New competitive strategies: Challenges to organizations and information technology

by A. C. Boynton
B. Victor
B. J. Pine II

The old competitive strategies of invention and mass production no longer work in an increasingly turbulent business environment. Successful firms are implementing the new competitive strategies of continuous improvement (constant process improvement) and mass customization—a dynamic flow of goods and services via a stable set of processes. This paper provides a "lens" through which managers can assess their firm's current competitive position, build a vision for where they must be in the future, and craft a transformation strategy to turn that future vision into reality.

How to succeed in today's rapidly changing competitive environment is a question weighing heavily on many a manager's mind. Everything seems to be changing—markets, customer demands, technologies, global boundaries, products, and processes. In the midst of this seemingly overwhelming change, managers are being asked to make critical competitive decisions that will affect not only the present position of their firm (the legal or competitive entity), but also its future success.

Much to their dismay, however, many managers are finding out, sometimes the hard way, that it is a different game, and the old rules do not apply anymore. To compete in today's rapidly changing competitive environment, new strategic responses are required that most managers may have never thought possible. In addition, managers must understand that at the heart of these new strategic responses is innovative management through advanced information technologies.

This paper begins by briefly discussing two firms that have developed innovative strategies to cope with our changing world. Based on their experience and other research cited, the paper then develops a framework of understanding, called the product-process change matrix, that managers can use as a "lens" to decipher and understand some of the most important challenges facing their firms. We then discuss the range of strategic choices managers must make in the face of their firms' particular changing environments. Managers must decide exactly how their firms will compete, given a specific combination of market demands and changing process capabilities and technologies available. We explore the challenges of designing the appropriate organization, given a specific strategy. We argue that all elements of the design, including process capabilities, control systems, award systems, information systems, culture, and personnel, must be strategically aligned with one another. With the changed conditions facing the firm and its chosen strategy, this is necessary to provide the capabilities required to achieve competitive advantage. It is our contention that the effective and innovative use of information technology is at the heart of the new organizational designs and capabilities required to meet current competitive challenges.

Experience of firms studied

Consider the recent experiences of two banking firms, Westpac Banking Corp. and Citibank N.A. (the banking business of Citicorp), that have similar industry settings but are facing different market conditions. Both firms use information technology to drive very different strategic responses.

For decades Westpac, a South Pacific financial services conglomerate, had comfortably dominated Australia's banking marketplace. Markets were stable, products known, and competition minimal. All that changed suddenly in the early 1980s as the marketplace was rapidly deregulated, and new competitors quickly moved in. Westpac's world was turned upside down. Customers were demanding faster product-to-market time, new product introduction, increased product variety, and more competitive pricing. To make matters worse, Westpac's information systems, which were engineered for relative stability and market conformity, were unable to cope with rapid product change. In response to the situation, Westpac made a critical strategic choice. Instead of continuing to compete on their stability and known products, they began to compete on *product differentiation.* That is, Westpac would engage in continuous invention of custom-tailored financial products. However, rather than listening to the old wisdom that product or service differentiation could be achieved only through constantly changing organizational structure and systems, Westpac decided to drive innovation from a stable base of technological processes. To do this they decided to create a completely new systems development and operational environment. Dubbed the CS90 (Core System for the 1990s), this would be a long-term, flexible information system to allow Westpac to consolidate everything it knows about the processes and expertise required to create new financial products into a set of highly flexible software modules. The intended result would be a flexible, innovative, and efficient product factory. Through the innovative use of information technology (I/T), Westpac has set out to break the old rules of competition by striving to become a low-cost product innovator. This would be a strategy in response to changing market conditions, driven by the capabilities provided through advanced information technology.

While Westpac faced rapid product and service proliferation, Citibank's U.S. Card Product Group (CPG), formally known as Citicorp Credit Services of Maryland, faced somewhat opposite competitive conditions. In the early 1990s, Citibank's CPG was positioned as one of the largest and most profitable issuers of multipurpose credit cards in the world. Although market competition was heavy, CPG had a well-defined, single-product focus in its credit card service, with a clear, long-term strategy to become "the best way to pay." The CPG goal was to offer extremely efficient, low-cost, high-quality service to its credit card holders. To achieve this goal, conventional wisdom would have suggested that CPG compete by designing and building a set of long-term, stable, and highly efficient process capabilities. It would also be wise to avoid frequent process or technological changes that would threaten efficiencies and quality. However, CPG chose to go against conventional wisdom. Believing that the key to present and future success in the credit card business lay in responsive service and continuous quality enhancement, CPG engaged in ongoing process improvement and transformation of its I/T capabilities. Rumored to be one of the largest private investors in information technology in the world, CPG acquired large-scale image processing (which reduced paperwork and data-entry requirements by integrating the payment, address-change, and check-processing functions). This system also integrated CitiNet** (CPG's proprietary merchant-authorization network) and its own satellite communications network. The latter network freed CPG from reliance upon use of a third-party network, and it improved CPG's control and service opportunities at the point of sale. By pursuing this innovative strategy, CPG put itself in a position to transform processes almost continuously without sacrificing efficiency, service quality, or service innovation. For Citibank's CPG, the capability to change and enhance core I/T capabilities has allowed it to provide the highest-quality, lowest-cost credit card service in the world.

There is much to be learned from the experiences of these two firms. Through three years of in-depth field research of a number of leading organizations such as Westpac, Citibank, and many others, we have witnessed a wide variety of firms from many different industries responding to the competitive environment of today by turning to new strategic responses that are based on innovative I/T systems and solutions.[1] On the one hand, some firms are choosing a strategy of low-cost product or service customization and invention. We call this strategy *mass customization*. Westpac's strategy of product customization and invention is being pursued through a strategy of process stability. This strategy seeks to build a stable set of core I/T process capabilities that are stable in the long term, but that are flexible, generic, and modular.

On the other hand, there are firms that appear to be pursuing a strategy of continually innovating process capabilities. At the same time these firms compete on price with standardized products in large, mature markets. We call this strategy *continuous improvement*. CPG pursued a strategy of low-cost, high-quality service for a well-defined, stable product by the continual transformation of core I/T process capabilities. The objective here is to pursue constant innovation within its I/T process platform and at the same time create the most efficient, highest-quality operations in the world.

There are implications for managers who would pursue such competitive strategies as these. We have found that each of these strategies requires new ways of thinking on the part of managers, not only about harnessing the power of I/T resources, but also about change, competition, and designing organizations. As the experiences of managers at Citibank and Westpac point out, turning to I/T as a strategic resource is essential for success in the new competitive environment. Before firms turn to I/T, however, managers must ask and answer a set of basic but critical questions about their firms' specific competitive environments and the nature of potential product and process changes. It is not enough for managers to declare, "everything is changing and so must my firm." Managers must also understand how and why everything is changing before making decisions about how their firms should adapt. It is our contention that understanding the nature of change is at the heart of organizational design and the alignment of I/T with a firm's strategic response.[2]

Product-process change matrix: A lens of understanding

In recent years, change in the competitive environment has threatened the existence of many firms. Change is often at the heart of strategic decisions about what type of organization to design. Recognition of this fact is an important first step for managers in understanding how very different the new competitive strategies are from those of the past. Although change can be understood in a variety of ways, change in the present competitive environment may be understood best by means of what we call the *product-process change matrix.*

As its name implies, there are two broad categories of change in this matrix. *Product change* involves the demands for new products or services. The changes firms face in their markets because of competitor moves, shifting customer preferences, or entering new geographical or national markets are categorized as product changes. *Process change* involves the procedures and technologies used to produce or deliver products or services. The term *process*, as it is used here, refers broadly to all the organizational capabilities resulting from people, systems, technologies, and procedures that are used to develop, produce, market, and deliver products or services.

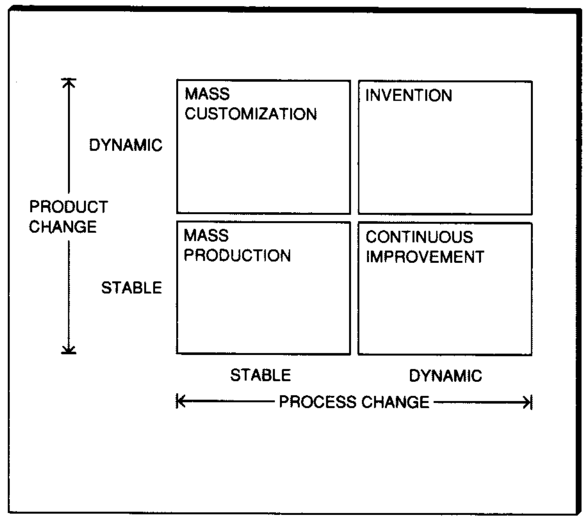
These two types of change can be either stable or dynamic. *Stable change* is slow, evolutionary, and generally predictable. *Dynamic change* is rapid, revolutionary, and generally unpredictable.[3] Taken together, these types of change provide the following four possible combinations of change conditions that can confront an organization, as illustrated in Figure 1:

- Stable product and process change
- Dynamic product and process change
- Stable product and dynamic process change
- Dynamic product and stable process change

Although the product-process change matrix is relatively straightforward, we note three points. For one thing, an understanding of the specific product and process types for which a firm has been designed and an understanding of how changing conditions require new strategies and organizational designs can help managers position their firms for competitive success. It is also important that managers understand that product and process change can be independent of one another and have different effects on the strategic options available to the firm. These changes can also affect the core capabilities and organizational designs required for success. For example, a firm may face market conditions that are changing moment by moment, but still may position itself to build relatively stable process capabilities that are flexible enough to respond to this dynamic product change. Finally, for each combination of change conditions, the managers and their firms approach the design and management of structure, I/T, and strategy quite differently.[4] In the cases of Westpac and Citibank, different change conditions resulted in critically important but different roles for I/T.

In short, the product-process change matrix serves as a valuable lens through which managers can: (1) assess their competitive position by understanding where their firms have been in the past; (2) build a vision of where their firms must be in the future; and (3) create a transformation strategy to turn that vision into reality. Through this three-step process, managers can align the strategic requirements within their firms with the advanced I/T capabilities that are increasing the competitive success of firms that use it.

