InnKnow FORUM

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No 6, Fall 2004

In Focus: New Product and Service Development

EDITORIAL

PRODUCT DEVELOPMENT ORGANIZATION AND IMPERATIVES

Because of globalization, facilitated access to best practices, and increased speed of information sharing and communication, companies in an industry tend to a greater and greater extent to share similar practices, tools and methods as far as operations and processes are concerned. For example, Enterprise Ressource Planning systems (ERPs) are used to automate low value-adding tasks, leading information flows and administrative processes to become more and more similar between firms (Davenport, 1998). As a result, the true potential for differentiation and competitive advantage lies in the ability of an individual firm to innovate, develop and introduce new products more rapidly on the market.

How to better organize for optimized product development performance has been a central focus of practitioners and management scholars alike, ever since the beginning of the 1990s when lean production principles were first formulated based on intensive benchmarking with the Japanese industrial "miracle" – in particular the Toyota Production System (Womack et al, 1990).

After a decade of concept and model development in academia, and continuous trial-and error change processes in business, there is a strong consensus concerning what issues managers need to master in order to meet the critical objectives of successful new product development, which are: maximizing the fit with customer needs, minimizing the time to market, and optimize resource allocation (Gupta et al, 2000). These issues include project organization, inter-functional development teams, tapping into suppliers' expertise in terms of product development, and managing the product development process as a knowledge creating and learning process. But before analysing these principles and methods in some more detail, let us clarify and illustrate what is actually meant when one talks about the product development process (much of what is said in this editorial applies also to the development of new services, although the service development process is normally much shorter and less resource intensive).

One of the most wide-spread and well-accepted conceptual descriptions of the NPD process is that of Clark & Fujimoto (1991) who identify five successive but overlapping stages of the process: **Concept Generation** where designers and product planners define the character of the product to become from a customer's perspective; **Product Planning** where the concept is translated into specifics for detailed design, including major specifications, technical choices and cost targets; **Product Engineering** where product plans are transformed into blueprints or CAD-drawings then into prototypes and ultimately into real parts and components; **Process Engineering** where the manufacturing tools that will realize the product are developed, and material flows, plant lay out, work organization and tasks are defined; **Production Process** where final products are made and assembled for the end customer. The NPD process then ends with feed-back into the product and process engineering steps from ramp-up production and pre-series.

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The *product development funnel* (Iansiti & Kosnik, 1999) is another process framework closely corresponding to that of Clark & Fujimoto. The funnel concept illustrates how customer needs and technological possibilities influence concept generation and selection and how projects then evolve through the subsequent steps of product design, prototyping and testing, and pilot production to end up in manufacturing ramp-up and release, all taking place under decreasing levels of uncertainty –which simultaneously means reduced flexibility- as the development phases unfold over time.

A third widely used model is the *stage-gate* model of new product development (Cooper et al, 2002). It identifies a series of development stages, similar to the ones described above, but complements these models by explicitly identifying a series of evaluation gates through which a new product project has to pass from idea to commercial launch. The stage-gate model creates discipline in the NPD process by requiring periodic systemic review of projects at multiple milestones in the development cycle.

Hughes & Chafin (1996) propose a final complementary dimension they call the *value proposition process* (VPP), consiting of keeping managers focused on four critical issues/questions: *capturing market value* (answering the question "does the customer care?"); *developing business value* (answering "do we care?"); *delivering winning solution* (answering "can we beat the competition?"); and *applying project and process planning* (answering "can we do it?"). Keeping these questions on the top of the development agenda calls for continuos performance monitoring from a customer satisfaction-, a financial-, a strategic management-, and a process management perspective. Figure 1 illustrates the product development process integrating and building on the steps of Clark & Fujimoto, the product development funnel, the stage-gate model, and the value proposition process.

Even though linear in their approach, it must be stressed that the conceptual descriptions and models analysed and illustrate above all emphasize concurrent engineering, overlapping tasks, and continuous cycling of problem solving processes.

Turning to the core imperatives in world-class product development, four areas are of particular importance.

