UNDERSTANDING THE SIMPLE METHODS IN THE DESIGN PHASE OF INNOVATIVE PRODUCTS - KNOWLEDGE FOR MARKET SUCCESS

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Abstract: *Planning the innovative products includes both a technical and commercial evaluation. Suppose, an organization is looking for a new product and has several alternatives that finish initial screening at the same time. Sometimes the organization will have enough resources to develop and market all of these innovations, but usually resources are limited and one product is being chosen above the others. So we need some simple methods to compare products and choose the best. There are several ways of comparing the products, one of this is Quality function deployment QFD and Break even point BEP method. The goal of this paper is commercial evaluation with Break even point method as method for comparing the products and QFD method usage on the theory and practice base.*

Keywords: BEP - BREAK EVEN POINT, QFD - QUALITY FUNCTION DEPLOYMENT, NEW PRODUCTS

1. Introduction

All organizations make products. These products might be goods - like a car, computer, house or clothes - or they might be services - like transport, a holiday, health care or insurance. An organization can only be successful if it makes the products that customers want. So an organization must find that kind of products that customers really demand, and then it must make the products to satisfy this demand.

Introducing a new product is expensive and needs careful planning. The planning for a new product goes through a number of stages. These start with the generation of ideas, and end when the product is actually sold to customers. The details of the planning depend on the organization and the product, but a common approach has next stages: generation of ideas - initial screening of ideas – conceptual and detailed design - development and testing - market and economic analysis - final product development - launch of product.

Most organizations continuously search for new *ideas* they can exploit. Some of these ideas come from within the organization - a research department may develop a new product, or the operations people may suggest a change to an existing product. Many ideas come from outside the organization - a competitor's product might be adapted to fit into a company's range, customers may demand a product that is not currently available, or new regulations make a new product essential.

Introducing a new product is expensive and needs careful planning. The planning for a new product goes through a number of stages. The generic product development process consists of six phases, as illustrated in figure 1. The process begins with a planning phase, which is the link to advanced research and technology development activities. The output of the planning phase is the project's mission statement, which is the input required to begin the concept development phase and which serves as a guide to the development team. The last stage of the product development process is the product launch, when the product becomes available for purchase in the marketplace[1,2].

One way of looking at the development process is as the initial creation of a wide set of alternative product concepts and then the subsequent narrowing of alternatives and increasing specification of the product until the product can be reliably and repeatable produced by the production system.

Another way of looking at the development process is as an information-processing system. The process begins with inputs such as the corporate objectives and the capabilities of available technologies, product platforms, and production systems. Various activities process the development information, formulating specifications, concepts, and design details. The process concludes when all the information required to support production and sales has been created and communicated.

In the early phases of product development, various risks are identified and prioritized. As the process progresses, risks are reduced as the key uncertainties are eliminated and the functions of the product are validated. When the process is completed, the team should have substantial confidence in the product, working correctly and being well received by the market[3,4].

Figure 1 identifies the key activities and responsibilities of the different functions of the organization during each development phase. Because of their continuous involvement in the process, we choose to articulate the roles of marketing, design, and manufacturing. Representatives from other functions, such as research, finance, field service, and sales, also play key roles at particular points in the process.

