Pergamon

European Management Journal Vol. 16, No. 2, pp. 169–189, 1998

Printed in Great Britain
PII: S0263-2373(97)00086-8
0263-2373/98 $19.00 + 0.00

A Structured Product Development Perspective for Service Operations

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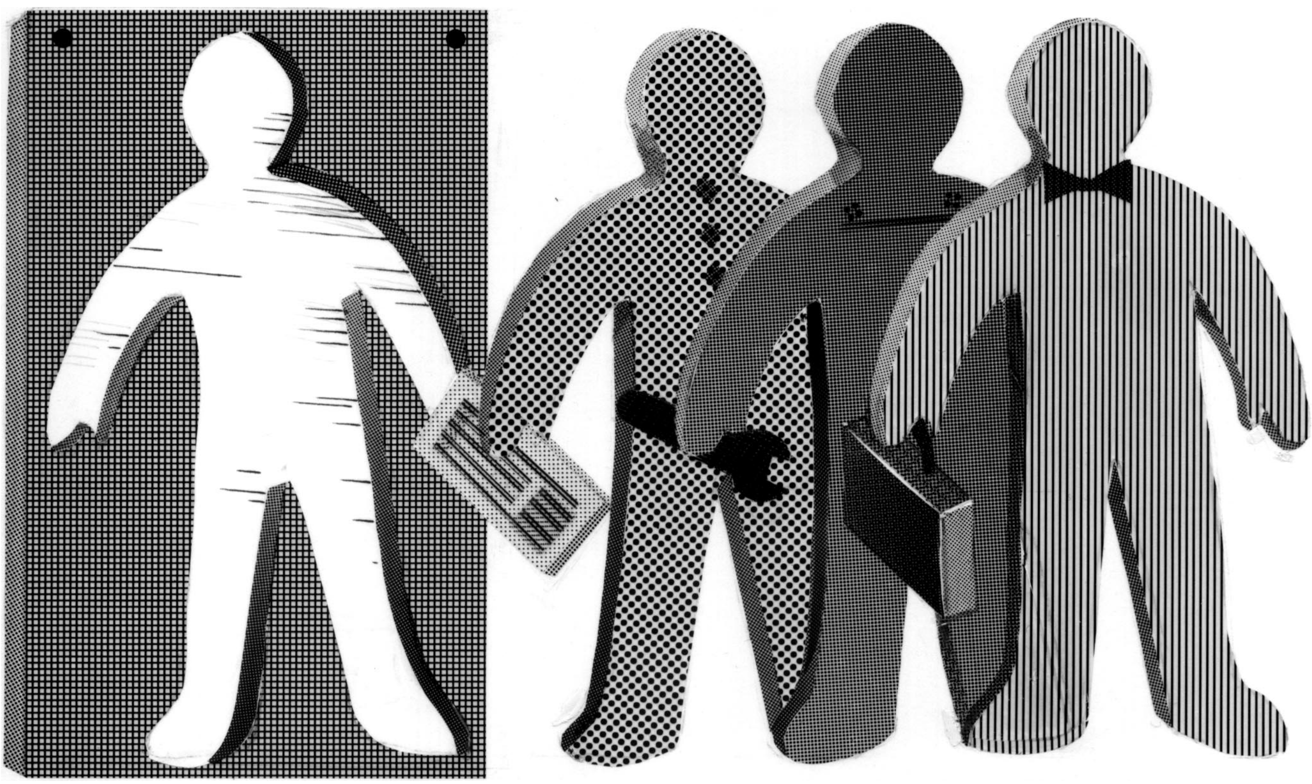
In this paper we review the literature on product development from a services perspective. We identify similarities in the creation and evolution of products and services, and discuss three types of knowledge that are commonly required in a development process: the sequence of steps or procedural plan that must be followed; the understanding of what components integrate the design and how they interact (architectural knowledge); and the principles and models that describe physical or human behavior in the system that is being designed. For each step of a generic development process we review the methods and tools that are widely used in product development and may be successfully applied to service development. To illustrate the notion of architectural knowledge in the service context, we introduce an example of a service operation structure and discuss important aspects of its components. Finally we explain the role of models in the development of products and services and argue how they can help design intangible elements. We conclude the paper by identifying gaps in the literature and suggesting directions for future research. © 1998 Elsevier Science Ltd. All rights reserved



Introduction

In this paper we review the literature on product development from a services perspective. For the services community we review methods and tools that are widely used for product development and may be successfully applied to service development. For the manufacturing audience we explore some aspects that might be considered in the development of services as a competitive edge for products.

Although products and services have tangible and intangible elements, most of the product development literature deals mainly with tangible characteristics of both. In a world of increasing competition, however, manufacturing companies are being required to not only design better products but also design the appropriate supporting services. One example of this new trend is the recent introduction of a line of cars with a differentiated network of dealerships and supporting services. On the services side, companies are being required to look for ways to make their operations more reliable, consistent, and replicable at the global level. This is more likely to be accomplished if a systematic, product-like approach for service development is employed.

The rest of the paper is organized as follows. In the second section we discuss the creation and evolution of products and services to point out similarities between the two contexts. In the third section we review development methodologies and three types of knowledge that are commonly required in the development of a product or service. The first is about the sequence of steps or procedural plan that must be followed in the development process. The second is the understanding of the components that integrate the design and how they interact (architectural knowledge). Finally, the third type of knowledge concerns the principles and models that describe physical or human behavior in the system that is being developed. Such principles are the foundation over which designers build models to assess tradeoffs and check the feasibility of design solutions.

Within this framework in the fourth section we review each step of a generic development process together with the tools and methods that can be employed at that step. In the fifth section we illustrate the notion of architectural knowledge in the context of services. We do so by introducing an example of a service operation structure with nine components and discussing important aspects of each. In the sixth section we discuss the role of models in a development process and argue how they can help design intangible elements. We conclude the paper by identifying gaps in the literature and suggesting directions for future research.

Product and Service Innovation

The greater the intangible component of a product or service, the more difficult it is to understand what the customers want, why they want it, and how to deliver it. The evaluation criteria of intangible elements are in general subjective, multi-dimensional (e.g., pleasure, courtesy, convenience, hope) and not always clearly defined. High intangibility is therefore at the root of most difficulties in dealing with innovation. It makes the precise definition of a concept and its subsequent design difficult at best.

The classical model for product evolution suggested by Abernathy and Utterback (1978) argues that when a major product innovation is first introduced to the market, its production processes and equipment are for general purpose, its materials are widely available, and 'performance criteria are vague and little understood.' As the product adoption grows, competition stimulates experimentation in both product and process, and a variety of designs compete for customer acceptance. Successive innovations are tested in the product until a dominant design emerges, influenced by a clearer definition of performance. Thereafter innovation is incremental for both product and process. Production process and equipment become dedicated to reap economies of scale, and special materials or technologies are introduced to improve the performance of the product.

Although the distinction between product and process is not always clear in services, the Abernathy–Utterback model provides insight for services as well. Sasser *et al*. (1978) discuss the evolution of a service operation in terms of cost, range of services, and geographical reach as it goes through stages of evolution similar to those described by the Abernathy–Utterback model: entrepreneurial, multi-site rationalization, growth, maturity, and decline/regeneration. A dominant design in services is the set of tangible and intangible elements implemented by functions that are essential for that service (core functions) and functions that support the service experience (peripheral functions). Once a firm offers a new feature that enhances the service experience, be it tangible (e.g., in-flight meal) or intangible (e.g., convenience, speed), competition soon follows and the new feature becomes part of the industry standard. Customers incorporate the new feature into their expectations and it becomes part of the dominant design. The existence of dominant designs in services can be observed by the similarity in operations and formats of both regulated and competitive service businesses, across a wide range of industries such as fast-foods, hotels, airlines, consulting, and so forth. As a dominant design appears and the industry matures, companies tend to use specialized technology or equipment whenever possible to improve performance of their service operation — fast-food restaurants, airlines, and banks are typical examples of such phenomenon.

Clark (1985) further elaborates on the emergence of a dominant design, arguing that the design process leads to the identification and analysis of the components of a product, and experimentation with their interrelations. Since some components are more relevant to the product concept, their design choices impose constraints on the design of other components, creating a hierarchy of design. The physical structure of a product and the interrelations among its parts are therefore the result of an interplay among customer requirements, technical constraints, and technical options during the design process. There seems to be a similar phenomenon in services, in which some parts of the operation are more relevant to the concept than others — a supermarket, for example, may be less dependent on its phone system than a pizza delivery service. Also, the outcome of the service design activity is constrained by choices made along the design process, depending on how early a decision is made concerning parts of the service operation, and how relevant those parts are to the service concept.

“Architectural variations often lead to new concepts”

Anderson and Tushman (1990) suggest that the core technology of a product or process ‘evolves through long periods of incremental change punctuated by technological discontinuities.’ Technological discontinuity is an innovation that either advances the price–performance frontier of the product by an order of magnitude, or changes the traditional process of making that product in such a way that it improves its cost or quality by an order of magnitude. They characterize discontinuities as either competence enhancing or competence destroying. While competence-enhancing discontinuities promote small improvements in performance, competence-destroying discontinuities allow order-of-magnitude improvements in performance and make obsolete the older process or technology.

Tracing a parallel to the service industry, the creation of discount brokerage of securities can be viewed as a technological discontinuity since it changed the traditional process of brokering securities, while advancing the price–performance of that service. Interestingly, this innovation was achieved by offering a narrower mix of services (i.e., no financial advice or research), and often a wider mix of products (i.e., broader choice of investment vehicles). The creation of category killers and wholesaler clubs in the retail industry are other similar examples.