Figure 1 Product-process change matrix



The old competitive strategies: Mass production and invention

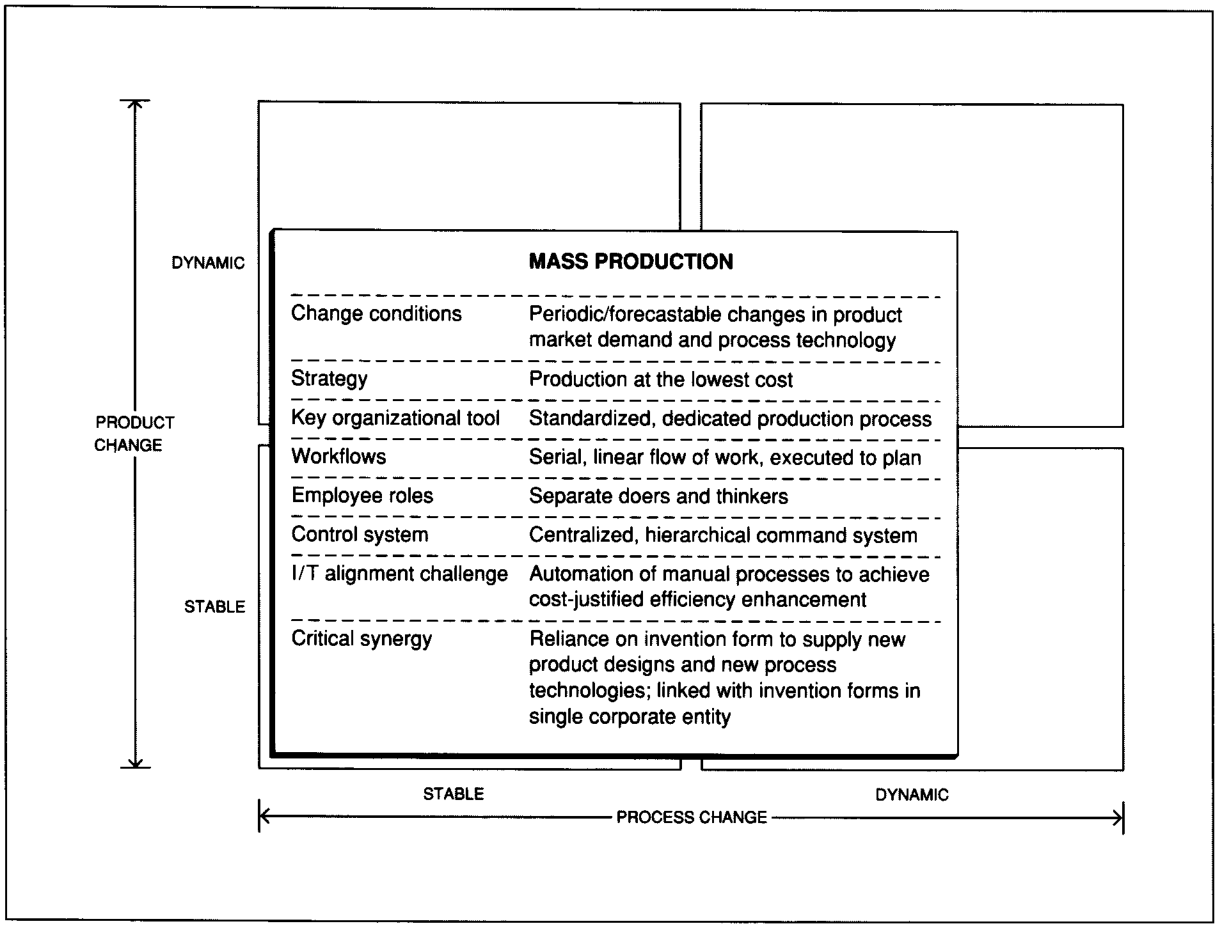
We turn now to an in-depth look at each of the four quadrants on the product-process change matrix. We begin with the two quadrants *mass production* and *invention*, which represent what we call the old competitive strategy.

Mass production: Stable product and process change. Throughout this century most large companies have competed under conditions of *stable product* and *stable process change*. Under these conditions, product specifications and demand are relatively stable and predictable. This permits a firm to standardize products, centralize decision making, routinize work and reward, develop and enforce standard rules and procedures, and allocate work to dedicated, specialized jobs. These are the elements of the mass production of goods and services.[5] Figure 2 describes organizational characteristics of mass production, also called "Fordism," after Henry Ford.

The mass-production design is often a large, hierarchical, vertically integrated organization. Information systems, in this case, tend to resemble the rest of the firm. People have used the metaphor of vertical stovepipes and silos for these information systems. They are efficient for the long term but are not very flexible.[6] Strategy and command are isolated from the work itself in management control units.[7] Maximum efficiency is achieved by dedicating the capital and human assets of the firm to the production of standardized goods or services.[8] Competitive advantage and profitability are founded on reduction of unit costs.

Change in either process or product works against the mass-production formula. Changes in product make machinery obsolete, force costly changeovers, and reduce managerial control. Changes in process complicate individual jobs, raise waste and error, and increase unit costs. Thus a mass-production organization is intended to respond to and initiate as little change as possible.[9] This design for stability requires limiting product variety, as illustrated by Ford's promise to deliver a car painted any color the customer desired, as long as it was black. Mass production also requires limiting process innovation. For example, E. I. Du Pont de Nemours & Co. (Du Pont) managers used to classify production lines into those that had been standardized, and those yet to be standardized.

Figure 2 Product-process change matrix

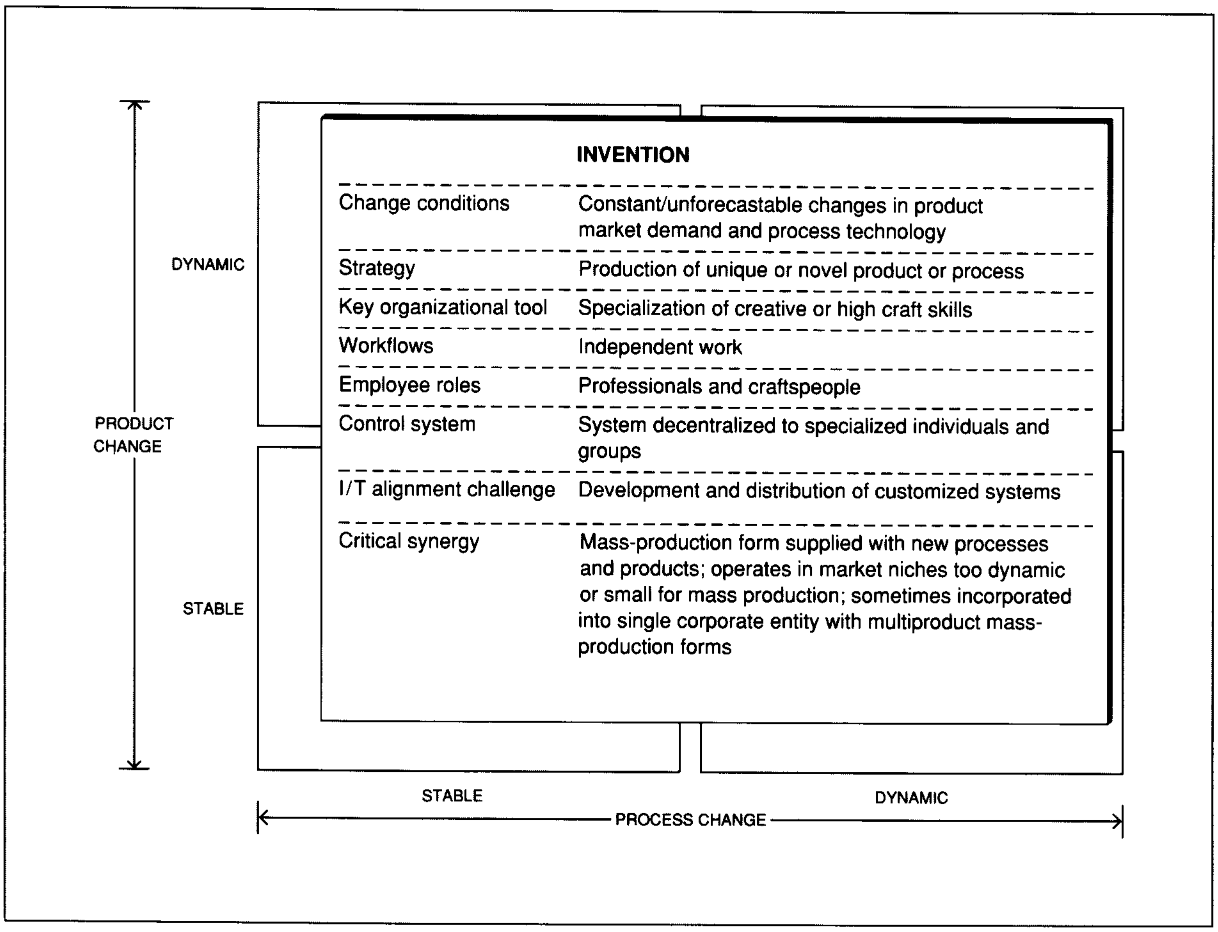


The role of information technology in mass production is relatively well understood. In the mass-production design, *I/T alignment* means the building and running of information systems that efficiently perform routine tasks. By substituting for previously manual processes, I/T has lowered costs, increased reliability, and reduced waste.

For nearly a century, the mass-production organization has clearly demonstrated its effectiveness under conditions where change is limited. However, mass production has never been able to eliminate completely the need for change. Shifting markets, intensifying competition, and advancing technologies have always forced it.[10] A distinct organizational design fills this need.

Invention: Dynamic product and process change. Another organizational design in our matrix is labeled invention, but is also known as organic or job-shop design. This design arose to take advantage of conditions involving both dynamic process and product change. Consider the basic characteristics of the invention design. In contrast to the large scale and stability of a mass-production organization, the invention design creates small volumes of new products, while constantly innovating the processes required to develop and produce them.[11] To take advantage of the possibilities of change, workers in invention organizations are assumed to require a wide degree of latitude in the exploration of new ideas, highly skilled jobs, and little responsibility for the costs of pro-

Figure 3 Product-process change matrix

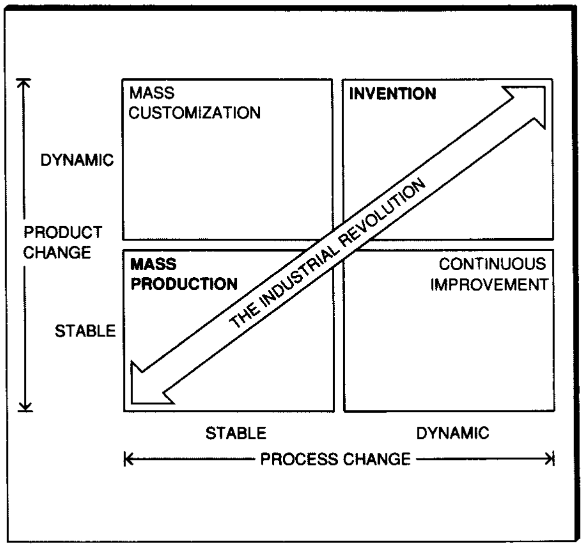


duction. These organizations often are separate research and development units within mass-production organizations. Indeed, the prototypical invention design organization is a research organization like AT&T Bell Laboratories. See Figure 3 for a description of organizational characteristics for invention.

Unlike the mass-production design that seeks stability, the invention design is inherently organized for change. The reason is that product specifications and work processes are unpredictable and constantly shifting. To compete under invention conditions, firms decentralize decision making, define jobs broadly, develop few rules or procedures, and evaluate performance subjectively. Information technology and systems are often distributed throughout the organization, perhaps in a loosely coupled structure, but flexible and adaptable to differing and changing requirements.[12] The role of I/T in an invention-oriented organization is to provide specialized and independent information-processing capabilities to support the creative process.[13]

In keeping with their organic designs, the innovative firms are generally smaller in size to ensure focus on product variety and process innovation. In such an environment, investments in product-specific process capabilities are high risk because dynamic change renders structures, systems, and know-how rapidly obsolete. For example, National Starch and Chemical Company, maker of a variety of adhesive products, is a firm that com-

Figure 4 The old competitive reality



petes through invention by creating new and revolutionary products. This requires continuous investments in changing process capabilities. National Starch has chosen a strategy of relying on product variety and process innovation and can charge a premium for its products. This premium offsets the cost of constant changes to process capabilities required to support ongoing product invention. National Starch thus competes under conditions of both dynamic product and dynamic process change.