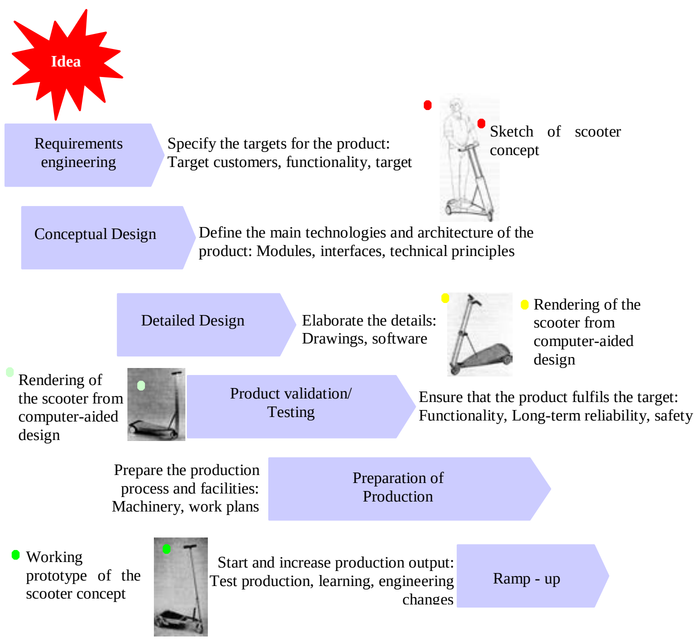

Fig. 1 *The key activities and responsibilities of the different functions of the organization during each development phase.*

A key component of market success is to recognize the customer, meet and exceed customer requirements. Not surprisingly, *quality function deployment* (QFD) had begun in Japan as a quality system for creating new innovative products to satisfy customer's wishes. To efficiently deliver value to customers it is necessary to listen to the voice of the customer throughout the product or service development. Quality experts in Japan developed the tools and techniques and organized them into a comprehensive system to assure quality and customer satisfaction in new and even innovative products and services.

A lot of companies are looking for new innovative products, but only few have alternatives that customers really demand. So we need some methods to compare products and choose the best. *Break-even method* is very useful for the obvious purpose of seeing how many units must be sold to make a profit, but they also help us with choices between alternative products. Figure 2 presents steps in design of products and well-known procedure methods from definition of the customer needs to the conceptual design.

In this paper I present both methods, which usage is very simple, but essential for success in the marketplace.

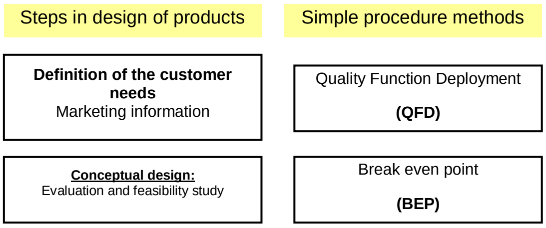

Fig. 2 *Steps and well-known procedure methods in Design of Innovative Product from Definition to the Conceptual design* [1].

2. Two simple, but important methods in design of innovative products

2.1 *QFD - simple method for market success*

QFD links the needs of the customer (and user) with design, development, engineering, manufacturing, and service functions. It helps organizations seek out both spoken and unspoken needs, translate these into actions and designs, and focus various business functions toward achieving common goal. QFD empowers organizations to exceed normal expectations and provide a level of unanticipated excitement that generates valued "QFD uses a series of interlocking matrices that translates customer needs into product and process characteristics."

In QFD method, product development translates customer expectations on function requirements into specific engineering and quality characteristics. Quality function deployment has four phases. Phase 1 gathers the voice of the customer puts it in words accurately understood by the producing organizations and analyzes it versus the capability and strategic plans of the organizations. Phase 2 identifies the area of priority breakthrough that will have a result in dramatic growth in market share for the producer. Phase 3 represents the breakthrough to new technology. Phase 4 represents the production of the new product and new technology at the highest possible quality standards.

QFD uses a series of *matrices* to document information collected and developed and represent the team's plan for a product. The QFD methodology is based on a systems engineering approach consisting of the following general steps:

- Derive top-level product requirements or technical characteristics from customer needs (product planning matrix).
- Develop product concepts to satisfy these requirements.
- Evaluate product concepts to select the optimum one (concept selection matrix).
- Partition system concept or architecture into subsystems or assemblies and flow-down higher level requirements or technical characteristics to these subsystems or assemblies.
- Derive lower level product requirements (assembly or part characteristics) and specification from subsystem/assembly requirements (assembly/part deployment matrix).
- For critical assemblies or parts, flow-down lower level product requirements (assembly or pail characteristics) to process planning.
- Determine manufacturing process steps to meet these assembly or part characteristics.
- Based in these process steps, determine set-up requirements, process controls and quality control to assure achievement of these critical assembly or part characteristics.