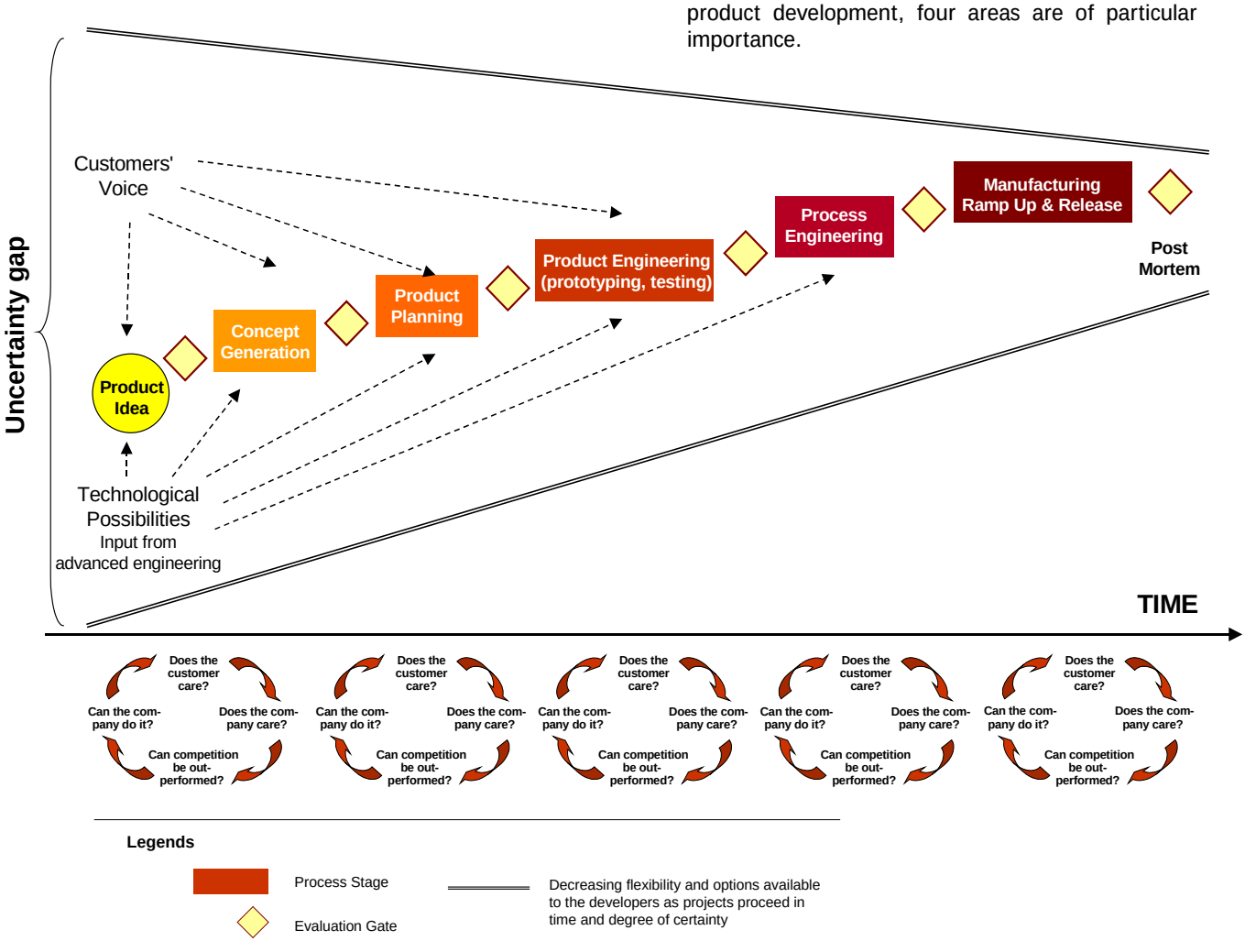

Figure 1. The New Product Development Process

Concurrent Engineering and Intensive Communication

Concurrent engineering relies on strong and permanent interaction between different engineering functions during the whole design and development process; the basic idea is that a product's design and the associated manufacturing process for it should evolve simultaneously (Durand, 1995). In this context *design for manufacturing* emphasizes the importance of early involvement of process engineering and manufacturing personnel in product planning and product engineering, in order to avoid late changes in a design that has already evolved and where all product functions are already interdependent. The design for manufacturing philosophy makes it possible to reverse the traditional sequence "adaptation of manufacturing to new design" and adapt the design to an innovative manufacturing process. Now, if managers wish to improve coordination and actually integrate different functions within their firm, or develop closer relations with other firms in a specific problem solving cycle (for example the process of developing a new component), cross-functional teams must be established between marketers, product and process engineers, purchasing managers and manufacturing staff. A broad range of competencies in the design team is essential for the integration of functions.

Intensive *communication*, which means rich, frequent and bi-directional information flows (between different steps in the product development process), is the second crucial element in order to achieve integration. Effective integration has, in fact, both a 'hard' side and a 'soft' side: organizational structure, work processes (including methods for framing and analyzing problems), skill development programs, and formal tools for analysis and communication are important, but tend to give few results if positive attitudes to change, trust between team members and between hierarchical levels, and commitment to common objectives fail to emerge.

Rationalized Supplier Relations and Continuous Supplier Involvement

Large engineering and manufacturing corporations in the automotive, appliances, hardware, electronics, etc. industries perform active search, apply rigorous selection procedures and develop long-term relationships with a reduced number of suppliers with a proven record of performance (Lee, 2004). The performance record does not only comprise cost, quality and delivery parameters, but first and foremost the suppliers' capability to provide design and development expertise for components and component systems. Under the name of "black box engineering" the assembler generates overall requirements on product functionality and performance, cost targets, and development lead time, then communicates this information to a couple of potential suppliers who carry out detailed engineering and testing. This practice relies on partnership and represents early involvement of suppliers and intensive interaction from concept generation and onwards. Assemblers might benefit from higher quality and lower cost due to suppliers' specialized expertise, while they maintain overall control over cost, quality and specifications of technical systems through integrated management.

Heavy-Weight Project Management

The traditional matrix organization, where people report both to their functional department and to a development program, is highly inefficient as far as product development lead-time, cost, quality and technological performance of the final product are concerned. The main reason, leading scholars argue, is that employees depend on their functional manager, who might have other priorities than to lend personnel to the development program (Midler, 1993; Womack & Jones 1994). In a project organization, conversely, all the necessary resources for developing a new product become under the direct control of the project manager for the project life time, i.e. from idea generation to product launch. A project organization can take different forms. Bowen *et al* (1994) identify four "stylized patterns" of project leadership and organization. These are:

- A *functional system*, where the basic work gets done within, and leadership occurs through, the functional organizations;
- A *lightweight project team system*, where a project manager coordinates and schedules activities through liaison representatives but the basic work and much of the substantive leadership occurs through the functions;
- A *heavyweight project team system*, where the work is done in the functions, but a project leader and a core team of functional leaders take responsibility for all aspects of the project; and
- A *dedicated project team system*, where the people working on the project are pulled out of their functional organizations and dedicated to a team led by a strong and empowered project leader.

Large development projecs are today almost exclusively managed in a heavy-weight or a dedicated team system. This has proven efficient for reaching project goals, but senior managers must keep potential conflics between functions and projects in check (Schilling, 2005).

Learning and Knowledge Management

With respect to the importance of integration discussed previously, what is needed is for development team members *know* enough about what their colleagues do and know in order to be able to ask the right questions, to anticipate problems, and provide the necessary information

during the design process. Briefly, different participants must also be able to understand the non-articulated *tacit* knowledge possessed by their colleagues.

Hence, another key imperative in NPD management is to manage the process as a learning and knowledge-creating one for everyone involved. Of particular importance is the transfer of knowledge within and between teams, and firms – especially involving suppliers in learning dynamics. Project management, stage overlapping, communication and supplier integration support knowledge sharing and transfer, as does the projects reviews conducted in a stage-gate organization. Recent research, however, has confirmed that when it comes to knowledge management, what makes the true difference of high-performing organizations are the intensive use of *job rotation* on the one hand and of *product development intranets* on the other (Soderquist & Prastcacos, 2002). This is because both job rotation and intranets support the sharing of tacit knowledge. Job rotation enable employees to develop the "art of the practice" by performing new task mirrorring new tacit knowledge. Intranets, enabling real-time reaction to information being posted, a "coffee-room" style discussion of ideas and opinions in relation to problem-solving, and extensive storage and retrieval functions, offer a new medium helping the sharing of tacit knowledge.

The Articles in this Issue

New product and service development is exiting; it is linked to innovation, strategic development and the ultimate survival of corporations. It is a turbulent process that requires a structuring framework, but where such frameworks must leave room for a large portion of creativity. In this issue of InnKnow FORUM, we present a few such frameworks and we also devote one article to the important issue of design and aesthetics in new product development.

Josiena Gotzsch analyses products in the consumer goods industry and proposes, based on two case examples from multinational corporations, a framework for integrating expression and charisma in product design.

In the second article, authored by myself, I present a framework developed in collaboration with other researchers and in close connection with automotive manufacturers, that classifies, based on a portfolio logic, different buyer-supplier relationships for optimized product development performance.

In the last article, George Ioannou, Katherine Pramataris and Gregory Prastacos propose a methodology for website development based on the Quality Function Deployment (QFD) framework. An inispensable tool in industrial development projects, they show that it can also be used effectively in the challanging endeavour of designing attractive and functional websites.

Klas Eric Soderquist

MANAGING PRODUCT CHARISMA

by Josiena Gotzsch

In the current competitive consumer goods market, product expression is a way to acquire a competitive edge over equally functional product designs, proposed by competing firms. In this article, it is described how a Philips range of small kitchen appliances and three Signal toothbrushes received an expression that specifically aims to appeal to its users. The Philips and Signal products have in common to be designed for competitive consumer goods markets. Users of these products are likely to be in frequent visual and tactile contact with this kind of products. Product appearance, therefore, is important. The methods used to develop an attractive product expression, however, varied in these case studies and included spontaneous idea generation, user-involvement in the product development process and market research before the development phase.