Henderson and Clark (1990) provide a link between Clark’s hierarchy of design and Anderson and Tushman’s technological discontinuities. They argue that product design requires two types of technical knowledge: component knowledge (knowledge about the concept and functions of each component) and architectural knowledge (knowledge about how to integrate the components into a consistent whole). The authors propose the term ‘architectural innovation’ to refer to those ‘innovations that change the way in which components of a product are linked together, while leaving the core design concepts (and thus basic knowledge underlying the components) untouched.’ When a major new feature is added to the dominant design of a product, both component and architectural knowledge about this new feature are integrated into the underlying knowledge of the dominant design of the product. Take, for example, the introduction of airbags as standard equipment in most passenger cars. It requires knowledge not only about the equipment itself, but also about how it affects other elements: steering wheel, dash board, fixtures for collision sensors, etc.

Services also provide good examples of architectural innovation. Consider, for example, a gym that decides to add a major piece of equipment to its facility (e.g., sauna, or swimming pool). By doing so, the gym has slightly changed its concept because it now offers the capabilities that the new equipment provide. Moreover, the new equipment brings into the gym new knowledge about its operation (how it works), and how it interacts with the rest of the gym through, for example, vibration, heat exchange, space and power requirements. Another interesting example is provided by stores that begin to use an Internet link to provide information and order entry interfaces. This innovation is mostly on the interface between two components of the system: the store and the customer. Notice that the store has neither changed its appearance or inventory nor has the customer been required to understand a whole new concept. All that changed was the link between the two. Exploring this example further, a completely virtual store does not need a physical facility, nor inventory on hand since it can ship orders directly from the vendors. This new concept eliminates the front-office and also changes the way customers interact with the ‘store.’ It is both an architectural innovation and a component innovation.

The example above suggests architectural variations often lead to new concepts, that is, identifying components and analyzing links between them can also be a source of innovation.

Development Process

The development of a new product or service generally starts with a coarse, information-poor format (e.g., an idea) and gradually evolves to a detailed, information-rich format (e.g., charts, blueprints). At each stage of the process, knowledge is added to the design with the help of tools, methods, models, and architectural knowledge. Starting from the identification of a need or opportunity, designers seek to understand desirable attributes of the prospective product and generate an initial concept. Those attributes are translated into component attributes, so that components can be separately designed and later integrated. Such translation, however, requires that components be known and their interaction be taken into account. When a product or service is the first of its kind, no previous architectural knowledge exists to help its design. Thus, an initial architecture is proposed and evolves over time until a dominant design emerges. At this point, the architectural knowledge becomes part of the methodology to develop other similar products or services.

Due to physical and technological limitations, not all sets of attributes are feasible, so that tradeoffs arise among the attributes. Designers need therefore to assess such tradeoffs to ensure the feasibility of a design solution and to make design refinements. They do it by using analytical or physical models that roughly replicate relevant behaviors of the system that is being designed. Models therefore have a pivotal role in the design quality: while complex behaviors in general require complex models for their reproduction, too complex a model may be cumbersome to use, and too simple a model may miss important behaviors. Designers must find a balance between model complexity and accuracy that fits their needs.

To illustrate the modeling process in the context of services, consider a simplified task of designing the front office of a bank. In deciding how much space to allocate to the waiting line for tellers, a tradeoff between two design variables arises (line space vs number of tellers). Fewer tellers imply less labor costs, but will generate longer waiting lines that would require more costly floor space. On the other hand, allocating a small area to the waiting line uses less floor space, but will require that more tellers be available, implying higher labor costs. To assess such a tradeoff we may use queueing theory to link the number of tellers with the number of customers in the waiting line, and then use estimates of labor costs and floor space to make the decision. Note that the scope of this abstraction need not be limited to the perspective provided by queueing theory. Allocating a small area to the waiting line assumes that waiting times will be shorter, which is related to customer satisfaction. Thus, we could for example, link waiting times and customer satisfaction through another model and assess the tradeoff between operational costs and customer satisfaction.

One of the difficulties in building models that support product or service design is that human behavior is difficult to predict or to model. Nevertheless the authors believe that human participants share, at least partially, common behaviors that could be described by general principles and appropriate models, which we introduce and discuss later in this paper. In the next sections we present three different types of knowledge used in the development process (procedural plan and methods; architectural knowledge; and principles and models).

Procedural Plan and Methods

Most product and service development methodologies proposed in the literature are presented in the form of a sequence of steps similar to those proposed by Urban and Hauser (1980) and the consulting company Booz-Allen and Hamilton (1982). There seems to be a consensus around the general sequence of stages that development projects evolve through (see the six stages shown in Figure 1).

Each stage represents a group of activities with a common objective as indicated by the label of the stage. Since the output of a stage is also an input for the next one, there is a degree of precedence between stages that imposes a time sequence. The process however moves forward and backward as solutions are proposed, tested and refined. We also indicate in Figure 1 the steps that define the architecture, and the central role of methods and models in the development process. Next we describe in more detail each stage and the methods available to perform them.

Strategic Assessment

The development of new products or services is strategic because of its lasting impact on the firm's profitability and growth. Innovative companies use it as a strategic vehicle to expand into new geographic regions, market segments, or to develop new capabilities. It is natural therefore for the development of a new product or service to start with a strategic assessment. Hax and Majluf (1991) propose a strategic planning framework with four phases that we discuss next: definition of mission; external analysis; internal analysis; and strategic analysis. Figure 2 shows an overview of the process.

The mission of a development project is generally determined by the firm's long-term strategy. It can be analyzed across two dimensions: degree of concept innovation, and degree of market innovation. It means that firms may develop new products and services for reasons ranging from a cosmetic change to serve a known market to a complete new concept to serve a new market. Each type of project has different uncertainties and impose different demands on a company's capabilities, logistical system, organizational structure, marketing, and so on, that must be taken into account in the development project.

The external analysis identifies trends, threats and opportunities in the industry by gathering data about

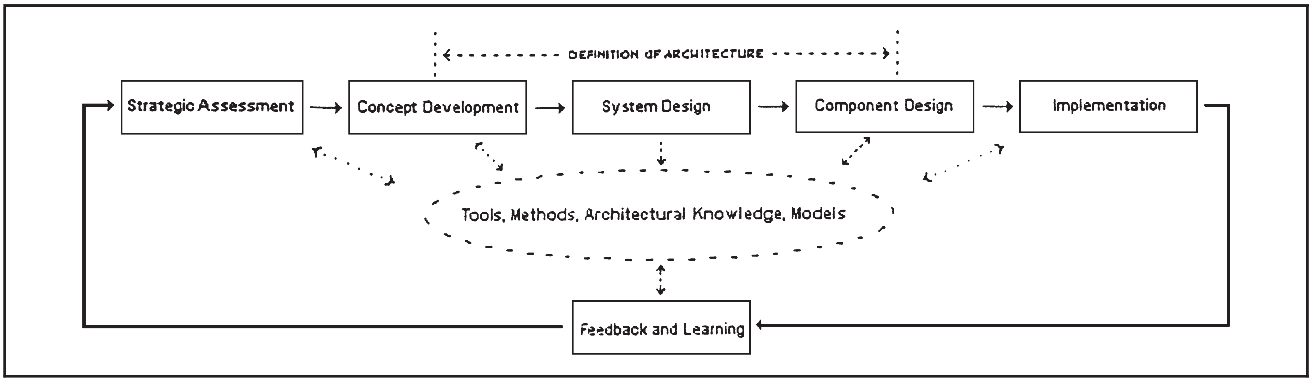


Figure 1 General Sequence of Stages of Development Projects.

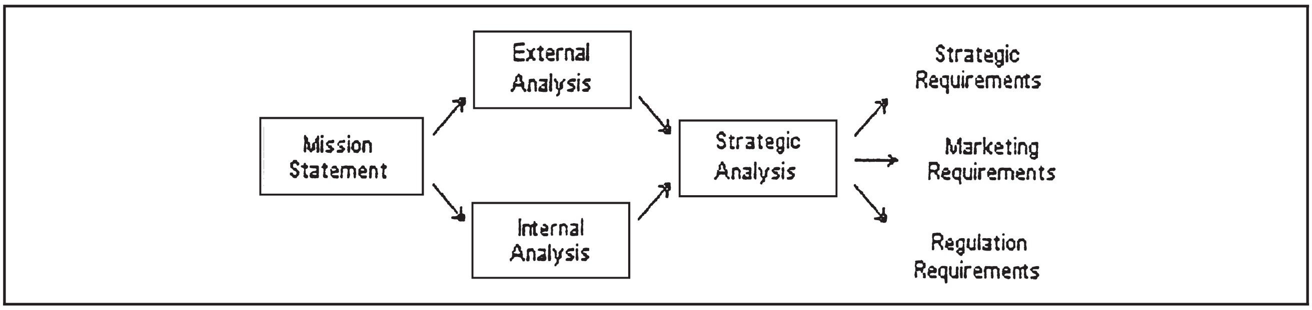


Figure 2 Activities of Strategic Assessment.

suppliers, customers, competitors, substitutes, regulations and other relevant aspects. In the case of a major innovation, an exploratory market research should help the company appraise the potential demand for the new product or service (see Kinnear and Taylor, 1991 for a thorough exposition on market research).

The internal analysis determines how the new product or service fits in the firm's current offering and how it will impact the firm's operations. It must also determine what skills, resources, and capabilities are needed in the development effort.