The following methodology has been suggested for implementing QFD. The following steps are important in QFD. However, there is a very specific process that should be followed when building the House of Quality - a complex graphical tool for product planning matrix (see Fig. 3). These steps are provided as an introduction.

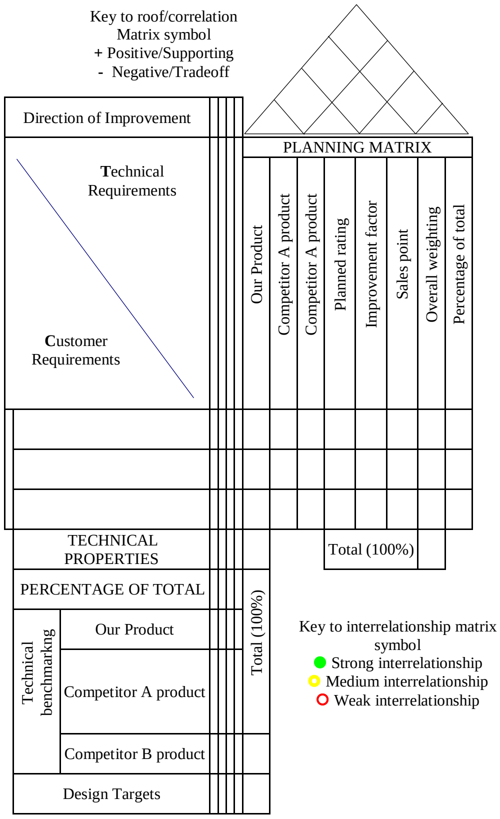

Fig. 3 *The expanded house of Quality QFD.*

Quality function deployment and the house of quality serve as a living document and a source of ready reference for related products, processes, and future improvements. Their purpose is to serve as a method for strengthening communications and tearing down internal and external walls. Through customer`s needs and competitive analysis, QFD helps to identify the critical technical components that require change. Issues are addressed that may never have surfaced before. These critical issues are then driven to identify the critical parts, manufacturing operations, and quality control measures needed to produce a product that fulfills both customer needs and producer needs within a shorter development cycle time. Tools such as designed experiments assist in the improvement of processes to meet those needs.

2.2 *BEP - simple method for market success*

Before introducing a new product, an organization must know if demand will be high enough to make a profit. The income generated must cover the cost of producing each unit, but it must also recover the money which was spent on development before the product was launched. This includes the costs of research, tooling, prototypes, market surveys, trial runs, and so on.

We can define the profit from selling a product as:

Profit = Income - Total costs

In this equation the total costs come from a number of sources and can be classified as:

- Fixed costs, which are constant regardless of the number of units made and
- Variable costs, which depend on the number of units made.

Research and development costs, for example, are fixed regardless of the number of units made. Other fixed costs come from marketing, administration, lighting, heating, rent, debt repayments and a range of overheads. On the other hand, the cost of raw materials, direct labour, maintenance and some other costs are directly affected by output - a doubling of output will double these costs. You have probably met this when running a car.

There is a fixed cost of repaying the purchase loan, road tax, insurance and a variable cost for each mile travelled for petrol, oil, tires, depreciation.

Then:

Total costs = fixed cost + variable cost

Total costs = fixed cost + number of units made × cost per unit

Total costs = $C_F + n \times C_U$

where:

n = number of units sold

C_F = fixed cost

C_U = variable cost per unit

The income is much simpler and comes from:

Income = number of units sold × price charged per unit

Income = $n \times P$

where:

P = price charged per unit

We now have an income and total costs that both rise linearly with the number of units made, as shown in Figure 4. The break-even point occurs when the income equals the total costs, and is the point where these lines cross each other.