The research investigated whether a *competitive market situation* had pushed the company towards the creation of a meaningful product design. Secondly, the company's *experience and attitude towards design* was analysed to understand the importance of a company's experience with the design function for the creation of an expressive product design. Thirdly, the influence of *human resources* on this specific part of the process was studied. This concerned questions about the need for specific skills and the time available for the project. Finally, the research analyzed the *pre-development process* and the actual *creation process*.

The Philips Essence Products

The Royal Philips Electronics group employs approximately 189,000 employees in 60 countries. Philips Domestic Appliances and Personal Care (Philips DAP) is part of the Royal Philips Electronics group and develops, produces and commercialises consumer products for electric shaving, beauty care, dental care, home care and food and beverage. Philips DAP has approximately 10,000 employees, eight production sites in seven different countries, and national sales organisations in more than 40 countries.

Between 1997 and 1999, Philips DAP and Philips Design developed a new product range called Philips Essence (see figure 2). In 1997, a new Business Unit Manager, coming from Unilever, obtained the task of rejuvenating the DAP organisation. He had a strong market-orientation and initiated a series of changes, one of which was the cooperation between the managers of the Food and the Beverage product groups for the development of a common marketing strategy. The idea was to develop logical clusters of products with the same quality level and product styling, and position them as sub brands of the Philips brand.

Figure 2. The tabletop products of the first Philips Essence range.

The market research for these new product ranges took place in Germany, Spain and England. This analysis resulted in a consumer segmentation that was based on the "consumer's attitude and behaviour in the kitchen". In 1998, five different consumer groups were defined. Two groups were chosen as being very interesting to start developing product ranges for. One of these user groups was called the "quality oriented traditionalists", defined as mature, high-end quality oriented consumers. They are interested in the "quality of the end result" (of cooking activities), are slightly older, have a higher education, more money to spend and like to dine in a nice way. They prefer to spend more money on a good product, instead of buying a product of lower quality. Products targeted at the "quality-oriented traditionalists" were given the brand name *Essence.* Essence became a Philips sub brand and stands for "perfect end result".

Philips Design and the Search for an Appropriate Visual Language

Within Philips Design a special team, the Visual Trend Analysis group (the VTA group), is dedicated to following visual trends in different world regions. The VTA group looks at changes in different aesthetic fields including fashion, interior and automotive design and other cultural domains such as contemporary art and web design. From this research, the team generates a prognosis of the development of aesthetics, so-called "aesthetic roadmaps" (Bevolo, 2000). For the Essence project, the VTA group worked with trend watchers in New York, Paris and Tokyo to obtain a vision of trends in colours and product shape that would please the "quality oriented traditionalists". This research showed that Essence consumers look for peace and tranquillity in their homes. These consumers also have an above-average interest in design, but are suspicious when confronted with radical changes. Essence products, therefore, do not make a loud design statement. They have a calm, serene and traditional image. Changes in the visual language of the Essence products should be carefully planned. The Essence style that is designed now will be different from an Essence design that will be created in the future, because it follows the evolving visual preference of the "quality-oriented traditionalists".

In the Philips Essence range, visual and tactile references to noble materials such as ceramics, stone and metal (chrome controls), as well as two specially developed colour palettes are used to respond to the user group's preference for quality. The Philips Essence project continued after the introduction of the first Essence product range in September 1999 with a second generation of commercialised in September 2002. According to the Essence Concept Manager and the Design Manager, this second Essence range is even more in line with the Essence concept than the initial Essence products.

The Signal Croissance Toothbrushes

Around 1990, the French design agency Barré & Associés proposed its product design services to Elida Fabergé, a company specialised in dental care products (now within the Unilever Group). In the 10 years that followed, Barré & Associés designed three toothbrushes for this company. The toothbrushes are part of the Elida Fabergé's Signal Croissance products – a range of toothbrushes specifically for children (croissance is the French word for growth, with, in this context, a strong under meaning related to the healthy and happy physical and mental development of children).

The agency Barré & Associés calls its vision of design "Vision Oblique". This approach is based on searching innovative possibilities that competition has not yet used, by focusing on the product user and on weak spots in a product category related both to the product's functionality and appearance (Barré & Lepage, 2001).

A Toothbrush "with feet"

To stimulate creativity, the agency's team listed negative aspects of toothbrushes for children that were available at that moment. Once this list established, the agency tried to solve them and specifically focused on aspects that had the potential to differentiate the product from competition. The design team thus recognized that in the early 90s, childrens' toothbrushes simply looked like miniature adult toothbrushes - explaining the lack of interest from the three to six year old in brushing their teeth. Playing is, however, very important to small children. A better product then, should make tooth brushing fun and attract the child towards the product.

The first Signal Croissance toothbrush (figure 3) was designed to look alive; it is standing up as it is placed on a separate support having two feet. With this design, the agency aimed "to take the drama out of brushing teeth" as expressed by the designers. The first Signal Croissance toothbrush was very successful. Signal's European market share increased from 8 to 42 % within two years

after the launch. Barré & Associés explain the success by the fact that *'*we transformed an inanimate object into a playmate".

Figure 3. Three Signal Croissance toothbrushes. In the front the first design followed by the third "suction disc" generation and in the back the second generation with arms (photo: B. Moyen, Lucy in the Sky, Annecy).

A Toothbrush "with arms"

This first success established the use of product design services at Elida Fabergé. However, competitors didn't take long to react and maintaining the newly acquired high share of the European market became difficult. A larger budget was attributed for the design of a second-generation toothbrush. Children were involved in the development of the new toothbrushes. The children were first asked to react to the agency's drawings. Then they were asked to draw a "lively toothbrush". After the creativity session, the agency analysed whether the children drew, for instance, the head at the place of the brush or elsewhere. The agency proposed new designs based on the children's reactions. In a much later stage of the project, models of the product proposals were tested. The agency then received feedback on these models from the 3 to 11-year-old children and from parents. The result of this process was the second Signal Croissance toothbrush with a support with arms (figure 3).

Further Developments

In their continuous search for more ambitious designs, the agency listed the negative characteristics of the first and second generations of toothbrushes. The team disliked that the toothbrush can topple over and looked for a support that could hold on all types of surfaces suggesting a system with a suction disc. The agency also discovered that this concept had not been patented. Elida Fabergé appreciated this new product proposal. It was decided that this third Signal Croissance toothbrush design (figure 3) would be produced in two sizes for children of different age groups. The third Signal Croissance Toothbrush with the suction disc was launched in 1997 in parallel to the previous models and variants of these, and Barré & Associés received royalties on every toothbrush sold.

Case Study Comparison and Discussion

In both the Philips and the Signal case, the **competitive market situation** pushed the companies towards a product appearance appealing to a precisely defined group of users, and to search for innovations in the product's functionality and its expression. For Philips, in the mature competitive market of small domestic appliances functional improvements are, however, difficult to find. The product appearance and significance for its user are therefore particularly important. Conversely, the Signal Croissance toothbrush was a breakthrough in its market. Rival firms were ignoring the potential of toothbrushes in a style specifically appealing to children. This appeared to be a great opportunity for product differentiation. When the competition is not or less focused on a user-oriented product expression, it offers a great opportunity to enhance product success.

