Maggi essay

A. Terry Uphill, University of Arizona, and William L, Chapman, Hughes Aircraft Co. ABSTRACT Quality function deployment (SF) helps to introduce the idea of quality in early phases of the design cycle and to reevaluate quality considerations throughout the system's entire life cycle.

This article presents a tutorial example of using SF to design a product. It shows which quality controls in the manufacturing process are most important to ensure customer satisfaction, Introduction Over the past 40 years, the Japanese have developed many techniques for improving quality in manufacturing processes. One of these, quality function deployment (SF), is becoming very popular in both Japan and the United States. SF started in Japan in the late asses and is now used by over half of Japan's major companies. It was introduced in American automobile manufacturing companies in the early asses; now many of our major corporations are using it, including John Deere, Ford, Chrysler, General Motors, Hughes Aircraft, Boeing, McDonnell Douglas, Martin Marietta, Texas Instruments, Hewlett Packard, Westinghouse, and MM, SF is the eel of the collection of tools now being called total quality management (TTS). SF strives to get the idea of quality introduced in early phases of the design cycle and to reevaluate quality issues throughout the product's entire life cycle. In most implementations, SF uses many matrices to discover interrelationships between customer demands, product characteristics, and manufacturing processes, as shown in Exhibit 1 . For example, the first SF chart compares the customer's demands to quality characteristics.

The second chart then investigates the relationships between these quality characteristics and characteristics of the product. The third chart

subsequently examines the relationships between these product characteristics and manufacturing processes. Finally, the manufacturing processes are compared to the quality controls that will be monitored during manufacturing.

An example will now be given for each of these charts. SF presents the data in a user-friendly format. The Japanese philosophy is that everyone participates in This refereed tutorial was accepted by Hal Ramsey, Associate Editor, May 1993.

Improving the product. Therefore, all system design tools should be usable by the chief scientist with a doctor of philosophy degree and the animator with a high school diploma. As a result, SF tools are mathematically simple. Toothbrush Inc. : A Heuristic Case Study At this point, we are going to branch away from the generic and focus on a specific example to illustrate the SF process. Assume that you are the chief executive officer of Toothbrush Inc a major toothpaste manufacturer, About the Authors A. Terry Uphill has been a professor of systems engineering at the University of Arizona in Tucson since 1984.

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Uphill and A. W, Women; CRY Press, 1992). Contact: Dir. A. Terry Uphill, Systems and Industrial Engineering, University of Arizona, Tucson, AZ 85721 , phone: (602) 621-6561 , e-mail: See. Arizona. Deed.

25 Engineering Management Journal VOLVO 5 No. 3 September 1993 Quality characteristics Product Manufacturing recesses 11 B« S Exhibit 1. The SF waterfall chart. And your market share has suddenly dropped.

You suspect this is the result of your competitor's new innovation. has developed a new toothpaste container called the Neat Squeeze dispenser and has endowed it with a substantial advertising budget. To understand this example better, you might want to cut open a Crest Neat Squeeze dispenser and see what is inside.) The function of's new Stand-up Tube is similar. To recapture your market share, you decide to redesign your product. Therefore, you plan a SF analysis of your product.

To begin with, you must find out what your customers want. Our Marketing Department asked all people who should provide input for the system design what they thought was important. In the SF literature, the aspects deemed important by the customer are variously called demands, wants, expectations, requirements, and needs.

We will use only the term customer demands. Based on customer surveys, we derived the following customer demands: No Waste-? Almost all the toothpaste comes out but not all over the bathroom. Small Footprint-? container takes up little counter space. Reasonable Cost-? let should cost about he same as present containers. Attractive Container-? The Sales Department says it must look good. By attractive container we mean that is must look good on the shelf in the store and also on the counter in the bathroom. Perhaps we should have divided this up controls into two customer demands, but we did not. It is easy to continually second guess the categories.

We advise that you review them once and move on. You can always go back and change things later. After listing the demands, the customer assigns a

weight indicating the relative importance of each demand. Usually the weights are between 1 and 0, with 10 being the most important. Exhibit 2 shows the customer demands and the associated weights for the Toothbrush Project. Sometimes these weights are pulled out of the air by the customer's expert. Sometimes they result from group discussions. And sometimes they are derived using quantitative decision-aiding tools such as the analytic hierarchy process (Stay, 1980; Uphill, 1991).