Synergy between mass production and invention. The product-process change matrix shows that the mass-production and invention designs and conditions are at opposite ends of the spectrum with respect to product and process change. In particular, mass production focuses on building an organization capable of competing under conditions of stable product and process change, whereas the world of invention is characterized by innovative processes and a widening demand for product variety. Even with these differences, a critical synergy grows between the mass-production design and the invention design. Their synergy has roots in the nineteenth century Industrial Revolution.[14] (See Figure 4.)

Although the mass-production firm is designed to respond to and initiate as little change as possible, occasionally it needs to retool completely new processes for completely new products. However, not only is the mass-production organizational design incapable of creating new and specialized products and processes, it is also seen as undesirable to use the mass-production organizational design even to try to create change. Thus it falls to the invention design to supply new products and processes for the mass producer. In effect, the mass-production design creates a demand for highly specialized and innovative process capabilities that only research and development organizations, specialized machinery makers, and other invention designs can fill.

This working synergy between the two types of designs is based on the unique capabilities of each type. Such a synergy also requires an effective allocation of the product market and product life cycle.[15] Invention designs reap premiums for their innovativeness during the emergence and early growth stages of the product life cycle. However, once a dominant product design has emerged and a market of sufficient size has developed, the mass producer takes over. The entry of the mass producer signals the beginning of the end of the competitive advantage of the invention design. If it is competing on innovativeness and variety, but not cost, the invention firm is eventually priced out of the market.[16]

For example, when competitors come in and imitate National Starch's product advances and begin to drive the cost down, National Starch abandons that particular product market and invents new product opportunities with another wave of process innovation. Premium prices are again possible, because customers value the new streams of invention. In those market niches that are neither stable nor large enough to create mass-production conditions, the invention firm is able to continue to compete on its differentiation advantage and charge higher prices for products. Whatever the specific situation, what is critical to understand is that there remains a steady symbiotic relationship between the mass-production design and the invention design.

The new competitive strategies: Mass customization and continuous improvement

Although mass production and invention have been the predominant forms of competition during the 20th century, we see this beginning to change. Many firms are facing neither simultaneous dynamic-dynamic change (in which high costs of process innovation are supported because premium prices are available from the continuous product innovation), nor simultaneous stable-stable change (where the focus is on building stable, efficient processes in response to predictable product demands). Instead, these designs are facing a whole new and different set of post-Fordist conditions, marked by different characteristics and qualities of change: stable product and dynamic process change, or dynamic product and stable process change. (See the Appendix for a discussion of this post-Fordist debate.)

Customers are increasingly making unique and unpredictable product demands.

Organizations competing under these new conditions of change are essentially operating in ways that contradict the old assumptions about competition.[17] For example, firms such as Westpac, Bally Engineered Structures, Inc., ABB Asea Brown Boveri Ltd., Corning Incorporated's Telecommunication Sector, and United Services Automobile Association (USAA) are now competing on product or service customization, without abandoning a cost advantage. Firms such as Citibank's CPG and IBM are frequently and significantly improving process quality, speed, and flexibility, without incurring crippling cost burdens.

We believe these firms and others like them are competing on new terms by designing organizations in new ways. What is emerging is not a single new organizational design, however, but two new designs, each of which is adapting to different rates of process and product change conditions. Each design brings with it competitive advantage through that adaptation. Our research has found that information technology is often the driving force that leads to competitive advantage for these new organizational designs. Just as a synergy existed between the mass-production and invention designs, a new synergy is developing between the new designs. This synergy may become the defining basis of competition into the next century.

Mass customization: Dynamic product change, stable process change. The first of these new designs competes under *dynamic product change* and *stable process change.* On the one hand, organizations across a variety of industries agree that customers are increasingly making unique and unpredictable product demands. Customers want the product or service that is right for them, and they want it now. As new competitors arrive and customer preferences change, predicting customer demand and articulating product specifications is becoming more difficult than ever. These are clearly conditions of dynamic product change.

On the other hand, these organizations also report that the basic processes their companies are instituting to meet these demands are more, not less, stable. The rapid and unpredictable process technology changes that the organization first experiences soon evolve into recognizable patterns. These patterns allow the organization to build stable but flexible platforms of process capabilities or know-how over time. As a result, organizations are able to improve process capabilities and know-how incrementally on a continuing basis. This increases the organization's base of knowledge, while continuing to increase process efficiencies. These are clearly conditions of stable process change.

If this scenario of dynamic product and stable process change, as noted on the product-process change matrix, is one of the realities of today's competitive environment (and our research tells us many leading organizations believe it is), many of today's companies need to be organized and managed not for mass production or invention, but for *mass customization.*[18] Mass customization is the ability to serve a wide range of customers and meet changing product demands through service or product variety and innovation. Simultaneously, mass customization builds on existing long-term process experience and knowledge. The result is increased efficiencies.

Consider our opening example of Westpac as an illustration of a firm responding to change by using I/T to become a mass customizer. As mentioned earlier, the Westpac marketplace was rapidly and irreversibly deregulated. New licenses were issued to foreign banks, new local banks were created, and the regulatory structure of banking products was largely dismantled. Suddenly the product and service market had changed radically. These things greatly concerned Westpac management.

On the surface, the key threat was *segment competition*. This meant that niche competitors could erode Westpac's profitable business by offering new specialty products with lower prices and superior service. Perhaps more worrisome was the fear that Westpac's information systems, which had been engineered for relative stability and market conformity, would not be able to respond to change quickly, flexibly, and efficiently.

The solution to the situation was not clear. Westpac had to compete in an environment of unpredictable market change and product demand. Thus it seemed that Westpac had either to remain a mass producer and improve on efficiencies and quality or to shift its competitive base. That is, shift from mass production based on specialized and stable process capabilities, rigid controls, and hierarchical structures geared toward low-cost mass production to a competitive base of invention based on flexible process capabilities, adaptable controls, and fluid structures. This alternative would be geared toward differentiation and continuous invention. Westpac management had the foresight to realize that, in the new competitive strategy, it could accomplish rapid product introduction and flexible response from a stable process base. Such a base could provide both efficiency and learning over the long term. In short, Westpac realized it could have simultaneously the product variety of an invention firm and the efficiencies of a mass producer.

Determined to remain at the top of the industry, Westpac managers ignored conventional wisdom and sought out a new wisdom. They sought a path that could flexibly accommodate change without sacrificing the learning and efficiencies gained by harnessing the large-scale know-how, capabilities, and identity of the organization. Their solution was to create a completely new systems development and operational environment. This would be the core system that would drive their vision for the 1990s and beyond.

This long-term yet flexible information system became known as the CS90. The system was designed so Westpac could consolidate everything it knew about the processes and expertise required to create new financial products into a set of highly flexible software modules. The result would be a flexible and efficient product factory. This factory would draw heavily upon expert systems and advanced software engineering that would combine different bits of knowledge quickly and at low cost, in response to changing product and service demands.

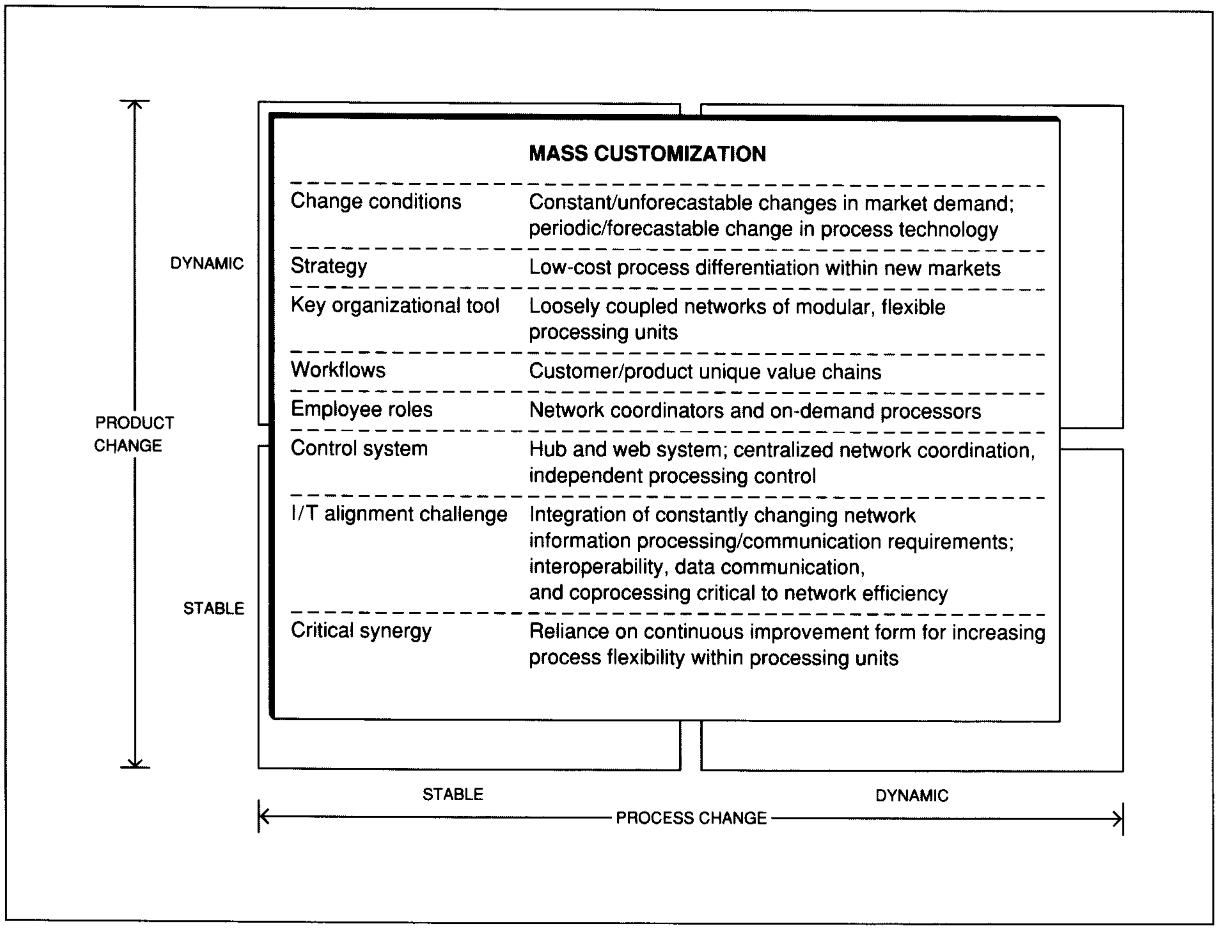
This system was designed with four competitive objectives in mind:

- *Productivity*. Reduce the costs of creating new and varied products by establishing a stable, efficient platform of capabilities.
- *Flexibility*. Create product systems that can handle a greater variety and range of customer and marketplace needs.
- *Responsiveness*. Improve timeliness of its response to market changes by both business and information systems staff.
- *Reusability*. Create a system of elements that can be combined and recombined across changing products and markets.

Thus, Westpac was preparing to respond rapidly to market change by combining and recombining organizational knowledge. This involved combining knowledge of financial product construction and distribution simply by tapping into its flexible product factory. Before this system, Westpac had to start from scratch each time and build a different information system for each different product. As mentioned earlier, information systems were on the critical path for all new product introductions and were the major contributor to decreases in product time-to-market. Systems had previously taken a long time to build and product introductions seemed always to be behind market requirements. With market change becoming more turbulent, slow system development threatened to cripple any competitive response based on new product introductions.