In the Philips and Signal case studies, the companies' **experience and the position of design** in the organisations varied considerably. Philips has a very mature experience in working with designers and its internal design department has a high status in the organisation. The demand for "more structured and intensive design approach" came from the marketing department and was based on demand in the market. In the Signal Croissance project, Elida Fabergé had little experience working with product design consultants, but this did not stop the creation of toothbrushes specifically appealing to small children. The company's marketing orientation made the company recognise the market potential of these new toothbrushes. It is therefore difficult to defend that it is indispensable for the company to have experience with design for the creation of a product with a user-oriented expression.

Concerning **human resources**, in Philips DAP, the new Business Manager had a strong market orientation and initiated the market research on which the philosophy and the image of the Philips Essence range were based. He stimulated others in the organisation for a user-oriented approach. Trend analysts and other new functions in the organisation supported the creation of the Essence concept and the development of products with a specified identity. At Signal, a marketing manager opened the design budget for Barré & Associés, but in this organisation people often change position.

The openness for design solutions, therefore, depends a lot on the specific product manager or marketing manager at that moment.

In the Philips Essence case, the organisation did put significantly more weight on the **pre-development phase** of the process than it had done in the past by analysing its consumers before starting the product creation process. The product creation process is supported by profound knowledge of the target consumer. The styling characteristics that would appeal to this user group were also examined. The pre-development process for the Signal toothbrushes was much "lighter". The objective to create the appearance of the toothbrush specifically appealing for children came forwards in the beginning of the project when the team looked for ways to differentiate the product.

Finally, concerning the **creation process**, Philips organised its product creators to work on the whole mix of products for this consumer group, instead of specialising on one product type. This was done in order to develop a product range with a consistent style appealing to a specific target group (of which much was known from previous research). Philips did not use much product testing during the creation process. In the Signal case, the toothbrushes were designed to appeal to children of a specific age group. The methods that were used to identify what a child within this group would like (or dislike) in a toothbrush varied from a creative idea development to product development involving children. For the first toothbrush design that was created for children, "only" the team's creativity and imagination was used. In a later stage, when competition became more important, the users (children) became involved in the product development process.

A Model for the Process of Achieving Product Expression

To structure the findings from this exploratory research the following model is proposed (Figure 4).

Competition pushes companies to the development of products that appeal to its user. In competitive consumer markets, fine-tuning the product's communicative value is one of the ways to obtain a superior design in comparison with rival products. Product superiority can be defined as a differentiated product with unique customer benefits and superior value for its user (Cooper and Kleinschmidt, 1995). A superior product might have both an advantage in functionality or in product appearance or in other advantages that are "built into its structure", such as a lower cost price or a design that allows customisation.

A pre-development process focused on user-orientated analysis and creativity appears to be crucial for the design of consumer products in competitive markets. It enables the identification of

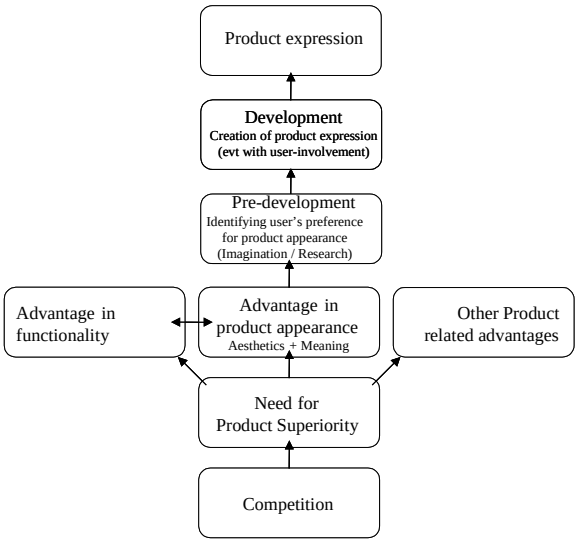

Figure 4. Steps in the process of the creation of an appropriate product expression

the user's preferences for different aspects in the product, including preferences for product appearance and future trends. The development process, finally, must integrate the information from the pre-development stage and translate the design factors defining superiority into concrete products.

The involvement of professional designers and users all throughout the process is important for keeping development focused on the design parameter and for capturing knowledge to be reduced in future projects. The result, a product with a specific product expression, embeds subjective user needs and communicates an image with distinctive added value to the consumers.

This article is based on a paper published in Les Cahiers du Management Technologique, vol 13, no 2, 2004.

OUTSOURCING PRODUCT DEVELOPMENT: A PORTFOLIO APPROACH TO SUPPLIER SELECTION

By Klas Eric Soderquist

Portfolio models are widely used in strategic planning essentially at the strategic business unit level. There exists a vast range of models that, until the emergence of the resource-based approach, were among the most frequently used tools in strategic management, including technology management. The Boston matrix, where businesses are positioned in terms of market growth rate and relative market share, is certainly one of the best known (Porter, 1980). General Electric pioneered another matrix, which is more marketing oriented. In this model, each business is rated in terms of market attractiveness and competitive position (Day, 1986). A third very popular matrix is Porter's (1980) model

of generic strategies. Porter proposes three generic strategies - differentiation, cost leadership, and focus - depending on positioning in terms of strategic advantage and strategic target. Portfolio models have been criticized for their general structure, in which the different dimensions are only approximate estimations of the parameters that are supposed to be measured, and for making managers think in boxes, missing dynamics of integrative and systemic strategic thinking (e.g., Capon et al, 1997). However, if classifications are regarded merely as eye-openers for a number of possible action plans, portfolio models provide a useful input for decision-makers.

As discussed in the editorial of this issue, supplier involvement, and supplier expertise as a crucial input in product development are today indispensable for keeping up with rapid change in technology and an increased demand for innovation under conditions of strict cost control. Outsourcing of the design and development of discrete components / accessories or entire component systems is today common practice in a variety of sectors ranging from aircraft manufacturing (e.g., Airbus) to fashion (e.g., Zara, Benetton and many others). As a consequence, the analysis and selection of suppliers for taking on different tasks and responsibilities with respect to product development is a critical activity.

Portfolio models can provide some assistance in this endeavour. A number of models have been developed and implemented with success in corporations (Kraljic, 1983, Olsen & Ellram, 1997, Bensau, 1999). These are presented and summarized in table 1.

It is important to note that these contributions are related to situations where the decision to outsource has already been made. The issue is to determine what kind of product development responsibility should be outsourced and what kind of supplier relationship needs to be built in order to match the requirements of the development tasks. The three models presented in table 1 have three steps in common: 1) Analysis of the products for which development is to be outsourced and classification of the products along two dimensions related to the importance of the purchase and the difficulty of the purchase. 2) Analysis of the supplier relationships required to deliver the products, 3) Action plans in order to match the product requirements with the supplier relationships.

