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ECONOMIC FEASIBILITY RESEARCH OF DESIGN PROCESS FOR NEW TECHNICAL PRODUCTS

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Abstract: *The paper reviews and refines the concepts of direct and indirect costs. The basic rules for minimizing costs have been analyzed. The cost determination of new technical producs, the different types of expenditures and their structure have been considered. The author team describes specific rules for minimizing costs. Conclusions and recommendations have been made.*

Keywords: *Economic Feasibility, Design Process, Developing New Products, Cost Determination*
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Introduction

The firm’s decision on whether or not to manufacture a new product design requires the economic analysis of many “downstream” production-related factors. This is a very dynamic, iterative process complicated by engineering changes, market forecasting uncertainties, resource availability, refinement of quality criteria, and other factors. (Duffey,M., McDermott,M. & Anderson, R.,2020). However, this type of experience is outside the scope of most project-based engineering design projects that conduct feasibility studies for production facilities to assess the technical and economic viability of new high-tech products. The industry decision-making about whether and how to proceed with product realization typically involves many other technical and logistic considerations to assess the economic feasibility of downstream production

Exposition

Elements of economic feasibility study of design process include:
– Product redesign for site-specific and resource-specific production
– Translating quality criteria of the product design into production design for inspection, testing, supplier qualification, etc.
– Cash flow and scheduling for production planning and ramp-up, including milestones and hurdles
– Human resource requirements: job/task definitions, training requirements, and management structure
– Materials management for raw, in-process, and finished goods (Dobreva, A. & Dobrev, V., 2018)
– Supplier qualification, contracting, delivery schedules, etc.
– Financial risk analysis of decision alternatives for production volume, equipment investment, inventory levels, etc.
– Facility layout, equipment selection and installation, power requirements, environmental considerations, etc.

Expenses that should be considered during a design process for a new product are one of the following two kinds:

1. *Direct expenses*
2. *Indirect or operating expenses*

The same cost could be considered as indirect in one industry and direct in another, depends of the activity area. *Direct expenses* are any expenses incurred to manufacture or purchase goods and to bring them into saleable condition. Direct expenses become part of the cost of the goods manufactured or purchased. They can include any costs other than materials and wages. Direct costs are those that can be attributed directly to a specific cost carrier, for example - material, consultants, tools, labor for the production of a specific element. Even any kind of subcontract, which is attributable to direct works, but the specific company does not possess the required skill. They are incurred for a specific product, and if they were not incurred, the production of that specific product would not be possible.

Expenses, incurred to sell goods and to operate the business are called *indirect expenses* (or operating expenses). These expenses are classified into the following groups:

- Office and administrative expenses;
- Director’s salary;
- Marketing, selling, and distribution expenses;
- Financial and other expenses;
- Security cost;
- Shipping and postage;
- Transport, etc.

From other side, the direct costs could be *fixed and variable*. Fixed costs do not change with increases or decreases in units of production volume, they are the same up to a certain level of production, while variable costs fluctuate and go up with an increase in production unit’s volume. Variable cost, as dependant of the production volume are mainly the materials used and salaries angaged, while fixed ones could be the rent of the property, insuransies, advertising, etc. and they remain fixed till certain level of production volume.

Any cost could be categorized under one of these categories:

- *direct and variable* – related to the product, traceable, change in proportion to the production volume, e.g direct material cost;

- *direct and fixed* - related to the product, traceable, does not change in proportion to the production volume, e.g. salary of supervisor first level;

- *indirect and variable* – not directly related to the product, not traceable, change in proportion to the production volume, e.g. power cost;

- *indirect and fixed* – not directly related to the product, not traceable to product, does not change in proportion to the production volume, e.g. salary of supervisor second level.

The idea of identifying the cost structure is to allocate costs between fixed and variable costs effectively. These costs are then associated with individual products and product lines to determin their correct pricing. Proper cost allocation is essential to identify and calculate the profits with each product and product line. Failure to correctly identify and allocate the costs may lead to over or under pricing.