The strategic path Westpac has chosen is an ambitious and costly one that has encountered formidable obstacles. Westpac is said to have spent nearly $200 million toward CS90. Despite the odds, Westpac management believes it is pursuing the correct strategy. Faced with dramatic

Figure 5 Product-process change matrix



market change, Westpac made the strategic choice to remain a global leader in financial products. Their management believes it is the right decision to drive innovation from stability and simultaneously achieve differentiation and low cost. Westpac's understanding of its product and process competitive environment and the critical role that I/T can play in forging new strategic responses is representative of what our research has found for many firms attempting to create strategies based on mass customization.

Characteristics of the mass-customization design. We now take a closer look at the organizational design required to provide firms with mass-customization capabilities. The major distinguishing characteristic of the mass-customization design is its capacity to produce product variety rapidly and inexpensively. In direct contradiction of the assumption that cost and variety are tradeoffs, mass customizers organize for efficient flexibility. A number of fundamental elements of these tradeoffs can also be identified, including process structure, decision-making structure, and organization of labor. Figure 5 gives a description of the characteristics of the mass-customization design.

One of the keys to mass customization is what might be labeled the network structure. The network structure in the mass-customization organization is a system of material or information flows between generic, reusable, flexible, modular units. It is important to understand that these units can be people, teams, software components, or manufacturing devices, depending on the critical resources employed by the firm. Whatever the combination of units, they must be loosely coupled. That is, they are not pre-engineered or prealigned for some known end product.[19] The network structure, when implemented, permits a unique combination of processing steps for any customer order. By engineering the flexibility of the processing units and coordinating the flow of materials or service needs between units, the mass customizer can produce virtually an infinite variety of products at costs competitive with the mass producer.[20] In the Westpac example, I/T was the driving force in the network structure that combined elements of knowledge essential in creating new financial products. For other firms, I/T plays a pivotal role in combining people in ways that meet the demands for mass customization.

Compare this network structure with the design requirements for mass production. Mass producers assume that change in product specifications introduces higher costs. They assume that change requires resetting production processes, relearning production tasks, and coordinating fluctuations in supply and processing requirements. I/T is used for single products and services that are designed to last for the long run. People are trained and specialized in known and long-term product or service needs. Today's mass customizer defies this old logic by organizing and engineering both the processes and the connections between processes for low-cost flexibility.[21] Instead of building a single-product, large-volume focused production process, the mass customizer builds a dynamic network of potentially infinite numbers of interchangeable and intercompatible individual unit production processes.[22] Thus, the challenge of alignment in the dynamic network environment of the mass-customization design is to make the unpredictable combinations of processing units function both seamlessly and efficiently.

Consider Bally Engineered Structures, Inc., of Bally, Pennsylvania. Established in 1933 as a custom-engineering and job shop manufacturer of building structures, by the 1970s the firm's industry had matured and price competition had become the dominant way of doing business. Customer orders had become subject to standardized product lines and standardized manufacturing processes. When Tom Pietrocini joined the company in 1983 as president, he found an ordinary mass-production company. Industry demand was shrinking, slowly eroding Bally's profitability. Pietrocini decided that a radical change was needed. He wanted to differentiate Bally's product again to meet more closely individual customer demands. This was a strategy similar to that which Bally had taken in its early days as a job shop. This time around, however, the customization strategy would be pursued differently. Bally would customize and remain cost competitive by employing information technology, work redesign, and flexible processes.

The mass customizer organizes and engineers both the processes and the connections between processes for low-cost flexibility.

Pietrocini's vision was to have all the manufacturing and administrative processes integrated by the information available on the computer. To him, the challenge in manufacturing was to transform data into information and then apply it to the workplace. Rather than simply automating the existing processes as mass-production designs have done with computers, Bally used its computer systems to completely re-engineer administrative processes. Particular attention was paid to reducing cycle time, eliminating waste, and providing more customization. Since 1983, this has resulted in more than a tenfold increase in Bally's envelope of variety. Bally now mass customizes a wide variety of structures, including walk-in coolers, freezers, insulated outdoor rooms, cold-storage buildings, and blast chillers. The company's modularized and modifiable panels and accessories can be put together in a virtually limitless number of ways to meet the needs of individual customers.

To support Bally's mass-customization strategy, the sales and ordering processes were completely redesigned. In the old system, each order changed an average of 2.5 times before the panels were finally manufactured. Because of the complexity of the structures under the old system, this would entail 86 distinct steps all done serially and would take up to two and a half weeks. That is to say, for a structure that in the end required only four days of manufacturing time, as much as five to seven weeks would be spent in processing change orders.

Using artificial intelligence software available on their IBM Application System/400*, Bally was able to capture the decision rules of its configuration experts, eliminate all the usual checking and rechecking, and reduce the number of steps each order change required. Today this process takes 56 mostly parallel steps, including feeding the new configuration directly into a computer-aided design (CAD) system. All this is almost always done in less than four hours. The CAD system automatically generates a drawing that can be sent via fax directly to a sales representative in the customer's office for verification. The system then feeds all the data to the manufacturing software to generate the bills of material for manufacturing. Pietrocini says that this process improvement "changes the whole dynamics of selling in this industry," allowing Bally to design custom structures essentially while the customer waits.

This move to re-engineer and align I/T systems has allowed Bally to transform itself incrementally over a long period of time. Bally began as an invention firm, evolved to a mass-production firm, and, through the vision of Pietrocini, has been transformed into a mass-customization firm. Bally is now able to take advantage of the synergy between continuous improvement and mass customization as the firm both customizes its products and services and periodically develops robust new processes for efficient flexibility. Bally's products command a 5 to 8 percent premium in the marketplace, and it can manufacture more customized structures and deliver them two to four times faster than competitors' more standardized versions. Like Westpac and Citibank's CPG, Bally is an example of a firm using I/T to drive its strategic response in a rapidly changing world. It is also an example of a firm that has realized that it must first answer important questions about the competitive conditions it faces.

It is important to understand that in some ways the mass-customization organizational design resembles the mass producer. There is a high degree of centralization in both designs. In the case of the mass customizer, coordination and control are centralized in the hub of a web of loosely linked processing units.[23] The central decision-making function allocates the work necessary to produce the customer's product or service order. For Bally and Westpac, the central control is provided through I/T platforms designed to drive efficient flexibility in product and service creation.

We see that this central control is also critical for firms that attempt to provide local (customized) response in individual countries and achieve mass capabilities on a worldwide basis. A powerful example of a central decision-making unit that is coupling loosely linked organizational units to form a competitive global giant can be found in Asea Brown Boveri (ABB).[24] The result of a merger in 1988 between two companies, Asea of Sweden and Brown Boveri of Switzerland, ABB is one of the most complex organizations in the world. It views itself as a federation of national companies that must respond to local needs. At the same time, ABB must be globally coordinated to take advantage of knowledge and process capabilities that exist throughout its worldwide operations. ABB generates more than $25 billion in revenues, has over 240 000 employees, and has major segments in power distribution and transmission, environmental control, and financial services.

In 1988 ABB encompassed a geographically extensive enterprise of over 850 operating subsidiaries. The company set out on an international acquisition path that, by the end of 1990, embodied over 1300 operating units. One of the most difficult problems facing senior managers was that of organizing these various worldwide businesses in order to centralize information accurately without stifling local initiative. The operating units had to remain responsive to their local market demands. The most significant operational effort to weave the ABB companies together at the top levels was the installation of a financial and managerial reporting system.

To improve the organization's ability to provide central coordination and evaluation of product and process capabilities without interfering with local responsiveness, ABB designed a vertical information system called ABACUS (Asea Brown Boveri Accounting and Communication Systems). ABACUS was designed to be powerful in its simplicity, with each country transmitting its results by company and technological business area on an almost continuous basis across a proprietary teleprocessing network called the ABB Corporate Network. The system was specifically designed for use by the senior management of ABB and the business area managements. ABACUS was not intended to be an accounting and reporting instrument for the needs of the individual companies. With such an information tool at their disposal, senior managers can discern regional trends, economic fluctuations, and internal managerial problems. ABACUS provides a universal language in that managers throughout ABB's global organization can understand the performance of any country or product group worldwide, thereby increasing the speed of decision making across product and process arenas. In short, ABACUS provides ABB's local companies and profit centers with independence. At the same time it ensures that the firm is taking advantage of the wealth of knowledge it accumulates about product and process performance and capabilities. The ABACUS system gives ABB the capability to transmit information rapidly and accurately to senior managers. This allows the firm to maintain global operations that are dynamically responsive by company and by profit center to local needs.

Unlike the mass producer, the mass customizer organizes labor to work effectively in a dynamic network of relationships, and to respond to work requirements as defined by customer needs. Whereas labor in the mass-production design was organized to perform specialized tasks according to a unitary set of rules and commands, the mass customizer organizes labor to routinely respond to a changing set of rules and commands. This requires that the setup time be greatly reduced to change from one set of inputs to be processed into a corresponding set of outputs, to a new set of inputs. Reducing setup times in the mass-customization organization involves three things: eliminating tasks that do not need to be done, streamlining all remaining tasks so that cycle time equals value-added time, and performing as many of those tasks in parallel with the preceding process operation as possible. This reduction applies to the plant floor, the back office, and the front office.

One company that has done all of this is the United Services Automobile Association (USAA), which focuses on insurance for military and ex-military personnel. USAA completely redesigned its policy services processes through information technology, replacing all the paper files that made their way through the back office in batches by creating computer images that are accessible to any service representative individually. In this way, USAA accomplished all the setup-time improvements mentioned above. It eliminated its paper inventory. It eliminated waste in the process and brought its cycle time down to its value-added time. USAA now works in lot sizes of one individual customer who receives personalized, customized service.[25] In speaking about the service this system provides, Robert F. McDermott, chief executive officer of USAA, said:

The mass customizer combines the product variety of the invention design with the production efficiency of the mass producer.

> [I]t changed the way we think. Now when you want to buy a new car, get it insured, add a driver, and change your coverage and address, you can make one phone call—average time, five minutes—and nothing else is necessary. One-stop, on-line, the policy goes out the door the next morning about 4 a.m. In one five-minute phone call, you and our service representative have done all the work that used to take 55 steps, umpteen people, two weeks, and a lot of money . . . . [I]t's a revolution in the relationship between the company and the customers, who now have instantaneous access to and control over their own financial transactions, no matter whom they're talking to. We've got 14,000 employees, but every time you call, you're talking to someone who's got your file in front of them.[26]

In summary, the mass customizer combines the product variety of the invention design with the production efficiency of the mass producer. To accomplish this, the mass customizer employs a new organizational design based on the network rather than the assembly line. Although this organization is designed to compete under conditions under which product change is highly variable, it does so by maintaining an evolutionary level of stable change in processes.

Continuous improvement: Stable product and dynamic process change. Although mass-customization conditions of dynamic product change characterize a number of markets, they do not represent all of them. In some markets, the nature of product demand is still relatively mature, stable, large, and homogeneous. These markets, however, are not necessarily havens for the traditional mass producer that achieves efficiencies through stability and avoiding change.

We now consider the kinds of designs that are effectively competing in these environments and how they are competing. As the product-process change matrix describes, in these environments winning organizations are competing on *dynamic process* terms. That is, they are achieving constant advances in process quality, speed, and cost, which are providing them with real competitive advantage. The quality revolution and increasingly severe cost and time competition in such industries as automobiles, financial services, machine tools, and retailing are being led by a new kind of competitor, one that we call the *continuous improvement* design.