Although useful for supporting supplier selection decisions, and for capturing terms and issues that are easily understood by procurement staff, our research in a number of automotive manufacturers indicate that there is need for integrating more of engineering issues into the portfolio thinking. The *product specification* is the fundamental means for developing, transmitting and communicating product development requirements between the customer and the outsourcing partners. Outsourced product development encompasses a large variety of specifications that can originate either from the supplier, from the buyer or from both.

The specifications must be adapted to the capabilities and needs of each supplier. Hence, one needs to distinguish between different types of suppliers, which according to our study, was a basic premise for proceeding into any kind of relationship classification.

Steps	Olsen & Ellram (1997)	Kraljic (1983)	Bensau (1999)
Step 1	Classify products with respect to two dimensions varying from Low to High • Factors describing the *Difficulty of Managing the Purchase Situation* • Factors influencing the *Importance of the Purchase*	Classify products with respect to two dimensions varying from Low to High • *Importance of the Purchase* • *Complexity of the Supply Market*	Classify products with respect to two dimensions varying from Low to High • *Buyer's Specific Investments* • *Supplier's Specific Investments*
Step 2	Analyze the supplier relationships for the above mentioned product categories with respect to two dimensions; • *Strength of the Relationship Between the Buyer – Supplier* varying from Low to Average to High • *Relative Supplier Attractiveness* varying from Low to Medium to High	Map the supplier strength versus the buyer strength for each of the products identified above in a 3*3 matrix with the following dimensions: • *Supplier Strength* (varying from Low to Medium to High) • *Buyer Strength* (Varying from Low to Medium to High)	Identify *contextual profiles* in terms of product, market and supplier characteristics for the four distinctive relationships resulting of the first matrix
Step 3	Develop *Action Plans* to match the product requirements with the desired supplier relationships	Develop *Action Plans* depending on the type situations: • Buyer should diversify • Buyer should exploit internal resources • Buyer should follow a balanced relationship	Design *management profiles* for each of the contextual profiles in order to take action

Table 1. Portfolio models for managing outsourced product development.

Although the portfolio models discuss a wide range of factors that distinguish between suppliers, they do not attempt to classify suppliers into distinct types or categories. A widely used supplier typology, developed from a benchmarking of best practices, is that of Kamath & Liker, 1994. Table 2 indicates these types and explains how they should be involved in the specification process.

	Approach to specifications
Partner Suppliers	Involve the supplier from the first instant and trust in its abilities to understand the interfaces and deliver a product that is compatible with all the necessary interfaces in the final product within the cost budget and quality levels decided jointly.
Mature Suppliers	Involve the supplier after the initial work of identifying overall design and critical dimensions are completed and thus the rough specifications are generated. The rough specifications contain functional data and rough envelopes of functionality. The supplier is entrusted in delivering the system within the quality, cost and budgets as decided jointly.
Child Suppliers	Involve the supplier after all the specifications have been cleared and simulated so that the supplier can deliver to buyer specifications.
Contractual Suppliers	Obtain a product by simply specifying out of the suppliers' catalogue. No need for any discussions concerning the product being bought.

Table 2, Approach to specifications with different types of suppliers (adopted from Kamath & Liker, 1994).

It is thus obvious that specifications have to be different for different types of suppliers - both in terms of the *type* of specifications and the *generator* of the specifications.

We propose a model relating, in a two-step approach:

- the component categories retaining the categories proposed by Olsen & Ellram, i.e., non critical, leverage, bottleneck and strategic,
- the generator of the specifications,
- the supplier categories, and
- the types of specifications.

STEP 1

First are established the links between specification generators and component categories (Figure 5).

Here the buyer has to internally evaluate its competency in each component category and then determine the generator of the specification. Three basic situations are possible in this matrix:

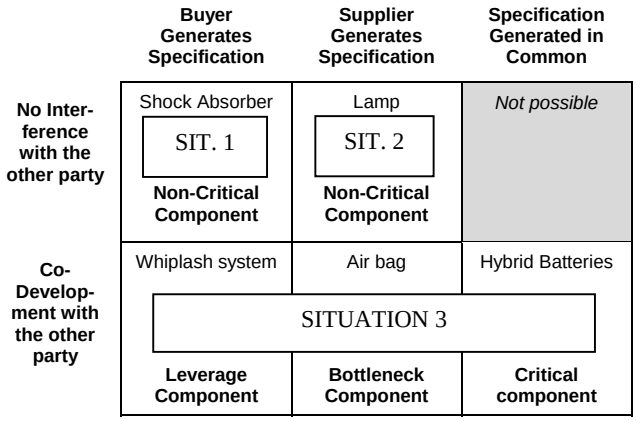

Figure 5. Link between component categories and specification generators (example from automotive industry).

- Situation 1: The buyer generates the specifications on its own without any interference from the suppliers. Such components are known as detail-controlled parts.
- Situation 2: The buyer purchases parts that are a result of the supplier-generated specifications, which have been subject to no interference from the buyer. Such components are known as supplier proprietary parts.
- Situation 3: The suppliers and the buyer engage in a range of relationships with each other, thereby generating components/specifications in an integrated manner. The range of relationships in this last type of interaction is collectively combined under the heading of co-development.

The following are examples, from the automotive industry, of products developed according to the five different modes of relations resulting from the three basic scenarios:

- Shock absorbers are manufactured based on specifications developed by the buyer and simply executed by the supplier.
- Lamps, which are highly standardized items (except for headlights), are confined entirely to the suppliers, both in terms of specification generation and development.
- In the case of the whiplash system, the OEM dictates the specifications and the supplier uses co-development in order to jointly create the part, following the initial specification of the OEM.
- For airbags, the suppliers are asked to generate the specifications and the OEM can engage in co-development with the supplier to fully meet the specifications.
- Total co-development, where the specifications are jointly generated and development can be exemplified with the case of hybrid car batteries. In general, co-development is prevalent for parts that may become sources of competitive differentiation or for brand new items coming out on the market.

Step 2

We have elucidated the fact that in order to develop the appropriate management approach for complex outsourcing situations, it is not enough to classify suppliers into different categories, nor does a component classification suffice. We also need to understand the specification relationship between the buyer and the suppliers. Thus, we will attempt to link the four categories of components in the portfolio models (strategic, non-critical, leverage and bottleneck) and the generator of the specifications (step 1) to the supplier types, and, in this process, also develop a link to the different types of specifications. Based on a thorough analysis of a large number of components in the studies firms, we classified components into the four component categories as identified by the portfolio models. Then, we identified, within each component category, what kind of supplier was used and what type of specification was required. The results were validated through interviews and focus groups consisting of engineers and purchasers. The following parameters were found to apply (table 3).

Non-critical items with a low innovation level (such as lamps, clips, bands, etc.) do not require partnership; hence they can be procured from any supplier. If specifications for these items were to follow an *industry standard*, their management could be simplified. Often, however, buyers operate with specialized drawings for commodities leading to extra cost. In order to fully leverage the economies of standardized simple parts, this strategy has to be deployed throughout the different tiers in the entire supply chain.