Maximizing quality while minimizing cost is the main goal of any developement of a new technical product. Here are a few specific cost-management tips for minimizing the costs of manufacturing a product, yet at the design stage:

1. **Design for Manufacturing -** Designing for manufacturing is a specialized approach to designing that prioritizes ease of product creation over other factors. It is a process of *proactively* designing products to optimize all the manufacturing functions: fabrication, assembly, test, procurement, shipping, delivery, service, and repair, and assure the best cost, quality, reliability, regulatory compliance, safety, time-to-market, and customer satisfaction. (Mitchell, J.**,** 2019).
   - **Minimize Set-Up (Fixturing or Tooling) -** set-up or fixturing is the process of physically flipping a part during the building process. This applies largely to CNC machining and can be the cause of significant price discrepancies due to relatively small design flaws
   - **Using the ideal form of the chosen material -** once an appropriate metal has been chosen, for instance, differentiating between its bar, sheet, and plate forms can help to drastically cut costs, as certain forms are often cheaper than others.
   - **Use Proper Part Tolerances - a** manufactured part's tolerance is the degree to which its exact dimensions can vary without it becoming unusable
   - **Adhere to specific process design guidelines -** to use specific design guidelines for parts to be produced by specific processes
   - **Simplify the design** for the fewest parts, interfaces, and process steps. Elegantly simple designs and uncomplicated processing, result in *inherently* high quality products. (Kamenov, K., Dobreva, A. & Ronkova, V. 2017)
   - **Reusing proven designs –** known design where parts, modules, software objects, and processes lead to minimization of the risk and assure quality, especially on critical aspects of the design.
   - **Use Multi-functional teamwork.** Break down the walls between departments with multi-functional design teams to ensure that *all* quality issues are raised and resolved early and that quality is indeed treated as a primary design goal.
   - **Document thoroughly and completely.** In the rush to develop products, many designers fail to document every aspect of the design thoroughly. Drawings, manufacturing instructions, and bills-of-material sent to the manufacturing or vendors need to convey the design *unambiguously* for manufacture, tooling, *and* inspection. Imprecise drawings invite misunderstandings and interpretation, which add cost, waste time, and may compromise quality.
2. **Considering the Materials -** Material options are vastly varied in modern manufacturing and each has a host of characteristics
   - **Considering Material Finishes -** Choosing less refined finishes ensures lower tooling prices and might not negatively affect the finished product's appearance.
   - **Minimize Manufacturing Waste -** active collaboration with a manufacturing engineer to ensure specific details that increase the likelihood of defective products
3. **Considering hollow structural options -** the thicker the wall of the part, the higher the chance of problems arising during production; using hollow structures for a product wherever possible allows for less material overall to be used to produce each part.
4. **Keep Physical Prototyping to a Minimum -** Software-aided performance tests reinforce this possibility with specialized options available to separate industries for stress testing parts and materials with high accuracy.
5. **Considering Value Engineering -** Value engineering centers on the refinement of a product's implicit functions in relation to its overall manufacturing cost. Value engineering is a systematic, organized approach to providing necessary functions in a project at the

lowest cost. It promotes the substitution of materials and methods with less expensive alternatives, without sacrificing functionality

6. **Specify quality parts from reliable sources -** The "rule of ten" specifies that it costs 10 times more to find and repair a defect at the next stage of assembly. All parts must have reliable sources that can deliver consistent quality over time in the volumes required.
7. **Use Off-the-Shelf Components -** Off-the-shelf components in manufacturing are product pieces that can simply be purchased instead of being crafted entirely from scratch.
8. **Minimize Manufacturing Waste -** Waste of any kind in the manufacturing process is costly. Elimination of defective products, scrap material is essential. Setting higher tolerances for parts that are neither functionally nor aesthetically critical. (Mitchell, J.**,** 2019).
9. **Select the highest quality processing -** Automated processing produces better and more consistent quality than manual labor.

Conclusion

To assess economic feasibility, management has to analyze costs and benefits associated with the proposed project. Cost estimating is essentially an intuitive process that attempts to predict the final outcome of a future capital expenses. Even though it seem impossible to come up with the exact number of costs and benefits for a particular project during this initial phase of the design process, one should spend the adequate of time in estimating the costs and benefits of the project for comparison with other alternatives.

For most companies, analysis of the profit potential of a new product design requires a very dynamic and interdisciplinary process to determine site-specific and resource-specific production requirements. Contributing to this process is an essential skill for many practicing engineers. The good product development is a potent competitive advantage. Product design establishes the feature set, how well the features work, and, hence, the marketability of the product. The design determines 80% of the cost and has significant influence on quality, reliability and serviceability. The product design process determines how quickly a new product can be introduced into the market place. The product design determines how easily the product is manufactured and how easy it will be to introduce manufacturing improvements like just-in-time and flexible manufacturing.

The immense cost saving potential of good product design is even becoming a viable alternative to automation and off-shore manufacturing.

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