The continuous improvement design is the second of the new designs we have observed. This type of organization competes under conditions of *stable product change* and *dynamic process change.* We term such designs continuous improvement designs because the organization manages rapid innovation and use of new process capabilities. They also strive constantly to improve their response to large, stable product requirements. In general, organizations facing a continuous improvement environment require systems and structures that facilitate long-term organizational learning about products, but at the same time achieve rapid and radical changes in the processes employed to meet stable product demands. Figure 6 describes characteristics of the continuous improvement design.

Consider again the experience of one of our opening examples, Citibank's U.S. Card Product Group. CPG's strategy has been to focus solely on the credit card market, or as Citibank says, to become "the best way to pay." The strategy has proved profitable.[27] We now discuss how CPG has managed to fare so well for so long. On the surface, CPG resembles the perfect mass producer. It is an efficient, large-scale operation that provides a well-defined, relatively standard service to millions of consumers. The CPG operational focus is on efficiency and low cost. However, one might question how this low cost is achieved.

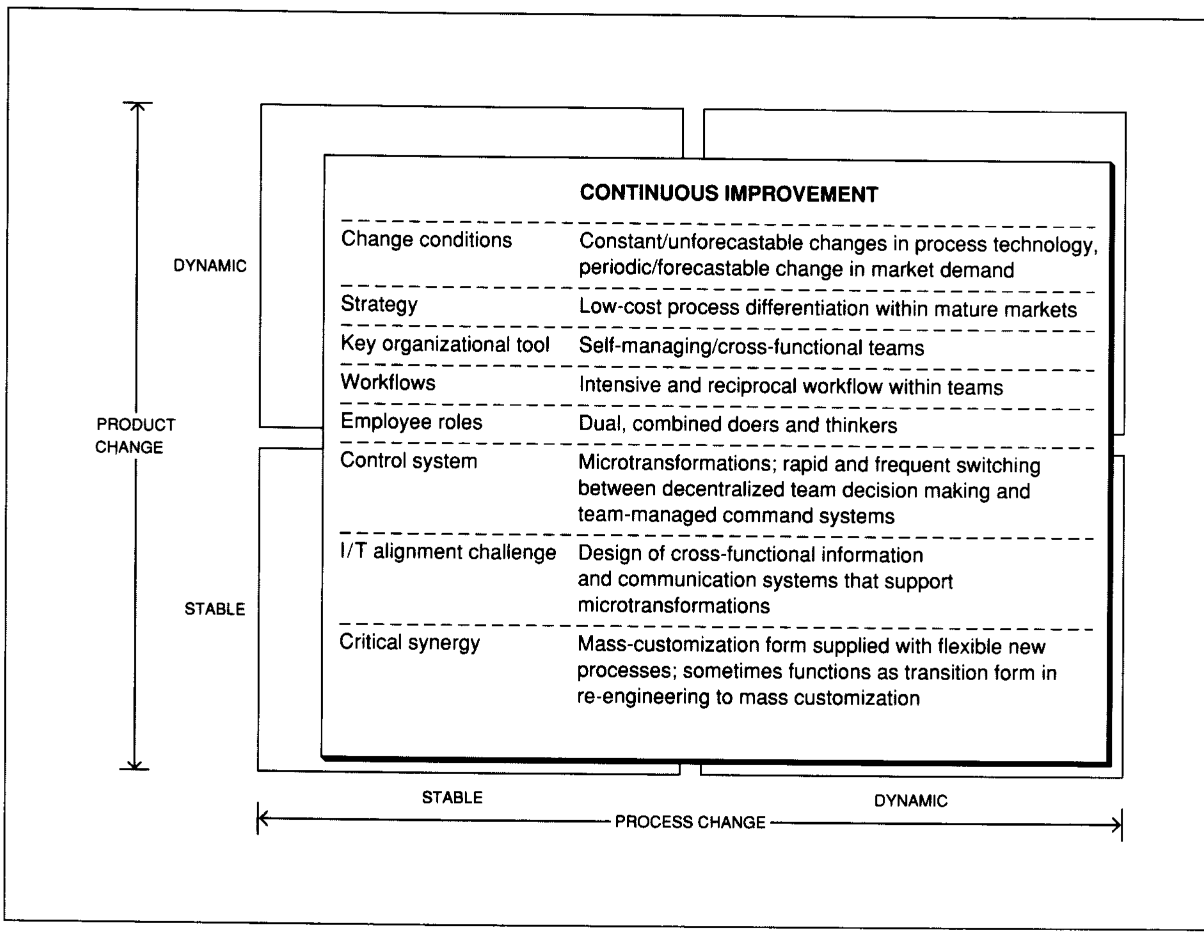
If CPG were a traditional mass-production design, conventional wisdom would dictate that it build long-term, stable operational capabilities. These things would be changed infrequently or only on the margin to move incrementally down the experience curve. However, that is not what CPG does. Instead, Citibank has adopted a new wisdom, taking a very different approach from that of the mass producer of the past.

Instead of building stable, inflexible process systems, Citibank has built core operational processes capable of continuous change and innovation, all the while maintaining its focus on a single product. In effect, Citibank CPG has turned itself into a continuous improvement design. Tom Huegel, an I/T manager in CPG, reflects this when he says, "Change is the norm here—change to improve the quality, innovativeness, and efficiency of how we do business in a business we know—becoming the best way to pay through credit cards."

CPG attempted to incorporate everything it had learned into designing and building a system that could change as the credit card industry and its customers changed. Jim Bailey, former chief executive officer of CPG, explained how CPG's approach to changing the I/T infrastructure developed:

> We tried to do it all—sit down, build an all-encompassing banking system in the early '80s called CBS. It was a disaster, because someone said we are going to sit down and design the ultimate, and then we are going to build pieces of it and put it into place. The problem is that humans are not smart enough to realize the obstacles they will run into. We tried with the advanced workstation to design it all up front and never got off the dime. Now we are much more gradual in our approach. We have invested in technology step by step, rather than

Figure 6 Product-process change matrix



in giant leaps. That approach has allowed us to master technology in a variety of ways.

How does CPG achieve this continuous change in critical systems capabilities that anticipates market changes and service needs? To a large extent it is through the direct and constant interaction between those in front-line marketing. Where requirements used to be handed "over the wall" from marketing to information services, now these groups work together as a team to quickly respond to changing service needs.

And service was the one thing that CPG wanted to perform best. The group believes that the two critical elements to service are technology and people, and each poses unique challenges. Many major service enhancements have been initiated by customer service people. If the system does not have the capability to do something, the philosophy has been to expand the system to provide better customer-service capabilities. For example, CPG gradually and consistently built flexibility into its system throughout the 1980s. The system used a variety of parameter-driven modules and a dramatically improved database design. Parameterized changes could be made overnight, and modules could be reprogrammed without affecting the entire system. CPG used its size and information-technology investments to build an infrastructure on which it could grow, expand, and change. Unlike most of its competitors, in 1991 CPG lowered interest rates charged to customers as general interest rates declined. This was a strategic competitive decision that CPG could make solely because it had the I/T capabilities that allowed rapid market response.

Characteristics of the continuous improvement design. As this example illustrates, the distinguishing characteristic of the continuous improvement design is its ongoing capacity to improve the operating performance of its processes and products rapidly and inexpensively. Many of the enhancements we saw at Citibank were not made in reaction to customer demands for better credit card service. They were made with foresight and an understanding of the philosophy of continuous process enhancement. The basic principal was that low-cost advantage can be achieved while investing in changing process capabilities that anticipate future market needs in service and quality. In direct contradiction to the old assumption that cost and process or product change are tradeoffs and that choices must be made between the two, continuous improvement designs organize for efficient process innovation. These designs also allow firms to achieve efficiency, quality, and ongoing product improvements simultaneously.[28]

The key to the continuous improvement design is a team-based structure.[29] The team structure is an integrated and ongoing collaboration among process specialists. The characteristic that distinguishes the team structure from the network is the collaborative nature of the work. Teams are intensive forums through which process change is pursued and implemented. The hand-off between operating units of a network stands in stark contrast with the codevelopment work of teams. The team structure permits the organization to make complex, value-adding transformations of its business processes. By integrating the specialized work of functional units and managing the rapid and effective refocusing of these functional units, the continuous improvement design pursues process innovation while remaining cost competitive with the mass producer.[30]

The importance of team-based structures for both product and process innovation has only recently been recognized in management literature. The classic prescription in mass production has been to isolate process and product innovation from production. The purpose is to buffer production from the disruptions of the developers and to free the developers from the short-term concerns of production.[31] More recent research and practice have muddied this picture by demonstrating that the interdependence among functional units, i.e., production, product development, information systems, and marketing, is intensely reciprocal.

The IBM facility in Rochester, Minnesota, that won the Malcolm Baldrige National Quality Award in 1990 is a good example of this interdependence. One of the reasons cited by the Baldrige examiners for bestowing the award on the IBM development laboratory was its process of listening and reacting to business partners. Although instigated by top management's desire for customer involvement in the development process of the Application System/400 (AS/400*) midrange computer, this activity was designed and implemented (beginning in 1986) by a small group of people who wanted the choices of individual customers and business partners to be heard. Up to that time, there had been a very big wall surrounding development programmers and engineers. Talking to customers, or to anyone in the marketing organization, was not a common practice in development organizations.

All that changed with a new idea called "early external involvement."[32] During the development of the AS/400, hundreds of business partners and customers provided feedback directly to engineers and programmers on functions that were still being developed. This activity resulted in a number of key incremental improvements to the product and the process. The quality of the AS/400 system was greatly enhanced, because hundreds of defects were found by the participants before (not after) the system's release to manufacturing and sales. Also, the product-development process was quickened by providing developers with a forum to air their problems and questions and gain immediate feedback. Decisions were reached sooner with better consensus. As a basic part of their involvement, the business partners and IBM systems engineers readied thousands of applications that could be announced and shipped with the system and gained expertise to provide such services as installation, training, system customization, and special programming. The key to the success of this activity was the cross-functional team of development, manufacturing, and marketing personnel that made it happen.

Also crucial was that team's willingness to do whatever it took to achieve its goals, including departing from company policy or creating new policy. In contrast to the mass producer, which separates doers from thinkers, the continuous improvement design organizes labor not only to follow the rules and procedures, but also to participate actively in the development of them. While the mass producer achieves efficiency by isolating innovation from the concerns of the work force, the continuous improvement design achieves efficiency by making innovation everyone's concern. For example, when asked how many process engineers he had, the plant manager at NUMMI (New United Motor Manufacturing, Inc.), a Toyota-General Motors joint venture in Fremont, California, pointed to his production floor of 2100 workers and said, "2100." Indeed, the prototypical continuous improvement design users have been such Japanese manufacturers as Toyota. This design has produced relatively standard products through constant enhancement of the processes of these manufacturers to achieve higher quality, lower costs, faster cycle time, less inventory, and greater innovation.

To make innovation efficient, the continuous improvement design manages an ongoing sequence of what we call *microtransformations*. Innovation is pursued by cross-functional teams that collaborate to improve operating processes or plan for product enhancement. The members of these teams then turn to their function-specific work and execute the rules they just developed, accomplishing a microtransformation. In this sense the teams of the continuous improvement design are intended to be as process-innovative as the invention design, and as process-efficient as the mass-production design.