The break-even point is the number of units that must be sold before an organization covers all costs and begins to make a profit.

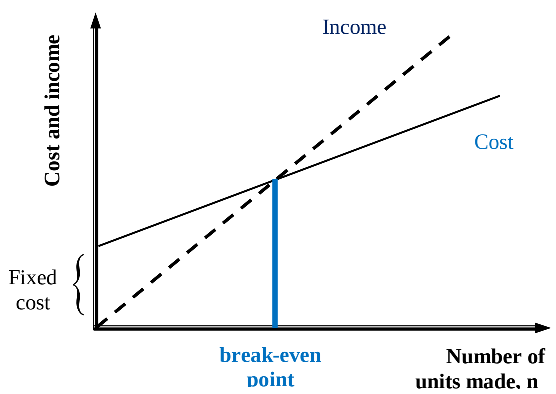

***Fig. 4** Defining the Break even point method*

3. Practical case study of BEP and QFD

3.1 Case study of BEP

To obtain the optimum performance from a structure of this kind and customer request, swing motorcycle arm generally has to be manufactured with steel or aluminium material solution[5].

Results of design and development team are three different swing arms, one creates from steel (A) and two creates from aluminium alloys (B and C).

In the concept development phase, the needs of the target market are identified, alternative product concepts are generated and evaluated, and one or more concepts are selected for further development and testing. A concept is a description of the form, function, and features of a product and is usually accompanied by a set of specifications, an analysis of competitive products, and an economic justification of the project.

Our three products pass the technical evaluation and it moves on to a commercial evaluation, which sees if it will make a profit. The technical evaluation and commercial analysis together form the feasibility study. Our organization is limited with resources and one product must be chosen above the others. Market sensing and evaluation is accomplished by demonstrations to potential customers, market tests, or market survey. Our company made the feasibility study for all three potential products, as shown in table 1.

***Table 1.** Technical and commercial analysis for all three products A, B and C*

	Product		
	A	**B**	**C**
Expected demand each year	12.000	16.500	18.500
Unit cost of production C_U	9,5 €	19 €	22 €
Unit selling price P	12 €	23,5 €	25 €
Fixed cost before production C_F	120.000 €	260.000 €	280.000 €
Expected product life	3 years	5 years	6 years

The Break-even points are calculated from:

$$n = \frac{C_F}{(P - C_U)}$$

For each product we have Break even point:

A: n = 120.000 / (12 – 9.5) = 48.000

B: n = 260.000 / (23.5 – 19) = 57.778

C: n = 280.000 / (25 – 22) = 93.334

If the company wants the lowest break-even point it would choose product A. But the company must be interest in the time taken to break point. For each product this gives:

A: 48.000 / 12.000 = 4 years

B: 57.778 / 16.500 = 3.5 years

C: 93.334 / 16.500 = 5 years

In this case product B is the first to start making the profit. Another objective might be to maximize long-term profit. For each product the lifetime profit is:

A: (3×12.000×12) – (3×12.000×9,5) – 120.000 = – 30.000 €

B: (5×16.500×23,5) – (5×16.500×19) – 260.000 = + 111.250 €

C: (6×18.500×25) – (6×18.500×22) – 280.000 = + 53.000 €

Product A makes a net loss over its expected life, while product B gives the best total profit. Overall, the best decision on the objectives of our case-study company is production of product B. Aluminium swing arm – product B passes the feasibility study and it moves to final design and testing. This is where the product changes from a prototype or concept model, to the form that will be sold to customer.

3.2 Case study of QFD

We can not imagine economy without continuous development, innovation and creativity. We show the design, solution and product development - the mechanism of building fittings with Quality Function Deployment method. QFD is a method of quality assurance based on pre-defined customer requirements, which reinforces the characteristics of the product, some of which depend on fulfillment of all the requirements, defines the critical points in the product and its manufacturing.