Finally, the strategic analysis weights the information generated by the internal and external analysis to generate marketing requirements (e.g., business opportunities, market segment and positioning); strategic requirements (e.g., use of a certain technology, expansion into new markets); and regulatory requirements (e.g., health, safety requirements) for the new product or service.

Concept Development

Once the company determines the marketing requirements (e.g., geographic expansion, target segments) for the new product or service, they must collect, through appropriate methods and tools, the voice of the customer. Thus, concept development starts with the identification of customer requirements (what customers need and expect to find in the product). They are then combined with other requirements identified in the strategic assessment stage (e.g., safety, regulation) and translated into attributes for the new product or service. Burchill and Shen (1992) propose a methodology they call 'Concept Engineering' to translate the voice of the customer into new concepts. We present a similar sequence of steps in Figure 3, calling attention also to other requirements that must be considered to generate a concept.

In the case of services, concept development requires special attention to intangibles such as ambience or social needs, that may be part of the service concept and therefore essential to shape the service experience. In the design of a hair salon, for example, a customer opinion such as 'I like to go to a salon where I can talk to other people,' may be translated into a requirement for the salon, that later becomes an attribute of its concept. In this example, an attribute for the salon could be that 'it must allow easy social interaction.' In the system design stage, that salon attribute may be translated into attributes for participants of the service delivery such as employees and the physical layout of the store. Possible translations might be: 'Employees must be friendly and receptive to conversation'; and 'the store layout must encourage interactions among customers.' Needless to say, one customer requirement may unfold into several attributes for a number of participants of the service system.

As we can see in Figure 3, the process starts with the collection of the voice of the customer. Griffin and Hauser (1993), thoroughly review methods available for that purpose. They compare techniques to ident-

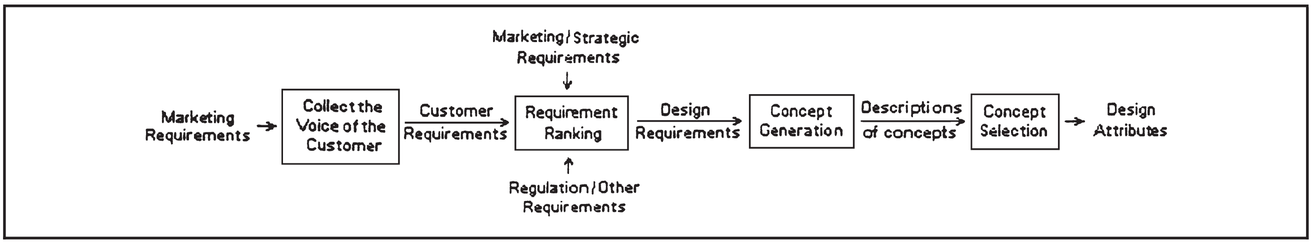


Figure 3 Activities of Concept Development.

ify customer needs (e.g., individual interviews, focus groups); techniques to structure or cluster customer needs; and techniques to estimate or measure need importance. They also suggest that the discussion with customers should identify basic needs (what customers expect from the product), articulated needs (what the customers would like to see in the product), and exciting needs (needs that if fulfilled will delight the customer). Burchill and Shen (1992) identify customer needs by clustering similar labels containing customers' verbatim opinions. They use questionnaires developed by Kano (1982) to classify needs in five categories: must-be (minimum requirement); attractive; one-dimensional (the more of the attribute the better); indifferent; and reverse (the more of the attribute the worse).

Andersen (1983) argues that a description of needs should distinguish between rational and emotional needs. It should also include a time dimension, that is, a description of needs in terms of existing and future (or latent) needs. Future or latent needs, however, are not easy to identify because customers are generally not aware of them yet. One possible way to identify them would be, for example, to monitor environmental trends (e.g., raising energy prices). von Hippel (1986) proposes that those needs are experienced by what he calls 'lead users.' The term was introduced to refer to 'users whose current strong needs will become general in a marketplace months or years in the future.' Since lead users experience needs ahead of the general market, they can also serve as a 'need-forecasting laboratory.' He also discusses how to identify lead users and to incorporate their input into marketing research analyses.

Note that design requirements may have different natures, such as physical (e.g., colorful, portable), functional (e.g., must provide food, laundry capability), intangible (e.g., degree of silence), operational (e.g., 24-hour operation, parking facility) and so on. Since some requirements are more critical than others, it is necessary to rank them and focus the concept generation on those that are most important. Conjoint analysis and utility functions are common tools employed for this purpose (refer to Shocker and Srinivasan, 1979 or Hauser and Urban, 1979 for good reviews). Wind *et al*. (1989), for example, describe in detail an application of conjoint analysis together with statistical and other marketing tools to the design of a new hotel concept.

Once design requirements are identified and ranked, a rough sketch of the attributes, functions, products and services that may meet them is generated. This is the concept generation step, when designers start to consider what attributes and functions of the physical system are likely to fulfil the design requirements. Suppose, for example, that in the hair salon case the following requirements are identified: 'it must allow easy social interaction;' 'it must provide innovative hair styles:' and 'it must convey an image of a futuristic place.' Those requirements may be translated into attributes for the whole system or parts of it, thereby beginning to shape the architecture of the service system. For example, the requirements might be translated into the following attributes: layout resembling a living-room; brightly colored; background music; neon decorations; state-of-the-art seats; bar; video-games; CAD system for hair design; manicure; make-up; etc. Depending on the emphasis put on each of these attributes, and their ranking, different concepts may be generated. Some screening procedure must therefore be employed to separate the most promising concepts for further development.

Ulrich and Eppinger (1995) defines concept selection as 'the process of evaluating concepts with respect to customer needs and other criteria, comparing the relative strengths and weaknesses of the concepts, and selecting one or more concepts for further investigation or development.' They list several methods for concept selection, and also propose a two-stage methodology for it. Their methodology starts with concept screening, using a method developed by Pugh (1990) that enables combination of concepts to improve the solution. After concept screening, the best concepts are given scores based on the assessment of how well they meet their design attributes, weighted by the relative importance of the attributes. The one or two concepts with the best scores proceed to the next stage.

System Design

During the concept development stage, the design requirements identified in the strategic assessment are translated into a concept described by attributes and functions that are likely to fulfil the requirements. In this stage, the concept is translated into attributes and functions for each component of the system, so that they can be designed separately for later integration. Thus, the purpose of system design is basically to find possible ways (or processes) to implement the concept with the components determined from architectural knowledge. It comprises not only the determination of what components are needed but also the design of the processes through which the components will interact.

All attributes and functions are analyzed individually to determine how they can be implemented by components of the system. The House of Quality (Hauser and Clausing, 1988) or Quality Function Deployment (QFD) helps this process by mapping the relationships between design attributes and component attributes in a 'relationship matrix' (see the step 'Parts Deployment' in Hauser and Clausing, 1988). Behara and Chase (1981) proposes the use of the House of Quality for service design, or 'Service Quality Deployment.' They call it 'House of Service,' and refer to service components as 'the service company facets,' which are divided into three major categories: Planning, Procedures, and Personnel. Notice that architectural knowledge is crucial in the application of this tool, for the design components must be known in advance to map product attributes into component attributes.

Pimmler and Eppinger (1994) suggest a methodology to determine the architecture of a system by studying expected interactions among its parts. In their words: 'Selecting the proper architecture of the product is an extremely influential decision which must be made during the concept development and system-level design phases of the project; the architecture defines the sub-systems upon which the team will work for the bulk of the development effort.' They argue that the choice of product architecture not only affects product performance but also the firm's development capability and manufacturing expertise. Rechtin (1991) explains that the architecture of a system is determined through two opposite processes: partitioning and aggregating. While partitioning imposes structure to the design problem by breaking it down into smaller subproblems, too many partitions make the design intractable. On the other hand, while aggregating similar functions and features helps simplify the design, too much aggregation may cause important details to be left out of the design. The author suggests that aggregating and partitioning functions often suggests a structure or architecture of the system itself. Thus, another way to decompose the design problem is through its 'function structure,' that is, to determine what means (or sub-functions) are necessary to implement a goal or function (see also Pahl and Beitz, 1984).

During the concept generation stage, attributes and specifications can be treated in a fairly loose way because the whole concept is roughly defined. However, as the design proceeds, they are successively refined to a level considered proper for implementation. If the specifications are too strict, the cost of the product will most likely increase unnecessarily. On the other hand, if the specifications are too loose, the integration of components will likely present problems which may lead to redesigns and delays. That is because every physical system has limitations, and the design implementation can rarely meet all specifications without tradeoffs. Ulrich and Eppinger (1995) suggest the use of competitive benchmarking whenever possible to determine target specifications for a product. This is generally the case of services, where competition through imitation is fairly common.

Specifications are essential to system design because they allow components to be designed separately for later integration into a consistent whole. Integrating components, however, requires special attention to effects resulting from expected or incidental interactions. Pahl and Beitz (1984) argue that interactions among the components of a physical system happen through flows of energy (e.g., mechanical, thermal, electrical), materials (e.g., gas, liquid, dust), and information signals (e.g., data, control pulses). Interestingly, in service systems information may be exchanged through a multitude of ways: ambience, emotion, noise and smells are just a few examples. To further illustrate, consider a hotel in which a conference room is placed close to the kitchen to enable the hotel to cater for executive dinners and receptions. In this case, the interaction between the kitchen and the conference room is expected and designed to allow, for example, easy flow of waiters and food. If, however, this interaction is not well understood, it may yield a poor design due to incidental, unanticipated interactions — noise from the kitchen may disturb people at the conference room.