The microtransformations created through the team-based structure have changed the role of supervision in these organizations. In the mass-production design, doers' jobs are designed for maximum efficiency. All work is allocated based on specialized functional capabilities and dedicated to the execution of standardized, product-defined tasks. The design of the jobs and the selection and evaluation of work processes are reserved for the managerial role. These thinkers are expected to preplan all doer roles and to evaluate and correct all doer task work. The difference in the continuous improvement design lies in the fact that the rules are generated by the same team that is expected to execute them. Thus, the self-managing work teams of the continuous improvement design make it both highly formalized and highly decentralized. The formalization and decentralization are both organic and mechanistic.

In addition, accomplishing these microtransformations requires the organization to support both extensive lateral cooperation and precise functional control. Team members must be able to evaluate and perform their own work as well as communicate and collaborate across functional and product boundaries to innovate work processes.

We now present the role of I/T in continuous improvement. Here, I/T alignment takes on its own unique challenges. Recall that the organizational focus in continuous-process change and transformation is an ongoing, intensive interaction among individuals from a variety of functions and roles throughout the organization. This interaction focuses on a well-defined set of product or service objectives, where teams are required to pay constant attention to changing process capabilities for improving quality and innovativeness. At the same time, team members efficiently create high-volume output.

To achieve this dual requirement at Citibank's CPG, product and process managers alike have access to the same information at the same time. Constant interaction occurs among managers of all areas and at all levels. At the same time, the interactions are purposefully focused and well orchestrated. Everyone has the same information, which is provided daily. No one is allowed to disagree as to the information. This common vision of reality based on common information, combined with the collective vision to become the "best way to pay" in the credit card industry, provides the groundwork for the constant process innovation that occurs at the heart of the CPG service capabilities.

Along with the common information, detailed, constantly updated, process-specific feedback is also provided to everyone. For example, information on the quality and response time of customer service is collected, analyzed, and reported several times a day. This function-specific information enables CPG employees to perform their jobs as efficiently and reliably as is possible. Thus the information system supports both innovation and production-efficiency requirements.

For CPG, the result of this sort of I/T alignment is both continuous process improvement and constant, highly efficient production, which translates into real value for CPG customers. The ongoing microtransformations that characterize the organization at CPG promise the continued building of vital new process capabilities for competing in the hotly contested credit card marketplace.

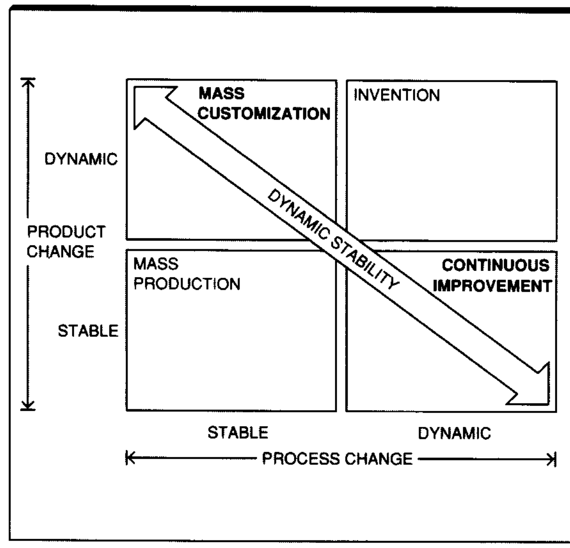
To that end, continuous improvement designs are taking advantage of breakthroughs in information-technology architecture that bring modularity, flexibility, and reusability to design systems to support microtransformations. For many, such systems are the key to enabling the organization to improve coordination, integration, and control of core capabilities and know-how across a variety of functional areas. In many cases, new I/T systems not only improve speed to market but also increase the efficiency and effectiveness of important process activities.

A new synergy between mass customization and continuous improvement: Dynamic stability

Just as there is a symbiotic relationship between the mass-production design and the invention design, there exists a vital relationship between mass customization and continuous improvement. As we briefly mentioned earlier, this new synergy may well define the basis of competition into the next century.

We refer to this synergy as *dynamic stability*, which defines organizational designs that combine the best of mass customization and continuous improvement. These organizations can respond to rapidly changing and unpredictable product or service markets (dynamic) from an efficient, long-term (stable), flexible, and adaptive base of process capabilities. Such stable process capabilities are the key to mass customizers and enable them to respond to dynamic product change. However, these process capabilities cannot be developed once for all time. Instead, they must be developed in a continuous-improvement stage. They are applied to competitive advantage as a mass customizer. They are continuously enhanced, using continuous improvement design characteristics to ensure that the organization maintains world-class process capabilities. See Figure 7 for an illustration of the new competitive strategy in a product-process change context.

Figure 7 The new competitive reality

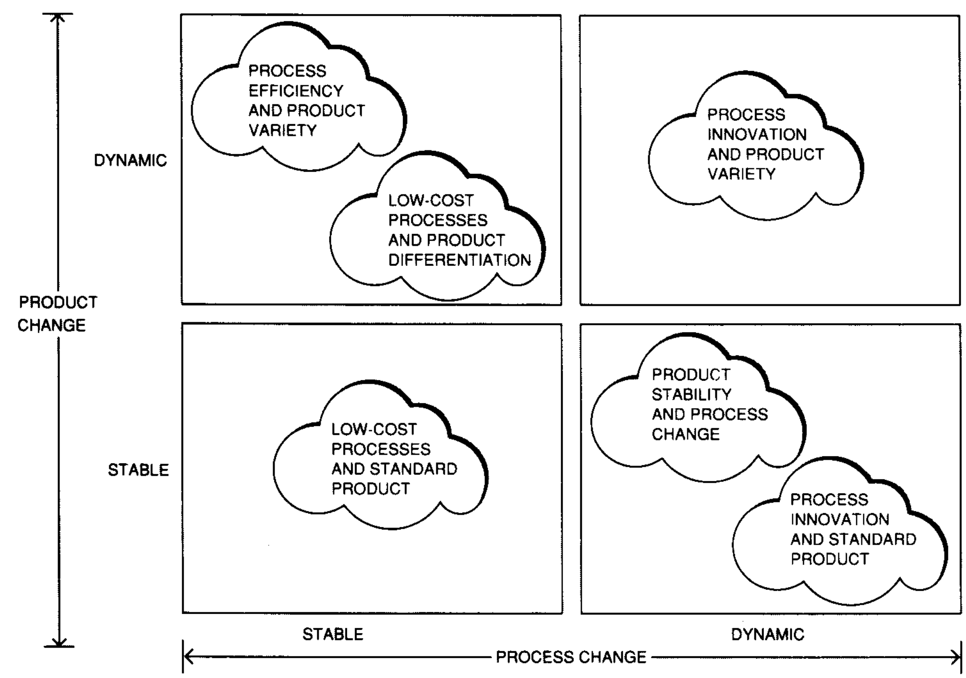


The synergy that exists between mass customization and continuous improvement revolves primarily around the need to adopt the invention and innovation of vital processes from the continuous improvement design. This can occur in three basic ways.

One way is that the mass-customization design may borrow process innovation from an entirely separate continuous improvement design. That is especially true when that process innovation results in low-cost, highly flexible process capabilities. By another mode, both the mass-customization design and the continuous improvement design coexist within the same organization, sharing process innovations within the organization. Third, as discussed in more detail later in this paper, companies attempting to move from mass production to mass customization must pursue a path through a stage of process re-engineering and development (continuous improvement) before they can apply those processes to mass customizing products or services.[33] We refer to this path as the *right path*.

There are also examples of organizations that can and must balance and move between the contin-

Figure 8 Managing contradictions



uous improvement and mass-customization designs. This is critical because, for long-term success, part of a mass customizer must attend to process innovation to increase its ability to pursue a strategy of efficient product variety. Mass customizers, while achieving a low-cost, product-variety strategic position, must be formidable competitors in many related industries. Thus they must continuously enhance their process capabilities that are the key to success. This attention to process development and its benefit to mass customization can be seen at Motorola, Inc. Motorola's development of its mass-customization capability as exhibited in the Bravo** Pager line of remote signaling devices was also managed by way of a continuous improvement design. Motorola put together a 24-member cross-functional team to design its new manufacturing process and assembly line. The team was charged with creating a completely automated, computer-integrated assembly line yielding tremendous economies of scale, but with lot sizes of one.

What we have observed is a vital new synergy between the continuous improvement design and the mass-customization design. A path is being drawn between the process innovation of the continuous improvement design and the efficient flexibility of the mass customizer. It is critical that today's organization take advantage of this synergy. It is also critical to be on the synergy path to creating the vital sense of dynamic stability that the new strategic reality requires. Of critical importance is to step back and understand that this new strategic response requires that contradictions inherent in the old competitive synergy of mass production and invention must now be managed simultaneously. It is no longer an either-or choice. Firms must choose a vision that includes both decentralization and centralization, global and local, fast and efficient, innovative and low cost. As the product-process change matrix informs us, the new reality depends on building visions and organizations that incorporate what used to be contradictions into a cohesive strategy and design capability, as shown in Figure 8.

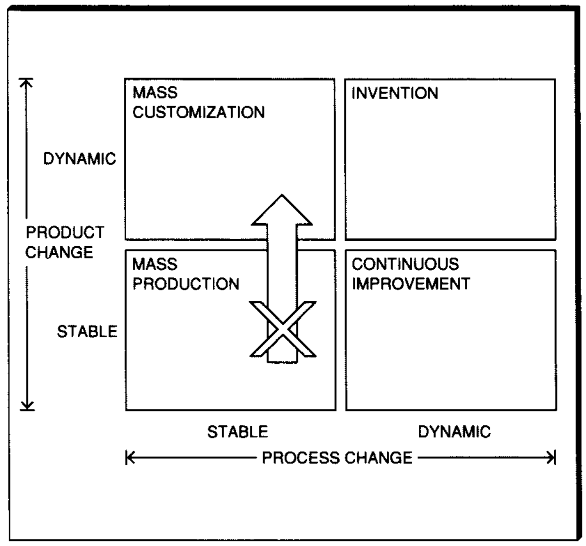
Taking the right path to mass customization

So far we have talked about the importance of having managers assess their competitive position by understanding where their firms are coming from, then formulating a vision for where their firms need to be in the future. Turning that future vision into reality does not just happen, however. Moving from the old reality into the new reality must proceed by a special path. We have called that path the right path.

Each of the mass-customization and continuous improvement organizations we have observed either adopted or developed new processes that could support the objective of efficient flexibility or continuous innovation. We have observed that it is just not possible to reapply processes used in mass production and simply transfer them to conditions of mass customization and continuous improvement. Processes created for conditions of mass production are designed and managed with efficiency and low cost in mind. They simply do not have the inherent flexibility to operate in a networked organization. Thus the path to dynamic stability requires that the organization undergo a significant process development or redevelopment effort aimed specifically at building process or knowledge capabilities. Any attempt to move to dynamic stability from the old competitive strategies without significant process transformation does not work. Using the product-process change matrix to illustrate the point, firms with process capabilities designed to manage change that characterizes mass production cannot take those capabilities and apply them to the change that characterizes the new competitive strategy. This is the wrong path to transformation. (See Figure 9.)

