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IMPLICATIONS OF GLOBALIZATION ON DESIGN FOR COST

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Summary

The paper discusses application of principles of Design for Cost, in light of the challenges of low-cost products from competitorsand off-shore production in low-wage countries. The advantages and disadvantages of outsourcing are presented. Case studies are given.

1 Introduction

International trade has always existed. Until the middle of the 20th century, this generally implied the movement of raw materials from the less-developed countries to the industrialized countries, and the export of manufactured goods from the latter to the former. More recently, as some of the less-developed countries have seen increasing industrialization, the flow of manufactured goods has been reversed to some extent. This has resulted in a loss of manufacturing jobs, as well as "white-collar" jobs in the industrialized countries. Along with a freer flow of capital, and to some extent labor, economies of both categories of countries has seen significant changes. These phenomena are included in the term "globalization," which is seen by many as a threat.

Product developers can meet these challenges in two ways: development of innovative products and reducing product costs. Cost reduction alone is not a substitute for innovation.

Principles of cost reduction are well established. These begin with a classification of costs: manufacturing costs, total costs and lifecycle costs; 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 fulfill 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. The area of low-cost product development that is most pertinent to the topic of this paper is the outsourcing of production. The advantages and disadvantages of outsourcing will be presented.

The paper discusses two case studies: Apple's iPod system, and Tata's Nano car. In the first instance an innovative product was designed in a high-wage country (USA) and manufactured in low-wage Asian countries. The second case is that of a product of established design, developed in a low-wage country (India), which never-the-less applies innovative product development procedures, along with application of principles of low-cost design.

2 Methods of Cost Reduction

Cost-oriented product development is systematical engineering work, which requires an interdisciplinary approach, and thus teamwork [1]. The costs and the possibilities of reducing the costs can be viewed from a variety of perspectives. The costs that are of interest here are those incurred by the products. A classification of costs, as shown in Figure 1, is useful. The basic costs that originate with the product itself are the manufacturing costs, that is,

those costs that can be assigned directly to the manufacturing process. These consist of the material and production costs for the product. In addition, there are costs that cannot be directly assigned to the product manufacture (e.g., administrative costs). They are combined with the manufacturing costs to form the company's total costs. The total costs, in turn, contribute to the lifecycle costs and are reflected in the product sales price. The lifecycle costs are costs that accrue to the product user, and are the sum of all costs associated with purchase, use, and disposal of the product. It is necessary to look at cost reduction in each of these phases.

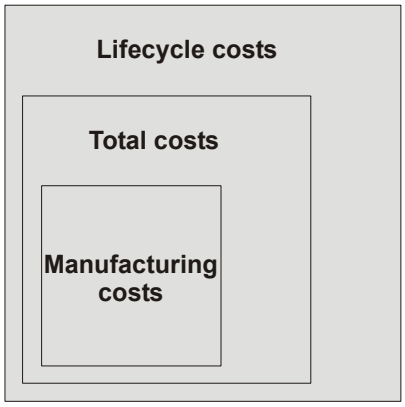

Fig. 1: Classification of costs

Manufacturing costs arise from material costs, part production costs and assembly costs. Chief design factors influencing the costs are: Task statement (requirements); Concept (function principle; e.g., physical principle, with material type, number and type of the active surfaces, complexity); Size (e.g., dimensions, amount of material); Quantities produced, and thus standardization, particularly in the case of single-unit and limited-lot production; and production and assembly technology, influenced strongly by materials, quantities produced, and sizes. Almost all of the departments in a company have influence on costs. The optimum choice of materials and production processes is one of the biggest challenges in product development.

Total costs are the sum of the manufacturing costs, design and development costs as well as marketing and administration costs. For determination of the cost-driving parameters of development, the costs of all processes initiated that way for development and care of the products are necessary. These processes include the diverse expenditures in marketing, production planning, purchasing, and other company functions. In many companies, too many tasks and too many projects are regarded as urgent and necessary, and are pursued more or less simultaneously. Thus, it is necessary to establish focal points of product development activities. Increasing the efficiency of product development requires addressing a number of areas, e.g., personnel qualification and motivation, forming the right organization, the structure of project management and time scheduling and capacity planning. Product development activities influence not only the direct costs of product development, but also the complexity of all processes in the company. Complexity in a company is determined by many things, but from a product development viewpoint, the following should be mentioned. (1) The number of different parts in the products; (2) the number of the technologies used; (3) the number of the participating designers and development partners; and (4) the extent of networking among all these entities. Additional influences certainly come from the markets, as well as from the organization of the company and other functions. One needs to consider the costs of complexity, costs of part variety and technology complexity and the cost of product variants. Product and part variety are very important for an established company, and can be reduced through standardization, using design part families, integral design and by

some organizational measures. Figure 2 shows the cost advantages of reducing product variants.