In this chart, it seems that our customer is the person that brushes his or her teeth with the toothpaste. However, the term customer includes all people who should provide input for the system design: buyers, store managers, others, stockholders, employees, company management, and the company's Manufacturing and Marketing departments. (Chapter 5 of Chapman, Uphill, and Women [1992] explains this more fully. To suggest the possibility of including these other facets of the customer on this or parallel SF charts, we now include two demands that are appropriate for the company: Company Demands: Customer Demands: Neatness Tidy Tip-? The tip stays clean and neat.

Retains Shape-? The container retains its original shape. Stays Put-? The container does not roll off the counter. Hygienic-? Toothpaste that touched the brush cannot be ran back into container. Squeezable-? People want to squeeze the container, they do not want a pump. Easy Open-? The cap opens and closes easily.

Time to Market-? the amount of time needed before the product can be sold Return on Investment-? profit divided by money and value of facilities

provided. Next, we asked our Systems Engineering Department to derive measures to assure that these customer and company demands are satisfied. In the SF literature, such measures are called quality characteristics; generally in systems theory, they are called figures of merit.

Quality character- 26 Engineering Management Journal Volvo. No. September 1993 CD Q_ Customer Tidy Tip Retains Shape Stays Put Hygienic Squeezable Easy Open No Waste Small Footprint Reasonable Cost Attractive Container Company Time to Market Return on Investment 10 4 7 6 5 9 8 Exhibit 2, Customer demands with their associated weights, cities should be quantitative and measurable. These are the quality characteristics for the Toothbrush Project: Quality Characteristics: Mess-? amount of toothpaste scraped off tip when half empty Pull-sack-? amount of toothpaste pulled back when done dispensing Pressure-? pressure needed to get the toothpaste outEffort-? number of turns or time or effort needed to remove cap Waste-? amount of toothpaste left in container at end of life cycle Counter Space-? amount of counter space occupied by container Deformation-? amount of change in shape of container when half empty Pleasing Appearance-? based on customer survey results Cost to Produce-? cost to manufacture the product Selling Price-? sales price for one item Time to Develop-? time needed to develop the product. In general, SF charts have something listed on the left and something listed along the top, as shown in Exhibit 3. The things listed on the left are called the What's and the wings listed along the top are called the Wows. To help determine the Wows we ask, " This is what the customer wants, now how can we measure it? " The next step in a SF analysis is determining the strength of the relationships (or the degree of

correlation) between the What's and the Wows. This is done by filling in the central matrix as shown in Exhibit 3.

Each element of the What's is compared to each element of the Wows. Four classifications are given. If they are strongly related, a value of 9, or a black disk with a white dot inside, is recorded in the appropriate cell. Moderate relationships re given a 3, or a circle. Weak relationships are given a 1, or a triangle. No relationship is given a O, or the cell is left blank.

The logarithmic 9-3-1 weighting was created by the Japanese and has been adopted by most SF users. These correlations are sometimes represented with symbols and sometimes with numbers. In fact, sometimes we use both in the same chart, as in Exhibit 3.

You should use whatever will make your customers most comfortable. Different symbols may even be used, because the foremost principle of SF is " copy the spirit, not the form" (Kaka, 1990), Each relationship can be either positive or negative. We want to know whether each customer demand can be measured by a quality characteristic, not whether it shows a positive or a negative relationship. If any row of this matrix is blank, then we cannot assure satisfaction of that customer demand; that demand, therefore, should either be eliminated or another quality characteristic should be added. Usually numerous customer demands are generated initially. And then, to save work, the least important ones are deleted. However, the deleted items should be recorded to assure future designers that these customer demands were indeed considered.

The next step is multiplying each cell's value by the weight of the customer demand and totaling the column for each quality characteristic. This is shown in the row labeled " Score" in Exhibit 4. The total score for each column indicates the importance of that characteristic in measuring the customer's satisfaction. Typically measures with low scores receive little consideration. However, this does not necessarily mean that they will not be used in the product design: They may still be necessary for contractual or other reasons. To satisfy the customer, we must pay strict attention to the measures with the highest cores.

This attention to the customer is the main purpose of the SF chart.