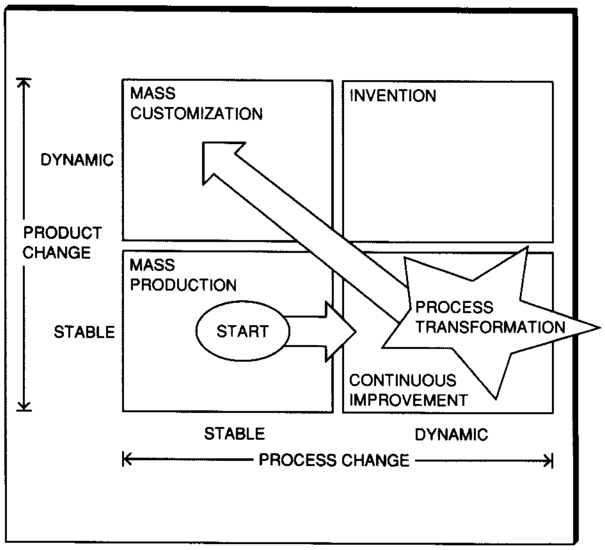
Naturally, the path to transformation requires significant changes in the information systems of many firms and new thinking on the part of managers. Taking a closer look at how I/T underscores the need for a right path transformation, we see that most firms' existing information architectures are built upon years of system development to support a wide range of administrative, support, and product applications. For most firms, these systems have been built to support the tenets of mass production. Functional specialization, hierarchical structure, and inflexibility to change result in inflexible vertical silos of information. For the requirements of mass production, a focus on functional specialization and information isolation was the right organizational formula. The demands on organizations and managers have changed, however, and so must the way information is handled. The simple fact is that the old information-processing capabilities no longer meet the new challenge of managing an organization's core competencies and responding to the dual competitive requirements of rapid product customization and production and distribution efficiency. As a result, attempts to apply existing information systems (or any other organizational resource) designed for mass production to rapidly changing markets usually result in neither flexibility nor efficiency. The result is usually organizational chaos.

Figure 9 Making the transformation: The wrong path



Consider the case of Citibank once again. In the early 1980s it wanted to improve market respon-

Figure 10 Making the transformation: The right path



siveness in its consumer banking group. Citibank introduced a strategy, called "Project Paradise," that was designed to decentralize information-processing capabilities quickly to as low a level of responsibility and control as possible. This decentralization was executed by taking information-processing capabilities and know-how specifically designed for stable and slow-changing product markets and applying them to the new competitive conditions of more rapid, unpredictable market change. Project Paradise turned out to be more of a nightmare than a paradise. Instead of improving market responsiveness, Citibank found itself drowning in a sea of systems, unable to collect, store, disseminate, or analyze vital information. Realizing it was on the wrong path to improving organizational responsiveness, Citibank quickly recentralized its information-management processes.

The failure of Project Paradise illustrates the important lesson that the right path to mass customization requires that the firm make significant up-front investments in general-purpose, flexible information capabilities to support the changing requirements of the competitive environment. As illustrated in Figure 10, the right path from mass production to mass customization requires that a firm move by fundamentally transforming its capabilities and processes.

Consider the experience of Corning, Incorporated, which is a manufacturer of fiber optics.[34] These are the glass fibers that allow communication by light rather than electricity. First developed in the 1970s, fiber-optics communication began extensive usage in the early 1980s. The origin of this movement was the deregulation of the telecommunications industry that induced MCI Communications Corp. and others to begin building fiber-optic networks. By 1986 Corning's fiber-optics operations at its Wilmington, North Carolina, plant were running 24 hours a day.

By 1990, however, product demands had drastically changed. The long-distance market, which had required only a few standard types of fibers, had become saturated. Despite the technical complexity of manufacturing, customers were starting to demand more customized products, lower costs, and faster delivery. In fact, the number of products went from single digits to several hundred as customers began demanding new and different combinations of fiber characteristics.

Because Corning's existing information and manufacturing systems were designed for mass production involving high demand, a few standard fiber products, and limited modifications, they were no longer meeting demand efficiently. The systems did not allow for modifications in product or production process to meet customer demands. A stovepipe information infrastructure blocked potentially useful information from being shared across production stages, and work in process could not be tracked.

Faced with these changes and shortcomings but determined to stay at the top, Corning decided to convert and expand its information and process manufacturing capabilities by investing in a multimillion-dollar information system called the Flexible Manufacturing System (FMS). Designed with flexibility and integration in mind, FMS will provide Corning with the proper information architecture to support planning, scheduling, operations management, and control. To describe this computer architecture renewal, Corning coined the term "data-centered architecture," meaning an architecture for information management that is founded on the relationships among the fundamental elements of information that the business uses to operate (e.g., orders, products, processes, and equipment). These are key assets of the business and critical to operations. The Corning FMS architecture is designed to serve the accessibility and accuracy of that asset. The new computer architecture will result in a data system that is highly accessible and places the key data assets under management to the benefit of all information-system users. It will serve as a flexible information resource through an access structure that is known to all and accessible from any computer system in the division.

The Corning FMS will also provide the necessary flexibility to handle the rapidly changing demands of the optical-fiber industry. The new system will give Corning the flexibility to adapt to new products and production processes; to obtain information about orders, production, and inventory on demand; and to track costs for orders, experiments, and custom products. Given the wide possibilities for customer product demand, including sizes, carrying capacities, lengths, and so on, this new system is vital to Corning's ability to compete effectively in the market.

In summary, Corning's new Flexible Manufacturing System means consolidating core knowledge about fiber-optic development and mass-production manufacturing processes into a single information system. That system will allow the organization to build high-quality customized fiber-optics at low cost in order to meet the dynamic product demands of a constantly changing competitive environment.

Understanding that transformation to mass customization must follow a carefully thought-out right path is a critical step to success for firms in attempting to position themselves on the new competitive strategies. Corning, Westpac, Bally, Citibank's CPG, and Asea Brown Boveri are all examples of firms taking the right path. Each is investing in and carefully designing information architectures that are stable and efficient platforms. These systems simultaneously provide flexible, general-purpose, information-processing capabilities. The firms themselves did not try to leapfrog existing capabilities without thinking through organizational design issues and consequent information challenges required for dynamic stability. In each case, careful engineering or re-engineering of process capabilities positioned the firms and their managers to meet the dual competitive challenges of product differentiation and low cost made possible by mass customization.

The investment that Corning is making and the investment underway at the other firms we have observed represent significant changes in their process capabilities. In each instance, these investments place each firm temporarily in a state of process change and adjustment. Unlike the firms of the past, these new organizational forms are taking advantage of advances in process capabilities to build stable, centralized platforms of process capabilities or knowledge to achieve both efficiency and dynamism.

Conclusion

From our observations, we have presented what we believe is the emergence of a new global competitive strategy. We have suggested that this new strategic reality requires managers to think in a wholly new way, not only about the possible role of I/T, but also about the necessity of first understanding process and product change. We have tried to develop a framework or lens through which managers can better view these rapid changes, come to a better decision about which strategies are necessary to achieve success in this new environment, and even begin to think about what it takes in this new reality to design and build a successful organization. We have shown by example that I/T is a key strategic resource for success in the new competitive environment. In fact, we hope it has been clear that the use of I/T is often the driving force behind success in this new reality.

Before firms turn to I/T, managers must ask and answer a set of basic but critical questions about their firms' specific competitive environment and the nature of product and process change. Today's managers must understand the nature of change before making decisions about where their firms have been in the past, what is an appropriate vision for their firms' future, and how their firms must specifically be changed to achieve their vision. In fact, our main theme in this paper is that understanding the nature of change is actually at the heart of organizational design and the alignment of I/T with a firm's strategic response.

Acknowledgments

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Appendix: From Fordism to post-Fordism

An important debate is emerging in economic and organization theory that reflects some of the broadest issues in understanding the new competitive strategy. We have prepared this appendix to provide managers with a better understanding of these issues.

Throughout the twentieth century, the combining of single-purpose technological capabilities, stable processes, specialized labor, and regulated demand to produce standard services or products has been known as mass production, the basis of large-scale organizational efficiency. Typified by Henry Ford's automobile firm, the mass-production design, along with the associated political, labor, and economic policies that grew up around it, has been termed "Fordism."

Today, however, a broad historical and economic change is occurring. The Fordist growth model so painstakingly constructed in the post-World War I years is currently in a state of serious demise. In response, a new and different family of organizational designs is steadily emerging that we have collectively termed "post-Fordist" designs.

Post-Fordist designs are known by a number of different specific names, such as "flexible specialization," "Toyotism," "lean manufacturing," and "mass customization." They are emerging in response to two main catalysts: a rapidly changing and highly unpredictable competitive environment, and existing organizational designs and policies (e.g., Fordism) that are unable to cope successfully with these turbulent conditions. In short, change in the world around us and the way we do business are no longer in sync.

The result of these changes is that a new business environment is emerging that requires a new way of doing business. Also, a new set of interrelated organizational and technological innovations is being developed at the organizational level. In turn, this set of innovations is giving rise to a new competitive trajectory in which efficient flexibility is the key to remaining competitive in a rapidly changing environment.[35] Just as Fordism required a technical basis for production (product standardization and stable production methods), post-Fordism also requires the new technical basis for transformation and production of information technology. This technology combines advances in telecommunications, computing, and microelectronics. Perhaps the most important dimension of this new technical basis is the relatively recent rise of flexible technology, such as modular and rapid-development software tools, numerically controlled machine tools, robots, flexible information and database storage and retrieval systems, electronic data interchange (EDI), and computer-integrated manufacturing.

Understanding the broad rise of post-Fordism and the fundamental changes that rise necessitates, particularly in the use of information technology, is a vital step toward understanding the new strategic reality managers must now face.