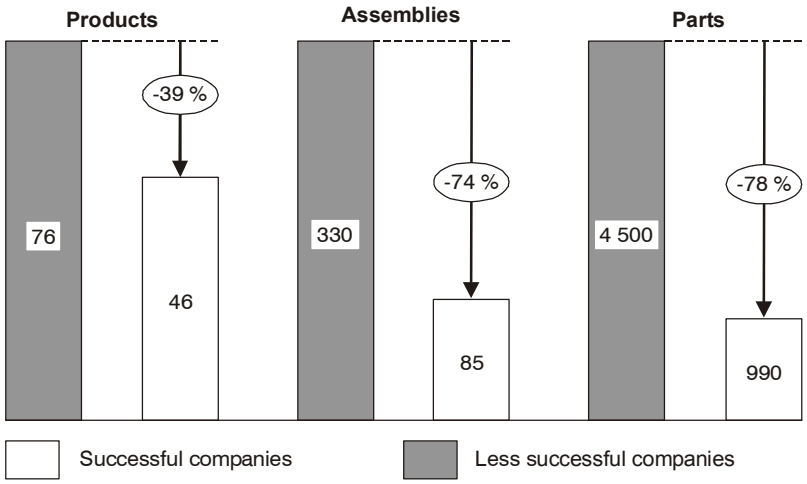

Fig. 2: Fewer variants; greater success

Lifecycle costs are those seen by the product user as the sum of all costs starting from the purchase and during the use (product life span) of a product (plant, machine, device, apparatus, etc.). These, along with the total costs are summarized in Figure 3. Lifecycle cost structure of a product varies, depending on the components of the various costs: capital, operating, maintenance, disposal costs, etc.

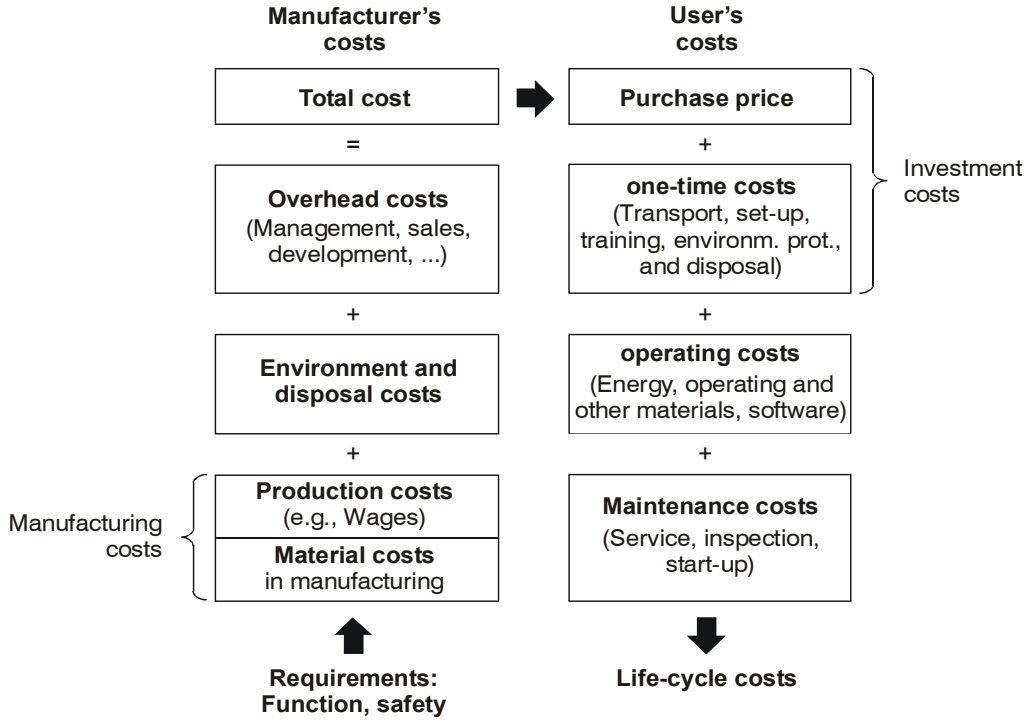

Fig. 3: Composition of lifecycle costs

3 Decision between In-house Development, versus Outsourcing

The tendency of product manufacturers to strengthen their respective core competencies and to assign peripheral activities to suppliers is a result of increasing and worldwide com-