The example above shows that although the level of detail at this stage is still coarse, designers need to start analyzing interactions among components to minimize integration problems later in the process. The analysis is supported by simple models that are employed to roughly check the feasibility of the design. Figure 4 shows a schematic of system design.

Component Design

Similarly to the previous step, where system attributes and specifications are mapped into component attributes and specifications, component design is also an iterative process of refining attributes and specifications. The design of each component pro-

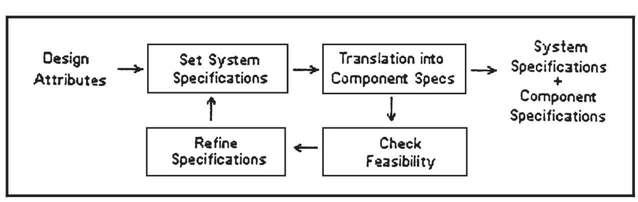


Figure 4 Activities of System Design.

ceeds by successively decomposing it into sub-systems (as long as it is necessary), generating specifications for the sub-system, checking their feasibility, and then designing each sub-system in the same way. Figure 5 shows an overview of the process of component design.

Three difficulties are commonly faced by designers in this step. The first is to manage the sequence of design decisions taking into account interdependencies among different components. The second is to translate non-numerical specifications into the physical design of each component. Finally, the third difficulty is to assess tradeoffs among non-numerical specifications.

The first difficulty arises because the design of a component generally constrains the design of others, imposing a precedence relationship among components. Since not all components can be designed concurrently or sequentially, designers need to determine, up to a certain level, dependencies among them and integrate their design accordingly. Since some design decisions are more restrictive than others, and may make unfeasible possible solutions to the problem, they should be taken as late in the process as possible to keep the design flexible to change. The notion of architectural knowledge discussed in the fifth section may help the assessment of component interdependencies by providing a framework to investigate the impact of the design of one component on the others.

The second difficulty arises from the existence of non-numerical attributes. In this case designers need to attach a metric to each attribute so that they can be measured and transformed into a specification. Ideally such metric should define the attribute as clearly and objectively as possible. This however is not always possible. For example, if 'having good diction' is an attribute for a phone operator, a metric that qualifies diction into degrees such as 'poor,' 'fair,' or 'good' transforms 'good diction' into a specification for the operator. The assessment however may be subjective and dependent on the person who listens to the operator.

Finally, non-numerical specifications make the assessment of tradeoffs between design variables more difficult. Although tradeoffs among measurable variables are traditionally assessed with the help of analytical models that establish a relationship between them (refer to our discussion about the use of principles and models in the sixth section of this paper), those relationships can also be described by causal-loop diagrams (see, for example, Senge, 1990). The difficulty involved in this assessment lies in understanding the nature of each non-numerical attribute and how they impact each other.

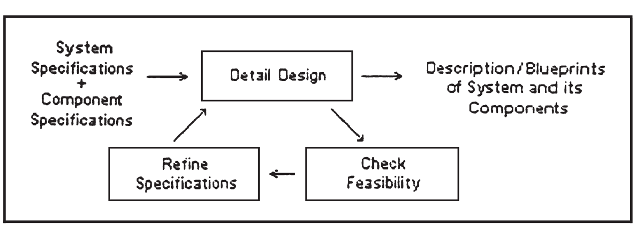


Figure 5 Activities of Component Design.

Concept Testing and Implementation

The output of the previous stage is a set of documents and blueprints that describe in detail every element of the product or service so that a production line or service system can be set up and begin operation. In both cases, however, this description may be inaccurate due to the impossibility of models to reproduce reality. In service systems, for example, the description of human elements requires not only a description of their physical appearance (uniforms, name tags, etc.), but also a description of expected behaviors and skills. Since human behavior is not fully understood, actual behavior in the system may be quite different from what is expected.

Due to the possibility that the product or service does not meet its design requirements, before a company commits resources for the production ramp-up or service implementation, the design is tested to make sure that the outcome of the development effort yields a product or service with the attributes and functions as originally planned. This test involves building prototypes (for tangible elements) or pilot operations (for processes); measuring their performance; comparing with expected performance; and refining the design so that the product or service exhibits the expected behavior.

There are established methodologies available for prototyping and market testing. Ulrich and Eppinger (1995), for example, discuss types and objectives of prototypes, and propose a plan for prototyping. Wheelwright and Clark (1992) advocate that to be effective, prototyping and market testing must be done under market conditions as close as possible to the ones that the new product or service will face after its launching. This seems to be specially important when the main benefit of the new concept is intangible. In this case customers must be able to experience the product or service to understand the concept. That is the reason why some service companies (e.g., hotel chains) implement a pilot operation before full-scale launching. Also, some companies allow customers to experience their products for a certain period without obligation to buy. Understanding that Murphy and Robison (1981) defined market testing for a new service as a technique 'designed to evaluate whether a prospective user (1) understands the idea of the proposed service; (2) reacts favorably to it, and (3) feels it offers benefits that answer unmet needs.'

Once the concept is tested in the market and its design is refined, the company must start planning a launching strategy for the new product or service. At this stage equipment is purchased and installed, physical facilities are built, decorated, furnished, and employees are recruited and trained. Recruiting and training must provide employees with the necessary skills to perform their functions satisfactorily. In services that require the participation of customers, employees must be trained not only to perform their functions, but also to induce customers to behave in desired manners. Note that human behavior is generally a consequence of not only training, but also the physical setting, reward systems and operating procedures. Although reward criteria and operating procedures can be taught through training and documentation, employee behavior is shaped over time by the organization's culture and internal marketing.

Figure 6 shows concept testing and implementation, with the activities of the former arranged in a cycle to indicate that they must be done interactively.

Feedback and Learning

The adoption of a development methodology facilitates learning because it enables the systematization of knowledge: modifications in the procedures and methods used during the project may be documented and incorporated into the methodology. The same happens with new methods and models that must also be formally included in the methodology for future use.

Although learning at the individual level starts the first day of the development project and continues throughout the product or service life cycle, it is common to dedicate a separate stage for the purpose of systematic learning. A company that does not use the knowledge generated in the development of a new product forfeits most benefits that a methodology brings. Wheelwright and Clark (1992) argue that learning for product development goes beyond changing procedures, methods, or models, and requires careful systematic effort. Individuals that participate in a development project naturally acquire new knowledge, but learning must also be extended to the organization. When a complex system is being designed, a number of individuals with diverse expertise interact to generate the design. Learning in this environment therefore requires a coordinated effort because no single individual has the knowledge needed to solve design problems alone. The authors list crucial items for a successful systematic learning that are similar to the three types of knowledge discussed in this paper: team processes (sharing mental models), a model of the development process (or a procedural plan), data analyses, patterns, and root causes (architectural knowledge, principles and models). They report that changing the development procedure, and adapting tools and methods is a possible way to capture insights and learning generated by the project. Also, using a 'project audit — a formal review conducted by a cross-functional team' appears to be of great help to organize the learning process.

The daily operation of the production or service system also generates learning that must be used in improvements and to develop future line extensions or similar services. Once the new product or service is introduced, customer suggestions and complaints become a source of valuable information that must be used as feedback or generate new insights. While most products carry manufacturing warranties that are generally claimed if the product is defective, service companies have a hard time to collect feedback from customers because only a few (the most dissatisfied or satisfied) ever return a feedback form (see Hart, 1988). The author advocates that service guarantees lead to a better collection of data on service failures, resulting in more opportunities for improvement. The service guarantee, however, must be designed so that it is easy to claim and promotes improvement in the system.

Architectural Knowledge

The notion of architecture is based on the assumption that a system can be divided into subsystems or components which interact to achieve a certain purpose. From the perspective of product or service development, establishing an architecture improves the development process in at least three ways. First, it forces a systematic search of alternatives in the system-design stage of the development effort. Second, it facilitates the design task by partitioning it into

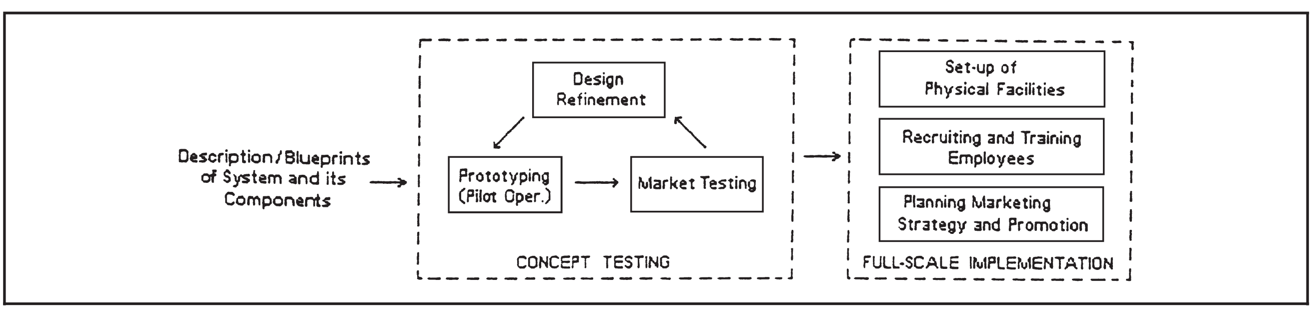


Figure 6 Activities of Service Implementation

smaller subproblems (the design of each component separately) for later integration. Finally, it requires that interactions among components be identified and analyzed, which by itself may lead to a deeper analysis and better results.