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Cited references and notes

1. This paper is based on an ongoing research project sponsored by the IBM Advanced Business Institute and the Darden Graduate School of Business Administration at the University of Virginia. The authors have met with over 120 managers from 18 firms based in six countries on five continents. The firms are from various industries, including health care, consumer products, industrial products, telecommunications, financial services, and industrial manufacturing.
2. For a more extensive discussion of aligning business strategy with information technology strategy, see J. C. Henderson and N. Venkatraman "Strategic Alignment: A Model for Organizational Transformation Through Information Technology," *Transforming Organizations*, T. A. Kochan and M. Useem, Editors, Oxford University Press, New York (1992), pp. 97–116.
3. See K. Clark, "Investment in New Technology and Competitive Advantage," *The Competitive Challenge: Strategies for Industrial Innovation and Review*, D. J. Teece, Editor, Ballinger Press, Cambridge, MA (1987); and M. J. Tushman and P. Anderson, "Technological Discontinuities and Organizational Environments," *Administrative Science Quarterly* **31**, No. 3, 439–465 (1987).
4. It is necessary here to recognize differences between the terms *firm* and *design*. By firm we mean a legal or competitive entity, e.g., the Corning Telecommunication Sector or the Citibank CPG. By design we mean an organizational form that consists of an interconnected set of capabilities, control systems, award systems, culture, and people. A large firm may, and often should, have different designs within its boundaries, or the designs change over time from one design to another. For example, while most of Ford Motor Co.'s processes and structures are dedi-

cated to mass production, it still contains new-product development units that are in many ways the exact opposite in design from the assembly lines and formal control structures existing throughout the rest of the firm. The point here is that managers must keep in mind that different departments, functions, or divisions of the firm may face different product and process change conditions and require different organizational designs to win competitively.
5. P. M. Blau and P. A. Schoenherr, *The Structure of Organizations*, Basic Books, New York (1971); and J. D. Thompson, *Organizations in Action*, McGraw-Hill Book Co., Inc., New York (1967).
6. J. R. Galbraith, *Designing Complex Organizations*, Addison-Wesley Publishing Co., Reading, MA (1973); R. H. Hall, "The Concept of Bureaucracy: An Empirical Assessment," *American Journal of Sociology* **69**, 32–40 (July 1963); and B. Allen and A. Boynton, "Information Architecture: The Search for Efficient Flexibility," *MIS Quarterly* **15**, No. 4, 435–445 (Winter 1992).
7. F. W. Taylor, *Scientific Management*, Harper, New York (1911); see also Reference 5, Thompson.
8. M. J. Piore and C. F. Sabel, *The Second Industrial Divide: Possibilities for Prosperity*, Basic Books, New York (1984).
9. See Reference 6, Galbraith.
10. A. D. Chandler, Jr., *Strategy and Structure: Chapters in the History of the American Industrial Enterprise*, The M.I.T. Press, Cambridge, MA (1962).
11. D. Miller, "Configurations of Strategy and Structure: Towards a Synthesis," *Strategic Management Journal* **7**, No. 3, 233–249 (1986); and T. Burns and G. M. Stalker, *The Management of Innovation,* Tavistock, London (1986).
12. See Reference 11, Burns and Stalker; Reference 6, Galbraith; and B. L. T. Hedberg, P. Nystrom, and W. H. Starbuck, "Camping on Seesaws: Prescriptions for Self-Designing Organizations," *Administrative Science Quarterly* **21**, No. 1, 41–65 (1976).
13. It is easy to see that the problem of information technology alignment in the either/or environment of mass production and invention is simply a matter of making the choice between (1) a centralized, efficient, routine information-processing capability, or (2) a distributed, specialized, flexible collection of systems, both of which can be readily managed with the planning and resource evaluation tools currently available.
14. This idea, known as industrial dualism, can be found in M. J. Piore, "Dualism as a Response to Flux and Uncertainty," and "The Technological Foundations of Dualism and Discontinuity," *Dualism and Discontinuity in Industrial Societies*, S. Berger and M. J. Piore, Editors, Cambridge University Press, New York (1980).
15. See Reference 8; see also Reference 11, Burns and Stalker.
16. W. J. Abernathy and J. M. Utterback, "Patterns of Industrial Innovation," *Technology Review* **80**, No. 7, 40–47 (June-July 1978).
17. S. M. Davis, *Future Perfect*, Addison-Wesley Publishing Co., Reading, MA (1978); C. A. Bartlett and S. Ghoshal, *Managing Across Borders: The Transnational Solution*, Harvard Business School Press, Boston, MA (1989); R. E. Miles and C. C. Snow, "Organizations: New Concepts for New Forms," *California Management Review* **28**, No. 3, 62–73 (1986); and C. K. Prahalad and G. Hamel, "The Core Competence of the Corporation," *Harvard Business Review* **90**, No. 3, 79–91 (May-June 1990).
18. For a complete discussion of this new design, see B. J. Pine II, *Mass Customization: The New Frontier in Business Competition*, Harvard Business School Press, Boston, MA (1993). See also Reference 17, Davis; Reference 8; A. C. Boynton and B. Victor, "Beyond Flexibility: Building and Managing the Dynamically Stable Organization," *California Management Review* **34**, No. 1, 53–66 (1991); and S. Davis and B. Davidson, *2020 Vision: Transform Your Business Today to Succeed in Tomorrow's Economy*, Simon & Schuster, New York (1991).
19. See Reference 18, Boynton and Victor, and also Pine.
20. See Reference 8; Reference 18, Pine; and Reference 17, Davis.
21. D. J. Teece, "Economies of Scope and Economies of the Enterprise," *Journal of Economic Behavior and Organization* **1**, No. 3, 223–247 (September 1980).
22. See Reference 18, Boynton and Victor; Reference 17, Davis; and Reference 18, Pine.
23. The value-chain activities for a mass customizer or for any other design do not have to be owned by the company in a vertically integrated fashion. For many companies, value-chain activities are acquired from other firms, thus extending the boundaries of the organization. This has given rise to the *disaggregated-value-chain* concept or the *networked organizational design*. Becoming a firm that relies extensively on external companies for value-chain activities is a critical strategic choice. Given the importance of maintaining tightly connected, flexible, and highly responsive process capabilities for mass customization, the decision to rely on externally owned value-chain process requirements should be made with extreme caution. This topic deserves more extensive discussion than this paper allows. For an excellent discussion of networks composed of multiple companies, see C. Snow, R. Miles, and H. Coleman, "Managing 21st Century Network Organizations," *Organizational Dynamics* **20**, No. 3, 5–20 (Winter 1992).
24. A. C. Boynton and M. Eaker, *ABB Asea Brown Boveri (A)*, Darden Educational Material Services, Graduate School of Business Administration, University of Virginia, Charlottesville, VA 22906 (1992); and A. C. Boynton and M. Eaker, *ABB Asea Brown Boveri (B)*, Darden Educational Material Services, Graduate School of Business Administration, University of Virginia, Charlottesville, VA 22906 (1992).
25. M. R. Vitale, J. J. Elam, and J. E. P. Morrison, *United Services Automobile Association (USAA)*, Harvard Business School Case 9-188-102, Cambridge, MA (1988); and C. A. Plesums and R. W. Bartles, "Large-Scale Image Systems: USAA Case Study," *IBM Systems Journal* **29**, No. 3, 343–355 (1990).
26. Quoted in T. Teal, "Service Comes First: An Interview with USAA's Robert F. McDermott," *Harvard Business Review* **69**, No. 5, 126 (September-October 1991).
27. A. C. Boynton, B. Victor, and M. Eaker, *Citibank Card Product Group*, Darden Educational Material Services, Graduate School of Business, University of Virginia, Charlottesville, VA 22906 (1991).
28. J. P. Womack, D. T. Jones, and D. Roos, *The Machine That Changed the World*, Rawson Associates, New York (1990); J. B. Quinn and P. C. Paquette, "Technology in Services: Creating Organizational Revolutions," *Sloan Management Review* **31**, No. 2, 67–78 (Winter 1990);

I. Nonaka, "Creating Order Out of Chaos," *California Management Review* **30**, No. 3, 57–73 (1988); I. Nonaka, "Redundant, Overlapping Organization: A Japanese Approach to Managing the Innovation Process," *Organizational Behavior and Industrial Relations Working Paper Series*, **OBIR-42**, University of California at Berkeley, Berkeley, CA (1989); I. Nonaka, "The Knowledge Creating Company," *Harvard Business Review* **69**, No. 6, 96–104 (November-December 1991); and T. Numagami, T. Ohta, and I. Nonaka, "Self-Renewal of Corporate Organizations: Equilibrium, Self-Sustaining, and Self-Renewing Models," *Organizational Behavior and Industrial Relations Working Paper Series,* **OBIR-43**, University of California at Berkeley, Berkeley, CA (1989).

29. See Reference 28, Nonaka, 1988; I. Nonaka, "Organizing Innovation as a Knowledge Creation Process: A Suggested Paradigm for Self-Renewing Organization," *Organizational Behavior and Industrial Relations Working Paper Series*, **OBIR-41**, University of California at Berkeley (1989); and P. S. Adler, "Workers and Flexible Manufacturing Systems: Three Installations Compared," *Journal of Organizational Behavior* **12**, No. 5, 447–460 (September 1991).
30. D. Leonard-Barton, "Implementing New Production Technologies: Exercises in Corporate Learning," *Managing Complexity in High Technology Organizations*, Oxford University Press, New York (1990), pp. 160–187; see also Reference 28, Nonaka, 1989.
31. See Reference 7, Taylor.
32. For a description of this process, see B. J. Pine II, "Design, Test, and Validation of the Application System/400 Through Early User Involvement," *IBM Systems Journal* **28**, No. 3, 376–385 (1989). See also R. A. Bauer, E. Collar, and V. Tang, with J. Wind and P. Houston, *The Silverlake Project: Transformation at IBM*, Oxford University Press, New York (1992).
33. See Reference 18, Boynton and Victor.
34. A. C. Boynton, *Corning Telecommunications Division Case Series*, Darden Educational Material Services, Graduate School of Business, University of Virginia, Charlottesville, VA 22906 (1991).
35. See Reference 29, Nonaka, 1989; Reference 18, Boynton and Victor, and also Pine.

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Andrew C. Boynton *International Institute for Management Development, Chemin de Bellerive 23, P.O. Box 915, CH-1001, Lausanne, Switzerland.* Dr. Boynton received his B.S. from Boston College and his M.B.A. and Ph.D. degrees from the University of North Carolina at Chapel Hill. He is assistant professor of business administration at Darden Graduate School of Business, University of Virginia, teaching both strategic management and leadership and information technology in the Darden M.B.A. program. He has published several books on topics related to managing information technologies and numerous articles on information technology planning, critical success factors, and strategic organizational change in such journals as *Sloan Management Review*, *MIS Quarterly*, *Data Base*, and *California Management Review*. Dr. Boynton has taught in a variety of executive programs around the world on topics associated with the strategic use of information technology and managing information technologies in large, complex organizations. During the 1992–1994 academic years, he is a visiting professor at the International Institute for Management Development.

Bart Victor *Kenan-Flagler Business School, University of North Carolina, Chapel Hill, North Carolina 27514 (electronic mail: UBART@UNC).* Dr. Victor is an associate professor of management in the Kenan-Flagler Graduate School of Business Administration. He received his B.A. in sociology from the University of California at Berkeley. After college he founded and operated a number of businesses in California, Illinois, and New York. Dr. Victor then went on to earn his Ph.D. in management from the University of North Carolina. He teaches graduate and undergraduate courses in organizational design. Dr. Victor's research interests have focused on culture and climates in organizations and problems in organizational design. His work has been published in many academic and professional journals, including *California Management Review*, *The Academy of Management Journal*, *The Academy of Management Review*, and *Administrative Science Quarterly*. Dr. Victor consults with firms nationally and in Japan on issues of management, organizational design, and business culture.

B. Joseph Pine II *IBM Advanced Business Institute, Mail Drop 1610, 44 South Broadway, White Plains, New York 10601 (electronic mail: pine@rhqvm07.vnet.ibm.com).* Mr. Pine is a program manager in the management research function of the IBM Advanced Business Institute, in concert with the IBM Consulting Group. He is responsible for research into leading-edge management and strategy issues that are incorporated into IBM management consulting practices and executive education. His book *Mass Customization: The New Frontier in Business Competition* was recently published by Harvard Business School Press. Prior to joining the Advanced Business Institute, Mr. Pine held a number of technical and managerial positions within IBM, mostly at Rochester, Minnesota, where he joined the company in 1980. He has received numerous awards for his achievements, including IBM's Outstanding Innovation Award. He also received an invitation from the Chairman of the Board to attend the company's Corporate Technical Recognition Event in 1989 for his efforts in bringing customers, business partners, and marketing personnel into the development process of the IBM Application System/400. Mr. Pine received his B.S. in applied mathematics from the University of Wisconsin-Stout in 1980, and his M.S. in the management of technology from the Massachusetts Institute of Technology Sloan School of Management in 1991.

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