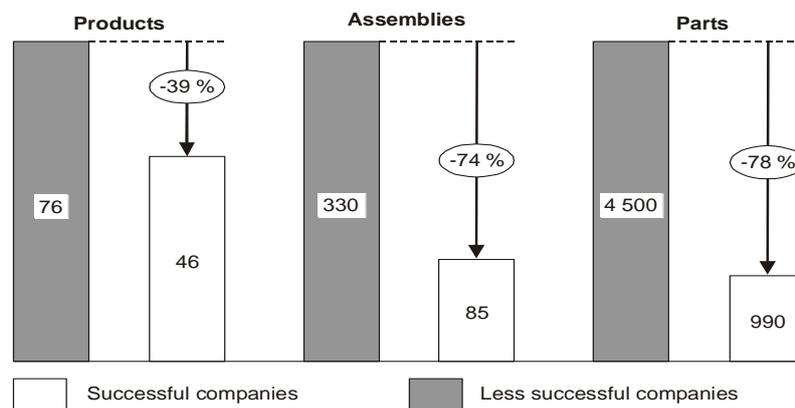


Figure 5. Fewer variants; greater success [Henzler 1993]

Investigations in industry have shown that cost reductions of 10-20% of the entire total costs are possible if unnecessary variants are dispensed with. This is due to savings in design and development, marketing and administration, and in a number of overhead costs that are assigned to manufacturing, production control, etc., see Figure 6 [Schuh 1989].

Summary

In light of the above discussion, we may summarize the steps and methods for improving the efficiency of product development, while concurrently reducing product costs, as follows:

- Arrange product development projects according to priority and importance.
- Employ personnel focused only on one project.
- Make personnel development and management, as well as improving the personnel structure the essential aims.
- Keep the organization continually advancing.
- Make decisions where the highest professional competence and the necessary oversight are present.
- Invest in time and capability in the early product development phases.
- Ensure properties of products early and with low effort.
- Discover the causes of change and avoid them in the future.
- Before carrying out the changes, test the entire process chain for their effects.
- Increase efficiency with tools for improvement of communication.
- Analyze and optimize the processes of development before using the new tools.
- During the introduction of new software, give equal weight to consideration of the applicable methods, the qualification of the personnel, and the adaptation of the organization.
- Training is needed in methods and their application in different situations.
- Define, advance and enhance the core competencies in product development.
- Build up and advance product development partnerships.
- Make the effects of complexity and complexity modification transparent.
- Search for existing or similar parts before deciding to develop entirely new parts.
- Examine and reveal all of the consequences of new variants.

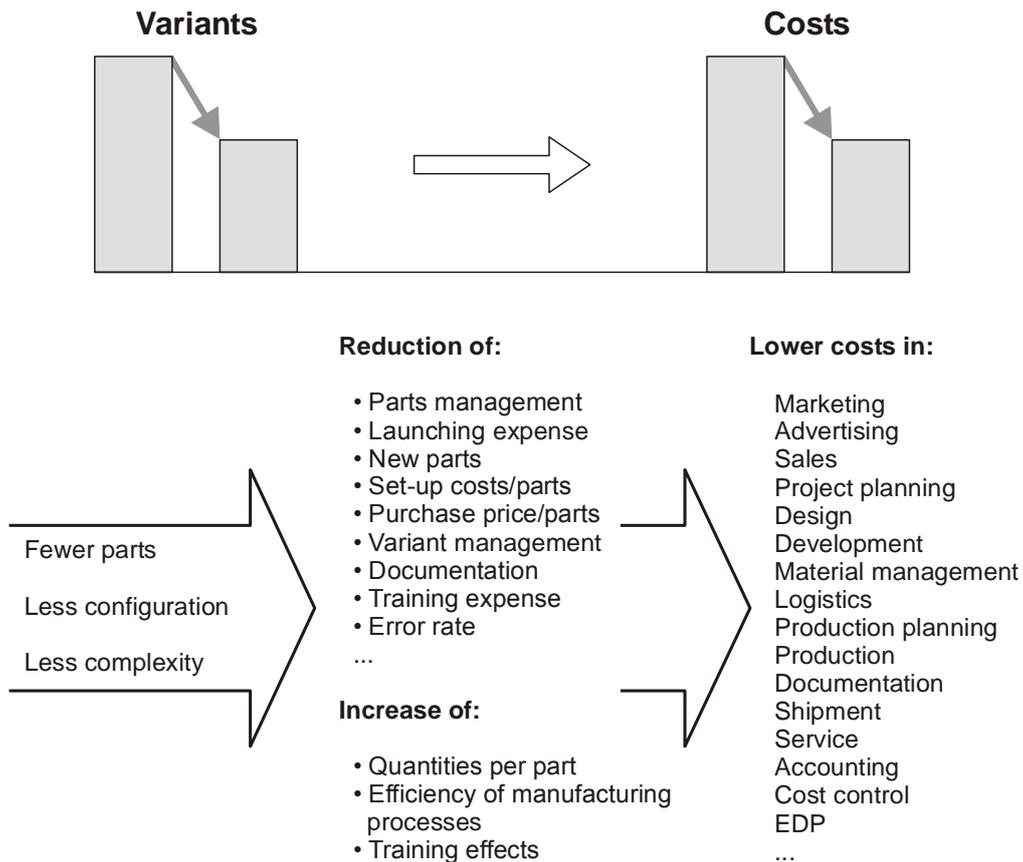


Figure 6. Fewer variants mean cost reduction in many company functions

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