As with non-critical items, **leverage components** have many suppliers. If black-box engineering is applied, i.e., the specifications are firstly developed internally by the OEM to a rough state restricting main parameters (function, cost, quality, system fit), the supplier base could be fully tapped and leverage exerted on existing suppliers. After handing the rough specification to the supplier, the latter would undertake further development and ultimate sealing. Toyota follows this approach in the case of leverage suppliers. Rough specifications are given to a large number of suppliers in order to exert leverage should the need arise. These suppliers need to be capable of developing a component based on the rough specifications from the OEM through a small-scale R&D division. The suppliers of leverage components are competing against many other suppliers for delivery of similar components, hence the differentiating criteria will be the "extra" that the supplier can add to the restricted specification of the OEM. Suppliers of leverage components are basically mature suppliers.

In the case of **bottleneck components**, the reduced number of capable suppliers makes it necessary to have collaborative agreements with them – the buyer has to act in a collaborative way right from the beginning. The relatively low strategic importance of the purchase means that the buyer can allow the supplier to develop the specifications and then help the supplier to standardize them, then jointly try to reduce the costs in the entire supply chain. Suppliers of bottleneck components are considered as experts in a complex technology field which is, however, not strategic for the buyer.

In the case of **strategic components**, the main aim is to be the first to market. There is a need for close relationships with the suppliers and early or even continuous involvement. Without integrated development, there will be a slack in competitiveness instead of continuous improvement of component performance. Suppliers of strategic components should be engaged in a collaborative specification setting where both the buyer and the supplier together generated the specifications. This situation calls for partner suppliers who are expected to be involved from the start of development or even before the development commences.

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Elaborating on the use of portfolio models for strategic procurement in the product development process, we propose an expansion incorporating a

Component	Specification generator	Supplier Types	Specification Types	Type of Specification relation between OEM and the supplier
Non-critical	Supplier *or* Buyer	Child or Contractual	Standard or closed specification from the buyer	Only the specification generator is active.
Leverage	Buyer	Mature (rough specification by customer)	Restrictive buyer => supplier, but turns to Collaborative	Supplier co-develops with the buyer after the rough specifications have been generated by the buyer.
Bottleneck	Supplier	Mature (rough specification by supplier)	Restrictive supplier => buyer, but turns to Collaborative	Buyer co-develops with the supplier after the rough specifications have been generated by the supplier.
Strategic	Buyer *and* Supplier	Partner	Collaborative	Direct and integrated. Both the buyer and the supplier co-develop with each other.

Table 3. Integrated links components-specifications-suppliers-relationships.

number of intricate issues. After an initial necessary classification of components and the type of supplier needed to develop and deliver specific components, we have explained how the important issue of generation of specifications, the relationship required and the type of specification required for a given component can be integrated. Then strategies can be developed to align the supplier to the requirements so that the supplier can deliver as required. This approach to supplier management in product development allows the engineers to be involved in the purchasing process through a close link between the category of purchase and the process of specifying. If it is clear who will generate the specification, then both purchasing and engineering can reap the benefits through reducing costs and late changes in the product development process. Moreover, the specification generation matrix allows the full talent of the suppliers to be tapped so as to avoid over- and under-management of the suppliers.

This article is based on a paper published in Long Range Planning, vol 33, no 2, 2000.

A QUALITY FUNCTION DEPLOYMENT APPROACH TO WEB SITE DEVELOPMENT

By George Ioannou, Katherine C. Pramataris and Gregory P. Prastacos

In recent years, we have witnessed a tremendous growth of the Internet and the use of the World Wide Web. There are currently approximately 3.6 million websites on the Internet, up from 250,000 in mid 1996.

Business enterprises need to engage in a constant race for cutting-edge web presence where the development, maintenance and promotion of a web site require high investments and particular competencies. However, the value and end-benefits of different forms of web presence may not be clear up-front due to high uncertainty and sometimes-poor analysis of Internet user requirements, coupled with important technology risk. Understanding the users' work domain is a growing field of research and professional practice and specific processes for initiating, developing, and launching web pages that explicitly incorporates usability techniques at several points in the development cycle are being developed.

We address the issue of capturing and integrating "the voice of the customer or user" into the development process from a different perspective, that of treating a Web site as a typical product, i.e., a product with certain attributes that should meet specific user needs. We apply the expertise assimilated in the field of product engineering design through the Quality Function Deployment (QFD) methodology that has been used with success in the several industry sectors since the 1970s. In the software development industry, QFD has been employed as a methodology for general software design and development (e.g., Erikson & McFadden, 1993). Haag *et al.* (1996) discuss the adaptation of *Software Quality Function Deployment* (SQFD) for software development by major firms including DEC, AT&T, Hewlett-Packard, and Texas Instruments. The authors define SQFD as a front-end requirements solicitation technique, adaptable to any software engineering methodology that quantifiably solicits and defines critical customer requirements.

The QFD Methodology

QFD is a structured method used to identify and prioritize customer requirements, and to translate these into engineering specifications for systematic deployment throughout a company at each stage of product or process development. Introduced in Japan in the mid 1960s, QFD has become the accepted methodology for development of products and services in Japan and has enabled businesses to successfully develop and introduce products in a fraction of the time required without using this approach (Jackson & Frigon, 1994). In the early 1980s, QFD was introduced at Xerox, and since then American businesses have exhibited substantially growing interest in this method. There are several approaches to QFD; each making use of matrices to organize and relate pieces of data to each other. The matrices are combined to form the "House of Quality" (Hauser & Clausing, 1988) shown in Figure 6.

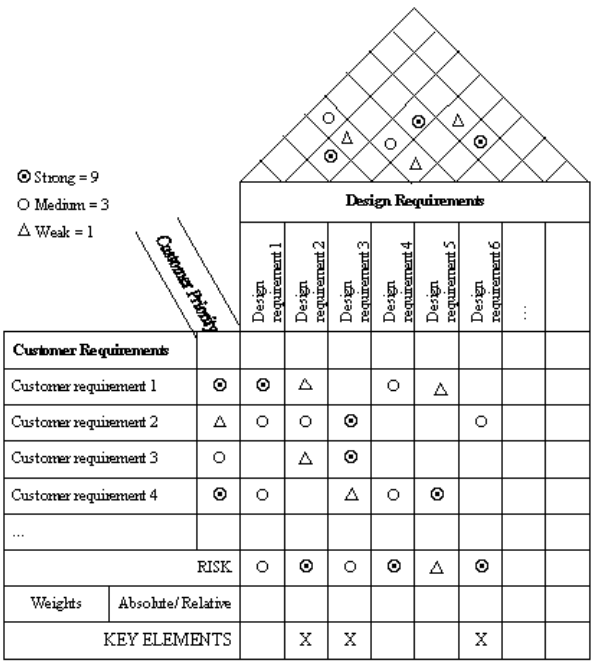


Figure 6: The House of Quality

The House of Quality starts with a "What-How" Matrix that first identifies the wants and needs of the customer, shown on the left column, and, second, shows the design or technical requirements

on the upper columns of the matrix (sometimes labeled the "ceiling"). The body of the House of Quality displays the relationships between the customer requirements and design requirements. The Interaction Matrix, also known as the Correlation Matrix, is the “roof” of the House of Quality, and is established to determine the technical interrelationships among the design requirements. This information is valuable as a basis for decisions regarding technical trade-offs (Jackson & Frigon, 1994). The symbols used in each box, if any, show whether the relationship between the two corresponding elements is strong or week, positive or negative. This way the House of Quality quickly reveals patterns and identifies weak points in the design requirements.