Given a concept, there may be several different architectures that map design attributes into functions and attributes of its components. This mapping is done at the system design stage with the help of architectural knowledge, that is, knowledge about what components integrate the system, and how they interlink. Some architectures however will likely emphasize some attributes in detriment to others. The attribute ranking done in the concept development stage may help determine which architecture best fits the concept. Similarly, there may be several different implementations of the same architecture. Prototyping and market testing support the search for the best implementation, given the input of customers.

To illustrate, let's consider a simplified case of a restaurant concept defined by the following attributes: exotic ambience; entertaining experience; traditional steak-house menu. There are several different architectures that map those attributes into a restaurant. We roughly describe three of them here. One would be a restaurant decorated in Middle Eastern style and belly dancers. Another would be a hibashi-type restaurant in which the food is prepared in front of the patrons with a hot plate in each table. A third possible architecture could be a similar restaurant but with a single central hot plate surrounded by a bar counter where patrons would sit. Note that the traditional steak-house menu somehow influences the architecture in the sense that it makes possible the second and third architectures — if the menu was mainly composed of baked food, the second and third architectures would be less attractive in the sense that it is not entertaining to watch food baking inside an oven. There are endless possibilities for the implementation of any of those architectures. Some implementations, however, fit better the concept than others. For example, hibashi-type restaurants are traditionally decorated with wood shaped with oriental motives — any implementation too different from that might not be approved by prospective customers.

In order to discuss architectural knowledge in the context of services, we use an example of a service operation structure with nine high-level components that are pervasive to most service operations and that may be designed and implemented in a new service. They are: internal organization; external organization; technology (soft or hard); customers; front-line employees; support employees; product mix; service mix; and customer interface, as shown in Figure 7. We use circles to depict each component, and intersect circles to illustrate cases of participants with characteristics of more than one component. For example, we define support employees as those who mainly do not have any kind of interaction with customers, and front-line employees as those who do. Still, support employees may eventually have contact with customers in some service situations, and front-line employees may eventually have back-office functions.

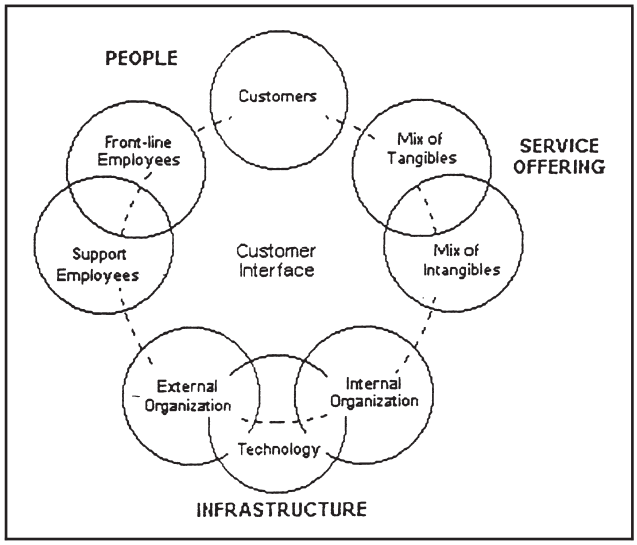


Figure 7 Components of a Service System Structure.

The physical structure of service organizations is composed of the internal organization, the external organization, and technology. The internal organization is the part of a service operation that is out of sight or reach of the customer. Although similar to the notion of 'Back Office,' the term 'internal organization' seems more appropriate in the sense that it may refer to several locations, physical facilities, and equipment utilized for service support and production (out of the sight of customers). Similarly, the external organization is the part of a service operation that can be reached or seen by customers. It includes facilities, vehicles, uniforms, and external signs, among other elements. Common examples are front-offices of banks or retail stores, parking lots, cafeterias, elevators, rooms or public areas of hotels, resorts, and hospitals. Technology participates in the physical structure as equipment or 'hard technology,' but it can also be viewed in a broader context as operating procedures, flows of activities, or information systems, often referred to as 'soft technology.' Thus, we define it as a distinct component that intersects both the internal and external organizations.

People are represented in a service system by the customers, front-line employees, and support employees. This two-type classification of employees does not consider function or hierarchical level, only the degree of contact with customers: 'Front-line employees' are those who interact directly with customers, while 'support employees' are those who contribute to the production of service without having direct contact with customers. Under this classification, managers who do not interact with customers are also viewed as supporting employees. It emphasizes the importance of having the right set of skills at all positions, specially those that interact directly with customers.

From a design perspective, we consider people as controllable (to some extent) participants in the system. In fact, training and selection allow service companies to shape the skills and personal characteristics of employees, and market positioning allows companies to target segments in which customers exhibit desired behaviors. As we will see, although it is impossible to control individual actions, people can be induced to behave in desirable ways by artifices like, for example, environmental cues and technology.

In the product and service offering we have a mix of tangibles and intangibles that are 'sold' to customers. A hotel, for example, may have the products and services traditionally offered by most hotels (room service, laundry, restaurant, etc.), but can also offer temporary offices, conference rooms, health clubs, and so on. Observe that the mix of tangibles and intangibles intersect to indicate those cases in which the distinction between them is blurry. For example, in the case of cable TV, while the cable signal is intangible and the decoder used for reception is tangible, one has no use without the other.

Finally, the interface is the set of all possible interactions (any contact through any medium) between customers and the service organization. It is perhaps the most complex component to design because successful service interactions are often the result of an interplay among various components. That is the reason why we depict it in the center of Figure 7, surrounded by all the other components.

It is important to note that just like the case of products, service quality is only achieved when all components work well and are properly coordinated. For example, no matter how politely an employee apologizes for service failures at the back office, the service experience may still be not as satisfactory as it could be. Although there are tactics for service recovery (see Hart *et al*., 1990), it should be clear that the role of service design is to carefully consider every possible detail in the new service so that failures are not caused endogenously.

In the sequel we further describe the components, clarifying their role in a service system and how they interact with each other. We point out issues that might be considered in their design as well as their functions and attributes.

“Although it is impossible to control individual actions, people can be induced to behave in desirable ways by artifices”

Internal Organization

The internal organization is the part of a service system that is out of sight of customers and competitors. It may be distributed in several locations (back-offices) or may have dedicated facilities for R & D, data processing, production, and other functions. The main consideration in its design is to provide service quality with as much efficiency at cost as low as possible.

Thompson (1967) proposes that organizations should be able to operate more efficiently by isolating their technical core from external disturbances. He refers to minimizing customer contact as 'decoupling.' Chase and Tansik (1980) elaborate on this notion, arguing that since the customers are a source of uncertainty, the less contact customers have with the service system, the more possible it should be to operate efficiently. The fundamental assumption advocated by the Contact Model is that customers are a source of uncertainty that should preferably be decoupled from the technical core for the sake of efficiency. Decoupling in this context, however, means reducing the physical presence of customers in the internal organization without necessarily limiting the exchange of information between customers and the service organization. Therefore, we define the internal organization as being decoupled from the external environment by visual contact only, and interacting with customers through any media other than personal contact.

Although economies of scale are commonly regarded as not very significant in services, the design of the internal organization must consider opportunities for such. Several firms have managed to achieve economies of scale through the use of technology; by centralizing back offices and decentralizing front offices; or by centralizing activities that require expensive personnel or equipment and decentralizing others that do not (refer to Quinn and Gagnon, 1986; Upah, 1980; and Porter, 1980, respectively).

Like any other service component, the internal organization must be designed based on its desired attributes and functions. The voice of the customer in this case is mainly given by the customers of the internal organization, that is, operations personnel (for facilities and equipment) and support employees, that may help determine the attributes of the internal organization. Those may include accessibility, illumination, ventilation, location of restroom, laundry facility for employees, directional or informational signs (reminding employees of messages), among others.

External Organization

The external organization is the part of the structure that is visible to customers and competitors. It is similar to the 'front-office' found in the literature, but with a broader definition. The external organization is composed by facilities and physical evidence used for service delivery. It may have several front-offices, or use intermediaries to perform some function, depending on the nature of the service business and its distribution channels. We discuss three aspects of the external organization: exterior design, interior design, and design of physical evidence.

Ward *et al*. (1992) suggest that customers start to form expectations about the service even before entering the facilities. They argue that customers tend to compare the external appearance of a service business with their mental models or 'prototypes' of what they expect that service facility to be. Upon entering the place, customers compare the interior appearance with their prototype and decide whether to stay or not. This mental process of categorizing the service setting prompts expectations and inferences about the type of service, quality, price, and behaviors. The authors conclude that more 'typical' outlets seem to be preferred by customers, and that the importance of exterior typicality or interior typicality was likely to depend on the service category — they are perceived by customers to be part of the dominant design of that category of services.

Upon entering a service facility for the first time, customers try to match that service business to a known category, and adopt certain behaviors which are based on how they perceive their roles in the service system (Solomon *et al*., 1985). When customers do not know their role in the system, they rely on other customers or on environmental cues to understand what behaviors are proper to that situation. In this case, the service setting and environmental cues can have great impact on the ability of customers to achieve their objectives. The floorplan, layout of equipment, and signage can help or hinder employees and customers from performing their tasks (Kelly *et al*., 1990).