petitive pressures, short-term order fluctuations and increasing product complexity. An essential basis for outsourcing was always to use the advantages of having a specialized supplier, with regard to costs, technology and schedules. Thus, the decision to be made is between in-house production and purchasing (make or buy). The extreme case of outsourcing is off-shoring, where production is moved to a different country.

Whole products are assigned to suppliers, including product development, production, assembly, and testing (system suppliers) - global networks of contract manufacturers (CMs) and original design manufacturers (ODMs) [5]. It is therefore a matter of more than just external production; it concerns the degree of performance capability in the company. Performance capability (strength) can be defined as the value-added portion in the production process that is provided by the company itself (production capability) and the value-added portion of the product development performance (development capability). Added value describes the total output/performance (sales revenues and changes in assets) minus the advance payments (materials purchase, external services, and interest on capital).

3.1 Advantages of outsourcing

- More flexibility at varying utilization, due to lower fixed costs.
- Low costs through low prime costs.
- Faster delivery and reaction capability.
- Special know-how of the supplier in a given specialty area.
- More capacity for the company's own core competence.
- Presence in the foreign market (with prescribed delivery range).
- Less capital investment in own production plants, therefore lower fixed and higher variable costs.
- No dependence on own equipment.

3.2 Disadvantages of outsourcing

- Loss of know-how to the suppliers and at times even to the competition.
- Possibly unsatisfactory quality.
- Design-for-manufacturability more difficult, since suppliers not known.
- Supplier loss potential due to: bankruptcy/sale/strike, or defects in the logistics chain of the suppliers.
- Expense for coordination with the suppliers, perhaps for their qualification (higher process costs).
- Relationship of trust with the suppliers must be created first.

3.3 Make or buy decision

The following points should be discussed regarding whether to perform the task yourself:

- The more strategically important it is (core competence).
- The more innovative it is.
- The more frequently it ensues (quantity effect).
- The smaller the possibility to standardize is.
- The more uncertain its planning may be.

The major argument against off-shoring is that manufacturing gets separated from engineering [2]. Burdens are placed on engineering, manufacturing and purchasing departments in dealing with the distant facilities. Procedures to implement cost reduction become problematical. Items to be considered are labor efficiency, training costs, shipping costs (especially in view of the increasing energy costs), quality costs, among others. It is important to look at the total costs. The following additional items need to be deliberated:

Labor costs and efficiency: True labor costs as fraction of the total costs should be carefully calculated. Labor efficiency is obvious; if the labor costs are half and the labor efficiency is also half, there is no saving.

Transportation costs, not only of the finished product, but also the raw materials, and all the necessary paperwork and administrative details. There is a longer turn-around time, thus slower response to market needs.

Training of workers and the consequent effects on quality; longer times to realization of errors and quality loss.

Production must be in-house, if:

- The company places value on absolute secrecy or on the security and expansion of know-how.
- No supplier is available, who might be a possibility on the basis of technology, quality or schedule.
- Great risks are involved in transportation.

External procurement is called for, if:

- The product can only be procured from suppliers because they have legal property rights or are the only ones to have the necessary know-how and/or the necessary quality standard.
- One's own company cannot supply the needed product of the specified quality or quantity, or within the required time.

Labor-intensive products such as textiles are candidates for off-shoring. Automating the production of such items is a challenge.

3.4 Improving one's Own Product Development Efficiency

Design has the dominant influence on the product cost, with estimates ranging from 65% [3] to 80% [2]; the biggest role is of the concept. The well-established ways of improving design are detailed in the literature [4]. These include Concurrent Engineering (design and devel-

opment, with input from manufacturing, marketing, purchasing, etc.), Design for Manufacturability (DFM), designing product and part families, standardization, etc. There are also possibilities of reducing costs by reducing overhead costs, rationalizing product lines, improving quality, among others.