QFD and Web Site Design and Development

The “artistic” design of websites has become a top priority, since sites have to be attractive. However, artistic design pays little attention to download times. Moreover, the content of a Web site must answer to the Web audience’s insatiable need for information. Thus, companies rush to post newsletters, product information, and annual reports on their sites only to realize that Web content requires context, thus, editorial-managerial guidance. Web audiences continuously become more diverse, demanding and sophisticated making site development a risky endeavour.

In this complex course of Web development and design, we propose that the application of QFD methodology can satisfy the increasing need for high quality, context-centric sites. The first step in applying QFD to the development of a Web site is to identify the “What’s” -user statements about the desirable site features- and “How’s” -a list of what one can measure and control in order to ensure that the customers’ requirements will be satisfied.

Website QFD “What’s”

The basic “what’s”, or in other words the factors a user looks for in a site that will make him/her visit and re-visit it are (Nielsen, 1999; Vrechopoulos *et al*, 1999):

- **Availability** which means that users expect that any site on the web is up-and-running, without any dysfunctions, whenever they want to access it, 24 hours a day, 7 days a week.
- **Functionality** meaning the ease of using a site for both expert and naive users: easy navigation, convenient use of site features and access to information the site promises to contain.
- **Integration of information**, which refers to having *all* the information and services users want in a certain category available on the site. Integration is measured through variables such as value-adding information, coherent, up-to-date and complete information, and relevant use of the hypertext properties of the Web, e.g., links to other relevant sites and sources of information.
- **Complete services**, which refers to the competitive advantage of sites supporting the whole buying process on-line in the sense of a "one-stop-shop" for a specific information topic, product or service.
- **Easy-to-find site**, which requires relevance between the URL address and the site’s content. It refers to the ease of remembering the address, the use of keywords and ‘meta-tags’ that facilitate a site’s identification and inclusion in the catalogues of popular search engines, and last but not least, a relevant marketing policy through advertisement, either on-line, on the web, or off-line via traditional media.
- **Responsiveness** to particular needs translated by customisation features and personalized services. For example, a benefit that users get from on-line publishers is that they have the possibility to customise a newspaper’s contents to their own profile and preferences.
- **Character**, finally, refers to the impression created by the site’s welcome page, the look and feel across pages, the proportion between text, animation and graphics, the site’s structure, etc. This is an element that also has an impact on a site’s quality. Multimedia is gaining popularity on the Web offering to site developers more design options but also requires design discipline.

Website QFD “How’s”

The degree to which a site satisfies the above user requirements, i.e., the “what’s” of QFD, depends on specific site characteristics. The following key characteristics are universally relevant to web sites:

- **Performance**, which refers to properties such as the time it takes for the site to download, the response time experienced by users requesting a specific site service, the number, type and frequency of error messages popping-up, etc. As such, this attribute is associated both with a site’s availability and its responsiveness. The users' experienced response time is determined by the weakest link in the chain from server to browser (Nielsen, 1999), i.e.: The throughput of the server; the server’s connection to the Internet; the Internet itself; the user’s connection to the Internet; the rendering speed of the user’s browser and computer. Web pages have to be designed with speed in mind. To keep page sizes small, graphics should be kept to a minimum and multimedia effects should only be used when they truly add to the user’s understanding of the information.
- **Name**: As mentioned above, a web site’s name and corresponding web address (URL) can greatly facilitate a user finding the site, even without using a search engine. There are several guidelines that have been published on naming and branding, including guidelines on web site addresses (Trout, 1997).
- **Welcome page**: The welcome or home page of a site creates the first impression to the user, and

should grasp his or her attention and incite further "digging" into the site. A firm rule for home page design is 'more is less': the *more* buttons and options you put on the home page, the *less* users are capable of quickly finding the information they need.

- **Structure**: No matter how creative, informative and fast a site is, it is useless if the user cannot find what he is looking for. Under this perspective, it is important that a site has a clear and consistent structure, organized in the way users expect to find it, by exploiting the discipline of information architecture (c.f. article in no. 4 of InnKnow FORUM).
- **Content**: The expression "content is king" is used in order to denote the importance of a Web site's content from the user's standpoint. Equally important is the process of "keeping it fresh" and ensuring the integrity and validity of the information. Other attributes associated with content are the depth and breadth of the available information. Most people absorb information from Web sites differently than they do from printed materials; on the Web, people tend to browse or scan information, rather than really "read" it the way you would read a book or a magazine article.
- **Usability**, which covers aspects that influence a site's ease of use, navigability, consistency of functionality across pages, etc. This attribute is highly valued by users, as it ensures that they can actually use the "product". Navigational structure and overviews are necessary to avoid user confusion and should be provided both in the large (server structure and location) and in the small (structure for the individual pages with iconic markers for the various types of information). The existence of a contents page and a site map can further improve navigation and search usability.
- **Aesthetics**: One of the factors that influence a user's response to a site is the first impression that will be created upon visiting the site, usually the site's home page. This impression depends on the overall look-and-feel of the site, the colours, the graphics used, the analogy between text and images, etc.
- **Services offered**: The previously described site characteristics are not always enough to attract and keep users at a site. As Web development advances, users become more and more demanding regarding the attributes they would expect to find at a site. Additional features users increasingly tend to look for include: *Interactivity*, defined as the facility for individuals and organizations to communicate directly with one another regardless of time and space; *Personalization* of content and services, i.e., dynamic adaptation of a site's content and structure to match the profile of each user; *Customisation* defined as the possibility for users to explicitly select between certain options, depending on their preferences and interests at the time; and *On-line customer service* that refers to offering customer support such as on-line form completion, on-line sales, or direct question-answer session, apart from a site's basic informative role.

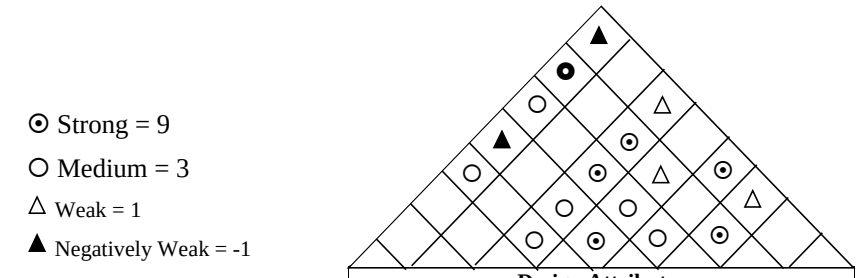
The importance of most of the attributes discussed above is underlined by the results of the 10th WWW User Survey, conducted by the Graphic, Visualization & Usability Center (GVU) of Georgia Tech Research Corporation (GVU, 1998). According to this survey, the main problems mentioned by users of the Web include: Speed, slow advertisements, broken web links, graphics, registration, difficulty in finding new information, paying for content and script errors.