The service setting and environmental cues can also influence behavior in subtle ways. For example, the furnishings of some fast food restaurants are purposefully a little uncomfortable to discourage customers from lingering. On the other hand, certain cafes try to provide an environment as comfortable as possible to their customers, encouraging them to stay as long as they please — it is just part of their service concept. Milliman (1982) reports that the tempo of background music in supermarkets and restaurants can affect traffic flows and revenues. Bitner (1992) argues that the service setting may encourage or block certain forms of social interactions among customers or between customers and employees. It may even encourage more consumption of the firm's service offering. An interesting example are restaurants that perform theatrical cooking in front of patrons. Since unknown customers usually sit together at the same table, the restaurant keeps all patrons of a table occupied all the time so that they do not feel embarrassed to share the table with someone they don't know. Also, a bar in the reception allows patrons to consume drinks before being directed to their dinner table.

When service companies try to communicate proper behaviors to customers, they do it through techniques known in the literature as 'organizational socialization' (Kelly *et al*., 1990). Organizational socialization is achieved through a number of means such as information signs, recorded messages, environmental cues, literature, differentiated fees, or explicitly training customers and employees. It is used to shape customers' expectations, communicate organizational values, teach how to best use facilities, guide queueing behavior, transmit reminders, control demand, etc. — the external organization may implement any of those functions. It has such a strong influence on customers' behavior and perception of the service quality that special attention must be given to its design. Recognizing its importance, Shostack (1985) states that the service setting should be deliberately designed to shape the 'service reality' rather than 'leave it to default.'

The unconscious characterization of service settings by customers reinforces the need of using their input to identify attributes of the external organization. Using the appropriate techniques (as discussed in Concept Development), service designers can extract images and feelings of customers, which are very important in the determination of the attributes of the external organization. Moreover, customers may also provide information about operational aspects of the external organization such as accessibility, store-hours, layout, etc. From that point onward, specialists must translate that information into design specifications.

Technology (Soft and Hard)

Quinn *et al*. (1990) define technology as 'the systematic application of knowledge — particularly about physical, chemical and systems phenomena — to useful purposes.' Levitt (1972) distinguishes between 'hard' technology (e.g., hardware, equipment), and 'soft' technology (e.g., software, operating procedures).

Technology may be used to enhance the capabilities of both employees and customers. With the help of well designed, easy-to-use systems, relatively inexperienced people can perform sophisticated tasks quickly, and without much training. Employees can have their scope of action enhanced in capability and flexibility to provide better service or more effective selling. It can also induce customer participation in the service process by enhancing the capability of customers to perform some activities. For example, service concepts that were unfeasible previously (e.g., home banking) are now a reality thanks to the use of data communication technology to link customers and the service organization. On the other hand, technology may also restrain operating procedures for the sake of uniformity and standardization, or due to regulations (e.g., airplane maintenance, bank accounting). By standardizing equipment and operating procedures, service organizations have been able to replicate the service concept and expand geographically through franchising, for example.

Chase and Stewart (1994) propose the use of both soft and hard technology to prevent service failures from happening. This application of technology is known as poka-yoke and has been widely used in manufacturing systems. They show practical poka-yokes in service systems and discuss similarities and differences of their manufacturing counterparts. The authors argue that service poka-yokes need often to induce customers to act in desirable ways, in which case they contribute to the process of 'organizational socialization' discussed in the previous component (External Organization).

Establishing an organizational climate for service quality may be regarded as soft technology in the form of organizational culture or compensation system that rewards customer-driven behavior by service employees. Such behavior is often perceived by the customers as service quality. It is important to understand, however, that when customers or employees are required to operate a piece of equipment or abide by procedural changes, the implementation of such innovation is dependent on its acceptance by them. Simple and repetitive tasks can be shifted to machines, resulting in cost savings, productivity and wage gains, as well as improved quality, and more fulfilling jobs.

Quinn and Paquette (1990) argue that in the same way that technology allows standardization, it can be used as entry barrier for competitive imitation. This is achieved by having customers using technology provided by the service organization, which may increase switching costs and lock customers into a relationship with the company (a common example is that of customer companies that link their information systems with the service provider's system for order entry, inventory status, etc.).

Bharadwaj *et al*. (1993) suggest that technology may create opportunities to exploit demand synergy by cross-selling services and cost synergy by centralizing administrative activities. A good example is the financial services industry, where companies use information technologies to distribute a variety of services to a diffused customer base.

As we can see, technology is used throughout a service organization, serving a number of functions and purposes. When designing this component therefore, it is necessary to determine what functions it will implement and what should be the corresponding attributes. In the design of ATMs, for example, it is necessary not only to determine the breadth and depth of functions they will allow customers to execute, but also attributes such as the layout, easiness of operation, clarity of instructions, and so forth. In the case of soft technology such as a process or operating procedure, many activities are performed simultaneously by employees, customers, and equipment. It is important therefore to determine what will be performed, where, how, and by whom, and how interactions among components affect the design of other components, so that the process can be executed smoothly.

Support Employees

Support employees are those who do not interact with customers but are necessary to implement core or peripheral functions. Although their impact on service quality is less straightforward to perceive, they have a fundamental role in the system. That is because customers usually go through routine service encounters without much awareness of the process, a state of mind referred to as 'mindlessness' (Solomon, 1985). Only when something deviates from the script, either positively or negatively, is when customers become aware of it. Airlines provide a good example: if everything goes perfectly in all steps of the process — reservations, check-in, inboard service — but one suitcase strays, that may be the strongest impression a customer will keep from the service. If the airline is not able to recover and deliver the suitcase, the effort of hundreds of other employees to assure service quality and customer satisfaction will most probably be wasted.

As in any other component, the attributes and functions of all support employees are determined at the system design stage. Then, the set of tools and skills needed to perform those functions is identified. In this process, operations personnel and employees can be of much help to simplify procedures and estimate service capacities needed to perform well the functions allocated to the position. Support employees can also be helpful in the design of technology, eliciting the attributes of tools or equipment that they will use.

Front-Line Employees

Front-line employees are those who interact directly with customers, either personally or through any communication media. Bowen and Schneider (1985) refer to front-line employees as 'Boundary-Spanning-Role' employees because they act as interface between the service organization and its customers.

They not only work with customers to deliver or create the service, but are also a major factor in shaping the customer's perception of service quality — any slip in the manners of a front-line employee can spoil the customer's overall impression about the service experience, even if everything else is perfect. Interestingly, the contact with customers is perceived by employees as enriching their jobs, which leads to greater job satisfaction.

Front-line employees receive immediate feedback about the service they provide through a variety of means. Thus, they perceive service quality and organizational effectiveness similarly to their customers. When management orientation or a badly designed system hinders their ability to perform their jobs well, they experience stress that generally leads to frustration, dissatisfaction, and ultimately indifference or willingness to quit.

As we discuss in the design of the customer interface, each interaction between customers and the service organization has different characteristics and attributes. Thus, depending on the interactions that front-line employees participate, they are required to perform different functions and to have different sets of skills. If front-line employees interact with customers over the phone, for example, their physical appearance is of less importance than good verbal and listening skills. On the other hand, when there is personal contact with customers, front-line employees must not only have good interpersonal skills but may also be 'packaged' to transmit or reinforce the company's image. Blackman (1985) discusses how the packaging of front-line employees goes beyond the simple visual consistency. Putting employees in uniforms helps convey an image that service will be the similar every time the customer experiences it. Moreover, uniforms is a constant reminder of the company's expectations about the employee.

The design of a front-line position therefore involves the determination of the right set of attributes and skills that the job demands, that is, the appropriate 'packaging,' and range of functions that the employee should have to provide good service.

Customers

In many service businesses the customer not only participates in the service production, but is also physically present in the facilities. In this situation, the behavior of a customer can affect the service experience of others. That is the reason why it is so important to monitor and manage customer behavior in the service setting. Noisy guests near your room in a hotel, or a queue delay in a check-out counter of a supermarket are two common examples that affect our everyday lives.

The service organization benefits from customer participation in a number of ways. It not only improves the efficiency of a service operation but may also be perceived by customers as better quality. By shifting some of the tasks required in the service production to customers, service firms reduce the labor required, and consequently reduce their costs. Since customers provide help just when it is required, the capacity to serve varies with demand, reducing the need for idle capacity. An interesting example is provided by the fast food technology. Through appropriate signs and the observation of other people, customers understand that they are supposed to dispose of their garbage and return the tray after the meal.

Involving customers in the service production also leads to their acceptance of some responsibility for the overall service quality. Companies, however, must determine whether customers have the appropriate knowledge to do what is expected from them, and whether customers are able to perform a task. Companies must also provide customers with tools and skills necessary to execute the role assigned to them. It involves training customers to use new tools, and educating them to reduce resistance to change. Mills and Morris (1983) suggest that in services that require relatively complex skills of the customers (e.g., consulting, tax accounting), companies should consider the possibility of educating or training customers in a pre-service encounter stage. In fact, this is commonly employed by hospitals and doctors to parents-to-be before the delivery of babies.

Considering customers in the design of service systems is therefore a process of defining the set of functions and behaviors expected from them. Naturally, their input is tantamount to define those functions and behaviors. The set of functions is then used to define the skills and tools required for successful performance. Moreover, the set of expected customer behaviors can provide information for the design of environmental cues, signs, technology, and objects that can be used to induce them.

Customer Interface

Bitran and Lojo (1993) suggest that the customer interface may be systematically analyzed and improved. They argue that service encounters happen through one or more phases dedicated to: access, check-in, diagnosis, service delivery, disengagement, and follow-up. Shostack (1985) observes that not only service encounters are manageable and controllable, but also that the best practices place a lot of emphasis on controllable details. In other words, outstanding service firms design quality into their delivery system and interface. To do so, it is necessary to determine not only the interactions that are necessary for the operation of the service, but also to anticipate interactions that may happen in an uncontrolled way.