4 Globalization

While globalization is viewed with alarm by some, the proponents argue its inevitability and point to rising living standards resulting in the developing countries. The many facets of globalization include not only the movement of goods – raw materials, parts and finished products – but also the flow of capital and interchange of ideas. The last is enabled by the increased ability to communicate in speed, volume and variety. Increasing number of people are moving up from the ranks of the poor. Economists state that new ideas are the fundamental source of higher living standards. The resulting larger middle-classes cause economic as well as cultural changes. Free trade is an essential element of today's globalization - it is a goal that is being approached with varying speeds and degrees of success. Globalization implies establishing production facilities in new locales, but also centers of research and development.

Globalization has implications in the two case studies presented below.

4.1 Apple's iPOD system

Apple's iPod video/audio system, designed in USA, is manufactured chiefly in East Asian countries. It consists of 451 parts [5] that are mainly generic. Retail price of the 30 GB model was $299 (2005). The most expensive component in it is the hard disk made by Toshiba, worth $73, followed by display, video and controller chips. The production process (supply chain) consists of a series of steps, which might be in / by different countries / companies. The difference between the values of inputs at each step (chips, board, etc.) and outputs (finished board) are the value added at the respective step. The hard drive contains about $54 in parts and labor; Toshiba's value added is thus $19. Value captured by the various entities and in the countries is shown in Table 1.

Estimated wholesale price: $224

Apple’s gross profit $80 (224-144=80)

Total of all inputs $144

Table 1: Value captured (gross profit) in a $299 unit sold in USA:

	USA	Japan	Korea	Total
Distribution/Retail	$75			$75
Apple	$80			$80
Suppliers	$8	$26	$1	$35
Total	$163	$26	$1	$190

Value added = gross profit + direct labor

In general, most of the profits accrue to the country where the product is developed and to the company that develops it, particularly if it controls the sales outlets.

4.2 Tata's Nano car

Nano car was designed as an affordable step up from a motor-scooter for a family of four in India. At a nominal price of $2500 (Rs 100 000), it would still be 3 times the median annual income, yet half the price of the current price leader. This is in contrast to USA where the cheapest car at $11000 is 25% of the local income. The result was achieved, not only by innovation in engineering, but rethinking the whole product development process. "It was in a mindset change - organizational innovation" [6].

Table 2: Cost breakdown of Nano [7]:

Body shell	Rs 25 000
Engine and transmission	Rs 30 000
Electricals	Rs 10 000
Interior elements	Rs 20 000
Tires and suspension	Rs 10 000
TOTAL	Rs 95 000

The major parts suppliers were consulted from the outset - who realized the positive effect this would have on their own business. Concurrent Engineering was practiced, e.g., every morning a meeting of designers, manufacturing teams, vendor development people. Among the innovations are:

- Modular design and distributed assembly: The car is made of components that can be built and shipped separately to be assembled in a variety of locations - it will be sold in kits that are distributed, and assembled in local plants. This is referred to as "open distribution" innovation.
- Reduced weight by using light design and an aluminum engine (own design) - with a single balancing shaft and two cylinders.
- Greater use of adhesives to replace welding.
- Eliminate actuators for adjusting headlamps.
- Alternator (Bosch) has output/weight of 35 amp/5 kg; standard unit: 40 amp/6 kg.
- Wheel bearings used are rated only for speeds up to 45 mph.
- Simplified instrument cluster is located in middle (same for L/R drive); dashboard is cast as a single piece.
- For the rack and pinion steering system, the steel rod of the steering was replaced with a steel tube, making it as one part instead of two, to save on machining and assembling costs.
- Complete drive train is placed in the rear.
- The supplier of the drive train tried 32 experimental variants to create the final driveshaft, to make it lighter and easier to manufacture. For the rear-wheel drive system,

they designed a smaller diameter of shaft, which made it lighter and saved on material costs.

The final costs of the various units are shown in Table 2.

5 Closing remarks

Outsourcing, especially off-shoring, can be justified in certain cases. These are: proximity of the production site to the customers (e.g., automobile plants in USA by foreign companies); small-size high-value products. In some cases transportation costs are a small portion of the total price, e.g., the moves of manufacturing from USA to Mexico, and from Western Europe to Eastern Europe. Products made largely from generic components, which do not call for intensive engagement of engineering with manufacturing, have proven to be candidates.

Companies should analyze their product development and manufacturing process and aim for higher efficiencies before embarking on outsourcing. Low-wage areas do not remain so for long, which calls for move to a new area - requiring the establishment of new facilities / partnerships - with all the associated costs.

6 Literature

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