The Web Site House of Quality

Figure 7 depicts the basic House of Quality for a web site, illustrating the interrelationships between the customer requirements and the web site characteristics. To fill out the various relational weights between QFD what's and how's, we have used the points raised in the above discussion of customer requirements and design attributes. For example, a customer/user requires high site availability and thus, this requirement (*Availability*) is characterized by a high (strong) customer priority. Furthermore, the site's availability is directly linked to the site's performance, thus imposing a strong relationship between this customer requirement (*Availability*) and the corresponding design attribute (*Performance*). Finally, the design attributes *Content* and *Services Offered* are linked with negatively weak relationships to the *Availability* customer requirement, since the elaboration (additional effort) on these two design attributes negatively affects (to a certain extent) the site' availability. For the customer requirement *Availability*, no other strong, medium, weak or negative relationships result. Following a similar reasoning, we proceed to the completion of all interrelationships between customer requirements and design attributes.

As shown in Figure 7, the first step of the QFD process identified *Performance*, *Content* and *Usability* as the key site characteristics that must meet customer requirements. These key elements correspond to the highest relative weights (207, 144 and 171, respectively), which are a combination of the risk, or else importance for the customer, and the overall value of the symbols associated with each element. For example, the relative weight of *Content* is calculated as 9 multiplied by 23, where 9 stands for the strong risk this attribute has and 23 is the sum of all the symbols in that column (Negatively Weak + Strong + Medium + Strong + Medium=-1+9+3+9+3), i.e., a measure of the value that this attribute has for all the customer requirements.

The implicit matrix of Figure 7 is the first of many matrices in the QFD process of translating customer needs into product requirements and system specifications. Following a three-phase QFD



⊙ Strong = 9
○ Medium = 3
△ Weak = 1
▲ Negatively Weak = -1
● Neg. Medium = -3
◘ Neg. Strong = -9

Customer Requirements	Customer Priority	Design Attributes: Performance	Name / Address	Welcome Page	Structure	Content	Usability	Nice look & feel / aesthetics	Services offered
Availability	⊙	⊙				▲			▲
Functionality	⊙			○	⊙		⊙	○	▲
Integration of Information	⊙				○	⊙			○
Complete Services	○			△		○			⊙
Responsiveness	○	⊙				⊙	○	●	○
Easy-to-find Site	△		⊙				△		
Character	△	△	△	⊙		○	○	⊙	△
RISK		⊙		○	○	⊙	⊙	○	○
Weights: Absolute		19	9	13	12	23	16	9	14
Weights: Relative		171	9	39	36	207	144	27	42
KEY ELEMENTS		X				X	X		

Figure 7: Web-Site House of Quality– 1st phase

approach for the design and development of web sites, we adopt the following terminology for each specific phase:

1. *Customer/ Visitor requirements*: These are the requirements that a visitor or customer of a web site has towards the site. These are shown on the left side of the House of Quality.
2. *Web-site characteristics*: These are the specific site features that "satisfy" the customer requirements, corresponding to the topside of the presented House of Quality.
3. *Design Attributes*: These are design elements of the web site that are associated to the characteristics that have been defined during the previous phase. Each design attribute may be further analysed, in a hierarchical way, into more detailed attributes and this step may be repeated as many times as required in order to reach the desired level of detail.
4. *Design Variables*: The final phase links detailed design attributes to measurable features and parameters. For a web site these may correspond to specific variables that are monitored by the web server, such as number of site visitors, number of hits, etc., or to measurable design elements, such as number of web pages, size of web pages etc.

This QFD approach adapted to the design and development of web sites is depicted in Figure 8.

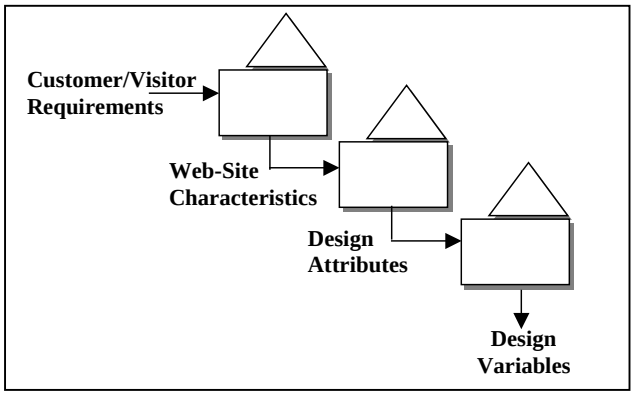


Figure 8: Three-Phase QFD Approach to Web Site Development

The work presented here is a first attempt to demonstrate the usage and potential of QFD methodology for the development of web sites. There are still many aspects of this approach that need to be clarified and tested in practical cases.

In the next issue of InnKnow FORUM we will present a further refinement of the initial House of Quality through this three-phase approach, by focusing our study on electronic retail web sites.

This article is based on a paper published in Les Cahiers du Management Technologique, vol 13, no 3, 2004.

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* Indicate references particularly useful for the practising manager.

USEFUL WEB LINKS

The Product Development and Management Association (PDMA), www.pdma.org

PDMA is a nonprofit professional organization dedicated to serving people with an interest in new products. The site has a broad content; particularly useful for practitioners is the link to the Visions Magazine and for academics the link to the Journal of Product Innovation Management.

New Product Dynamics,
www.newproductdynamics.com

Site developed and managed by Product Development pioneers P. Smith and D. Reinertsen. Contains useful info particularly on management of cost, time, risks and development teams.

Leading Research (Harvard Business School)
http://www.hbs.edu/units/tom/research-leading.html

A research update oriented to practitioners from the Technology and Operations Management Center of HBS. The site contains also info on new publications and running projects on front-line areas of Technology and Operations.

IDEO Corporation www.ideo.com

Ideo is a private company focused on design and innovation. It is maybe the most well-known corporation when it comes to creativity and unique processes for designing and developing new products. The site contains interesting product examples and a pdf download of the 2004 Business Week article focusing on "The Power of Design".

Industrial Designers Society of America,
www.idsa.org

The site is an entry point to the profession of the designer. Rich in content, information on research, events, new technologies, design discussions, expert advice and news is available. www.innovationjournal.org/ is the link to the quarterly publication of the association.

Place au Design, www.placeaudesign.com

This site about design, unfortunately only in French, is fun, easy to navigate and instructive. Supported by the French Ministry of Industry.

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NEXT AND PREVIOUS NEWSLETTERS

The next InnKnow FORUM, to be published Spring 2005, will feature a range of articles on different topics. The lead article will be devoted to **Regional Innovation Dynamics**.

The focus of previous newsletters, available on our website, was:

Change Management (no 1, 2002).

Strategic Performance Measurement – Balanced Scorecard (no 2, 2002).

Innovation and Entrepreneurship (no. 3, 2003).

Managing Knowledge (no 4, 2003).

Competency-Based Management (no 5, 2004).

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