Chase (1981), for example, analyses interactions in which the customer is in direct contact with the service facility. He suggests that direct contact with the customer may be reduced or enhanced with advantages for both the company and the customer. He proposes strategies for contact reduction (e.g., by automating the interface) and for contact improvement (e.g., use of signs to indicate queueing patterns and take-a-number systems).

Designing the customer interface therefore consists in systematically designing all interactions between customers and the service system consistently with the service concept. Each interaction has attributes determined by five dimensions, which we discuss next: purpose; duration and time delay; breadth and depth of options; nature of contact; and media employed.

Since service interactions are in general 'purposive and task oriented' (Solomon, 1985), there are not many different objectives or purposes for customers to interact with service organizations. That simplifies the design of the interface because there is only a limited set of functions that it may accomplish. Interactions with different purposes, however, may have different attributes. Problem-solving interactions, for example, may have their attributes related to assertiveness and responsiveness whereas the socialization interactions may not. We list some possible interaction purposes in Figure 8.

The duration and time delays of a service interaction are also important dimensions in determining its attributes. For example, Lovelock (1984) notes that the longer it takes for the service delivery to be completed, the more likely it will be for customers to require information about the work in progress, such as completion date or time, costs, etc. Maister (1985) observes that the passage of time in service interactions is felt in different ways, depending on whether customers are kept entertained, are treated fairly, are kept informed, etc. That is the reason why service companies try to entertain or keep customers busy while they are waiting. The rule of thumb is to keep customers busy (or entertained) while they wait and keep customers informed when there are delays. It is important to notice however that a longer duration of customer involvement is not necessarily bad when the customer is properly treated — it may expose the customer to more of the company's service offering, and motivate more sales.

During service interactions menus of options are often made available explicitly or implicitly to customers, so that they can choose the course of action to take. Those options however have an enormous impact on the interaction. Each option that is made available requires that the service organization have the adequate capacity to respond properly to that demand. By carefully designing the breadth and depth of options in the menu made available to customers, the service company is able to control service interactions so that only certain types of demands are imposed to appropriate parts of the organization. In this way the service system has to cope with less uncertainty, and customers also get a better service because each interaction can be more focused to the type of demand it is designed for. Focusing (or limiting) the menu of options on service interactions is widely employed by airlines, supermarkets, hotels, banks, and other service businesses, in the form of counters assigned to a narrow set of activities, such as ticketing, problem solving, express check-out counters, and so forth.

We must also consider other types of contact beyond person-to-person interactions: person-to-machine, person-to-object, and person-to-environment. Service interactions occur between customers and machines (e.g., automatic answering systems), between customers and objects or any physical evidence used by the service organization (e.g., stickers, catalogs, windows), and between customers and the environment through background music, smells, etc. Although service encounters may take a number of different forms, they are always experienced through

- Exchange of information (e.g. for shaping expectations, inform customers, confirm transactions, communication, complaints, follow-up, diagnosis)
- Delivery of intangible elements (e.g. advice, hope, pleasure)
- Delivery of tangible elements (e.g. merchandise, reports, meals)
- Tangibilization or materialization (e.g. reminders, stickers, reports)
- Transaction (e.g. reservation, ordering, payment)
- Problem solving (e.g. customer service, exchanges, refunds)
- Sales Effort (e.g. visits, expositions, merchandising)
- Service recovery (given that a failure has occurred)
- Advertisement or awareness
- Socialization
- Feedback

Figure 8 Service Interaction Purposes.

one or more of the five senses that also shape the attributes of each interaction. To illustrate, consider two situations of a person-to-machine interaction with the same purpose of exchanging information (account balances, for example). The customer may call a number and navigate through an automatic response system, or operate an automatic teller machine. In each case different menus of choices are made available and different senses are used — each interaction has a distinct set of attributes but the same purpose.

The interface may also have long-term, strategic importance to the business. It may make switching costs high enough to keep customers hooked up to the service provider's information systems, and it may also be used to keep customers aware of a service even when they do not have to interact with the service organization for a long period of time (e.g., major surgery, central heating repair, etc.). Blackman (1985) proposes the use of a series of short interactions to shape expectations, educate potential users, or remind customers of previous service experiences to avoid a situation in which 'the forgetting curve dooms a business to deal primarily with new customers.'

Service Offering

Service organizations frequently offer a menu of services and products, generally called 'service offering.' Examples are abundant: restaurants offer a set of dishes in their menus, hospitals specialized in certain health problems, and insurance companies offer policies with different coverage.

Gronroos (1987) argues that the 'basic service package' is a combination of core service, facilitating services, and supporting services. Core service is the primary purpose of the service company, whereas supporting and facilitating services complement the core service (e.g., reservation services in airlines) or make it more attractive (e.g., in-flight movies). Similarly, a service organization also has core products as well as supporting and facilitating products. Core products are those related with the primary competence of the company whereas supporting and facilitating products are tangibles that either help the consumption of the core products and services or make them more attractive.

When the service offering encompasses a portfolio of core products and core services, they may share supporting and facilitating products and services to achieve economies of scope. For example, a school may offer executive education programs together with undergraduate and graduate programs. Each program may have dedicated supporting and facilitating services as well as share them with the other programs.

The objective of explicitly considering the service offering as a component of the service architecture is to identify the core products and services of the company as well as the supporting and facilitating products and services that should be offered together. The determination of the offering generates specifications for other parts of the organization because each product and service requires that the organization have adequate capacity to respond properly to the corresponding demand — when the impact of adding new products or services to an existing service offering is overlooked, parts of the organization may become congested decreasing the overall service quality.

Since the service offering is crucial to position the company *vis-à-vis* its competition, its depth and breadth are typically decided based on marketing and strategic considerations. For example, companies may be able to reap economies of scale or scope by focusing their product and service offering. In the retail industry category killers offer a wide choice of products within a narrow market segment (e.g., office supplies, do-it-yourself, etc.). On the other side of the spectrum there are convenience stores that offer a large number of different products ranging from food to office supplies, but limited brand choice for each product.

The service offering is an important facet of the service concept, and as such must have its elements aligned with the service concept (it would not make much sense for example, to design a Chinese restaurant with a menu of French specialties). Innovations in the offering, however, have little patent protection. In spite of that, service firms can still impose barriers to imitation by using resources that cannot be traded either because their value is not well defined or because they are endogenous, specific to the firm (Dierickx and Cool, 1989).

Models and Principles

Modeling is a fundamental part of the design activity. In manufacturing, engineering models have traditionally been used to design new products. Since models are abstract representations of the system they seek to reproduce, they can be used for experimental investigation instead of the real system, at lower cost and less time. By constructing models and analyzing their behavior, designers can develop a better understanding of the real system and improve the design. Models can also help designers to assess tradeoffs among attributes of the system, predict future behavior, or understand unexpected interactions among components of the system.

In sciences such as Physics and Chemistry, there are fundamental principles that describe phenomena in the context of those sciences by means of equations.

In other sciences like Psychology, principles not stated through mathematical equations can nevertheless be used as building blocks for research in the field. No matter the format through which principles are expressed, they are the theoretical foundation over which models are built. The types of behaviors that can be represented by a model, therefore, are limited by the model's theoretical perspective. Moreover, the quality of the final design depends not only on the ability of designers to apply models to evaluate design decisions and carry out design refinements, but also on the quality of the available models (Hoover *et al.*, 1991).

When developing new models, designers use variables to represent cause and effect factors of real-world phenomena. Since the relationship among those variables are in general non-linear and complex, designers have to restrict the scope of their models so that they are complex enough to capture the desired behavior, but also simple enough that they do not become too cumbersome. The appropriate level of aggregation of a model must also be carefully considered. For example, it is certainly inappropriate to consider the individual behavior of molecules to model the (macro) behavior of a gas in a container — such a model would be too complex to be of any practical use. Still, the behavior of a gas is very predictable, and can be described by thermodynamic models. In the same line of reasoning, modeling human behavior at the individual level is sometimes inappropriate for design decisions.

"The forgetting curve dooms a business to deal primarily with new customers"

Observe that the design activity requires models that are able to reproduce as well as explain behavior in the system. The difficulty of building such models for service design is that human behavior is not as predictable as the behavior of physical objects under natural laws. Thus, few models and principles have been proposed that help assess tradeoffs for service design. Therefore, identifying what principles and models are appropriate for service design is an important first step to make possible their application. We try to do it in the sequel when we discuss some principles and types of models available in the literature, that may help service design.

Maister (1985) proposes a set of principles that describe the psychology of waiting. One of the principles, for example, states that unoccupied waiting feels longer than otherwise. The passage of time therefore has a psychological factor attached to it that must be considered in the design of services. Larson (1987) relates the psychology of waiting to customer satisfaction and queueing phenomena. He suggests desirable attributes of a service system, given that customers will have to wait for service. Taylor (1994) discusses the impact of delays on the customer's evaluation of the overall service for airlines. She reports that 'delays trigger a negative mood' in customers resulting in a 'negative-mood bias' in their evaluation of service. She finds consistent differences in the evaluation of service attributes (other than punctuality) between delayed and non-delayed passengers. See Figure 9 for a schematic of Taylor's model of the wait experience.