The introduction of QFD methods in the new products development phase is one of the most difficult steps. At this stage, we have to choose a large number of important information such as customer requirements, weight of importance and direction of improvements, that define the future steps of the project for the end - product.

Building a house of quality QFD looks simple. Good construction of this house depends on good cooperation between the project team with a group of potential buyers of a new innovative product. Complexity of the house depends on the number of customer requirements and quality characteristics of R&D team.

Figure 5 shows the QFD house of quality for mechanism of building fittings.

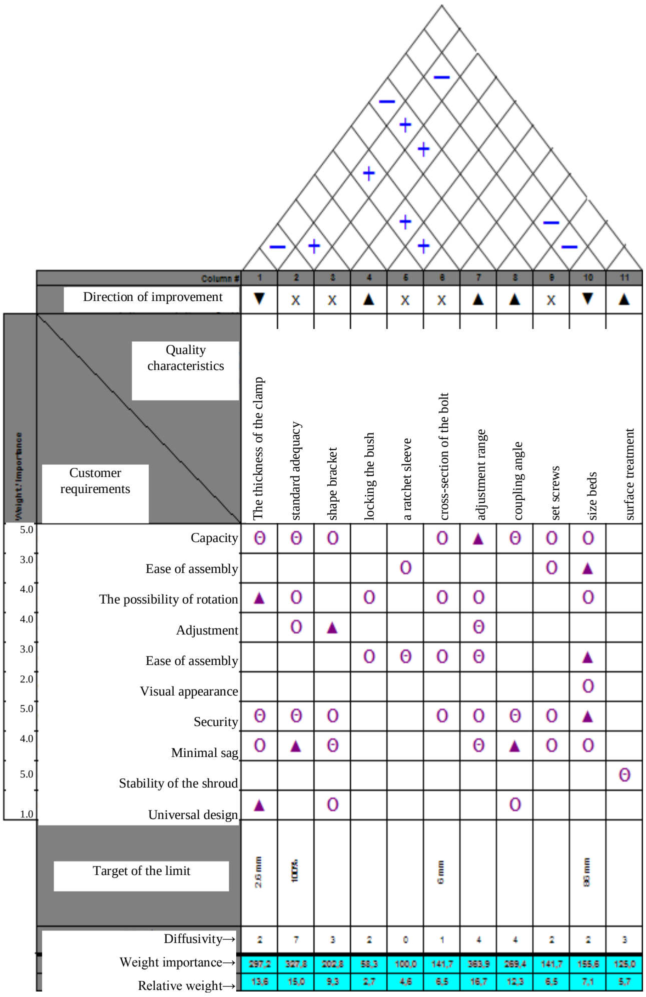

Fig.5 *QFD - Mechanism of building fittings*

4. Conclusions

The economic success of manufacturing firms depends on their ability to identify the needs of customers and to quickly create products that meet these needs and can be produced at low cost. Achieving these goals is not solely a marketing problem, nor is it solely a design problem or a manufacturing problem; it is a product development problem involving all of these functions[6].

Product development process is the sequence of different steps or activities which enterprise employs to conceive, design, and commercialize a product. Before the start of the mass production of a new product it is necessary to use several calculation and technical methods. Companies can use in their strategy a few simple methods and skills for success in the market. QFD and BEP are methods that can be a significant extent affect the performance of the product in the market.

Quality function deployment and the house of quality serve as a living document and a source of ready reference for related products, processes, and future improvements. Their purpose is to serve as a method for strengthening communications and tearing down internal and external walls. Through customer needs and competitive analysis, QFD helps to identify the critical technical components that require change.

The main advantage of break-even analysis is that it points out the relationship between cost, production volume and returns. It can be extended to show how changes in fixed cost-variable cost relationships, in commodity prices, or in revenues, will affect profit levels and break-even points.

Calculation of break-even point is important for every business because it tells business owners and managers how much sales are needed to cover all fixed as well as variable expenses of the business or the sales volume after which the business will start generating profit.

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