The psychology of waiting and its relationship with customer satisfaction provide a model to understand the behavior of customers subject to delays. Service designers should therefore use such model to design the service system accordingly. That is, given a theoretical foundation and corresponding models, designers can use the models to achieve better designs. In the case of possible delays, a service designer may either try to minimize the burden of waiting by entertaining, enlightening, and informing, or add capacity to the service facility. The difference between the two courses of action is in the models that must be used to support each. In the first case, the model is an attempt to represent the psychological mechanisms that operate in customers' minds while they wait. In the second case, the model must consider the physical structure of the service system, customer arrival and service rates, to provide an estimate of the appropriate capacity necessary to match demand and supply. In either case the analysis helps a better understanding of the set of attributes for the service interaction and the place where it occurs.

Mehrabian and Russell (1974) provide a set of principles that help understand human behavioral responses to stimuli from the physical environment. Supported by empirical findings, they argue that human response to the physical environment can be of either approach or avoidance, moderated by three emotional dimensions: pleasure–displeasure, arousal–non-arousal, and dominant–submissive. Bateson and Hui (1987) revise the Mehrabian–Russell model to consider dominance as antecedent of pleasure and arousal. They conclude that dominance and perceived control are 'closely associated theoretical constructs,' and directly correlate with pleasure. Crowding, for example, inversely correlates with pleasure and perceived control, and directly correlates with arousal. They conclude that negative responses caused by loss of control due to crowding can be minimized by returning some control to the customer. A greater degree of choice (for example, choice about where to wait for a long job) can lower the customer's 'perceived crowding' and consequently improve customer satisfaction.

Donovan and Rossiter (1994) use the Mehrabian–Russell model to understand the effects of store environ-

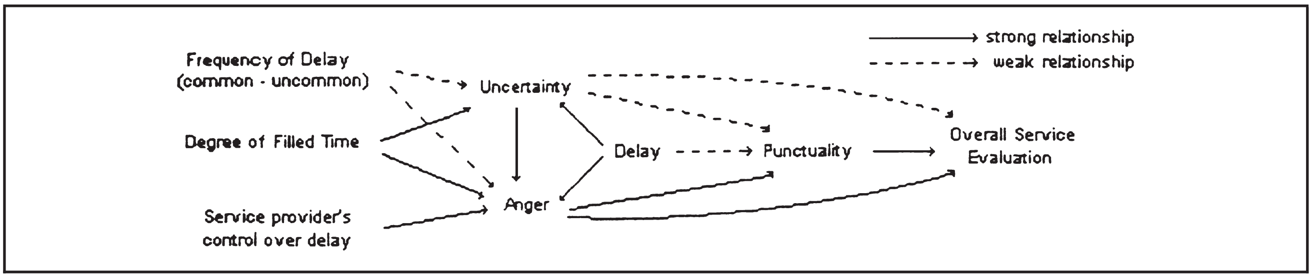


Figure 9 Taylor's Model of the Wait Experience.

ment on shopping behavior and patronage. They argue that pleasure and arousal interact with each other in such a way that arousal intensifies pleasure or displeasure reactions. Moreover, although cognitive factors (e.g., location, price — quality of merchandise, variety) largely account for store selection and planned purchases, emotional affect and store-induced pleasure are important determinants of behavior within the store (e.g., time, affiliation, and spending behavior). They advocate the use of experimentation to determine which specific types of in-store stimuli (e.g., color arrangement, layouts, noise levels, lighting) evoke desired emotional responses. That is the reason why prototyping and testing may also be so important in services.

Wener (1985) discusses the effect of disorientation on customers and employees. He argues that disorientation may be the result of lack of previous experience, confusing designs, and lack or misplacement of orientation aids. Lack of previous experience or familiarity with the service setting is also related to lack of control, which also leads to increased stress, perceived crowding, or other negative responses. That is one of the reasons why fast food restaurants and other service firms look so similar from the outside. Customers start to buy a service even before entering the facility, and feel more comfortable in a familiar environment. This model is certainly useful in the design of the external organization, as discussed in the architecture of services.

It is now easy to understand the mechanisms behind the rule of thumb of entertaining and informing the customer. By doing so, a service company is generating pleasant stimuli or providing more control to customers, which in turn translates into positive service experiences, and by association into a positive view of the firm.

Somewhat related to perceived control is the issue of risk in the consumption of services. Guseman (1981) argues that services are generally perceived to be riskier because of their inherent intangibility, heterogeneity in quality, and fuzzy quality standards. While a faulty product can be promptly returned, services often cannot, particularly those with high degree of intangibility (e.g., art performances, professional services). The risks associated with the purchase of a product are discussed by Roselius (1971) in terms of four types of losses: time, hazard, ego, and money losses. In the purchase of a product or service customers try to employ (consciously or not) risk reduction methods that are different whether it is a product or service. Guseman (1981) concludes that customers are more prone to rely on word-of-mouth, and on tangible factors such as appearance and location of buildings, internal design of facilities, and appearance and demeanor of employees as a surrogate of service quality (or risk reduction method). He suggests that service guarantees can be offered to shift some control to customers and reduce the perceived risk associated with purchase of services.

The principles and models discussed so far represent possible psychological mechanisms that explain particular individual behaviors in service settings. They establish simple direct relationships that can be observed in real settings. There are models however that seek to reproduce (and explain) more complex behaviors with time delays and feedback loops. They are represented by causal-loop diagrams and system dynamics models that map relationships of cause and effect in a service system (refer to Forrester (1961) for a good exposition on System Dynamics).

System Dynamics models are useful in the design of service systems because they allow a better understanding of how intangible variables (e.g., frustration, fatigue, excitement) affect behavior of human participants in the service setting, and ultimately its quality. By employing them, service designers can build into the service system mechanisms that minimize undesirable effects, or maximize desirable effects. For example, once companies understood that entertaining customers makes them more comfortable about waiting, several firms installed televisions in their waiting rooms.

Schlesinger and Heskett's Cycle of Failures Model is a causal-loop diagram which shows how problems traditionally regarded as exogenous to the service system are in fact structurally embedded in its design (Schlesinger and Heskett, 1991). Pue (1996) uses a system dynamics model to simulate the effects of management policies in a service setting. He investigates (among other relationships) the effects of lack of service capacity on work pressure, employee turnover and customer satisfaction to propose a dynamic model of service quality. Finally, Senge and Sterman

(1992) report a case study of applying system dynamic models for improving quality and cost performance in the insurance industry.

Another class of models that may be used in service design is operations research models. Since a large number of references is available in the literature, we cite just a few for the sake of brevity. Generally, their use in the context of service design address two basic types of problems: performance evaluation and optimization. Performance evaluation problems either estimate the capacity necessary to achieve a target performance level, or estimate performance given a target capacity level. Ittig (1994), for example, investigates the impact of having demand as a function of average waiting times in designing the number of check-out counters of a supermarket; Sze (1984) describes a telephone operator system through a queueing model to predict average delays; and Albin (1990) uses a queueing network model to analyze the causes of delays in a health center appointment clinic. Optimization problems try to maximize some performance measure at the appropriate planning level (strategic, tactical or operational). Bitran and Mondschein (1995), for example, propose a model for dynamically determining optimal allocation of hotel rooms, subject to the current occupancy, reservations, and expected demand.

The research cited above shows that with the appropriate theoretical base and modeling techniques it is possible to approach the design of services from a modeling perspective. In fact, much of the knowledge incorporated in the models discussed in this section has already been used in practice by leading service organizations. Models allow a systematization of this knowledge by expressing it in a format that is simpler to learn and to apply.

Conclusion and Future Research

The literature on product development encompasses several frameworks that deal with different aspects of the problem. We attempted to integrate the various contributions in the course of this paper and discussed them from a service perspective.

Similarly to the concept of design for manufacturability (see Whitney, 1988), in services there is the need of designing for reproducibility. When a service company plans to expand domestically or internationally, reproducibility of the service concept becomes a fundamental attribute in creating a company identity, reducing costs, and ensuring quality. The challenge is to design a service system for reproducibility but with flexibility to recognize and adapt to differences in culture, legal systems, regulations, and local infrastructure, among other factors. How the development effort should accommodate this requirement is an important topic for future research.

The discussion of methods and models available for product development indicates the inability of some models to support certain aspects of service development. For example, it would be desirable to develop models that address in greater depth the connection between tangible design variables (capacity, location, etc.) and intangible ones such as customer satisfaction and customer retention, among other variables. It would also be desirable to develop appropriate metrics that enable the translation of intangible attributes into specifications that can be used for service design.

In order to illustrate the notion of architecture in services, we introduced in Figure 7 a service operation structure with components that we believe are pervasive to most service companies. It is sometimes possible, however, to describe the service system in different ways (e.g., through functions and processes) that may provide different insights and enrich the development effort. A study of alternative representations of service systems is a topic that requires further research. It may help designers understand, among other issues, how design decisions freeze parts of the final design and drive the search for solutions in the development effort.

Finally, this paper has attempted to show that methods available for product development can be very useful in service design when complemented to consider specific service characteristics. However, as in the case of any methodology, it must be adapted to the particular needs of each company. Not all steps and methods should be applied in the development of every service. Trying to do so can be cumbersome and may slow down the development process.

Acknowledgements

This work was partially supported by the Brazilian Department of Education — CAPES Foundation Grant #125-92/2. The authors would like to thank Julio Gomes, Prof. Rogelio Oliva, Prof. Steve Eppinger, and Prof. Richard Chase for their valuable contributions and references.

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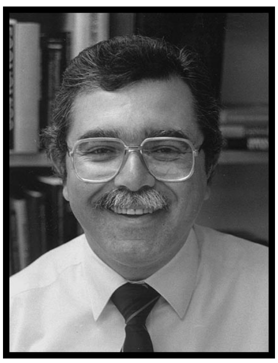

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