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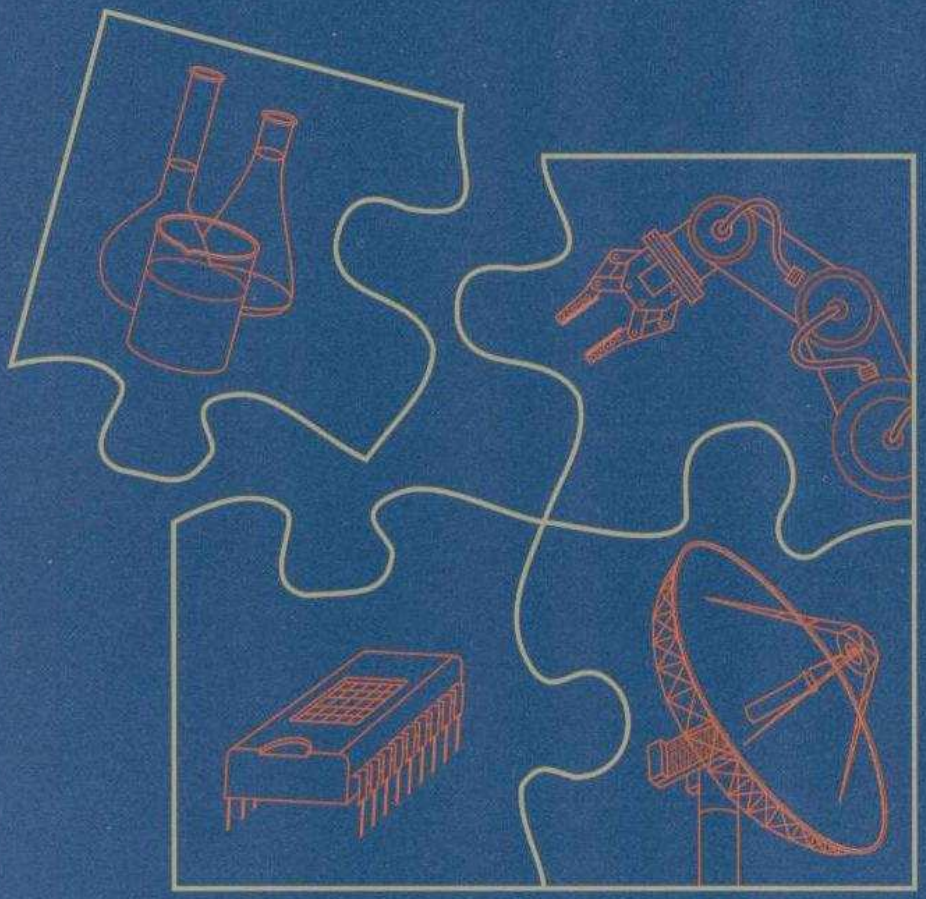
Mastering Technology Management for Competitive Advantage



Viewpoint

A Viewpoint

by Iddo T. Hadar
William P. Sommers

Ten years of hard-earned experience have rewritten the rules that managers applied to the technology markets of the early 1980s. Conventional wisdom then suggested that by maximizing technological innovation and getting it to market first, a firm could effectively shut out the competition. At least it could gain the market leadership position and, as a result, earn the best financial returns.

Over the past decade, however, real-world experience has demonstrated that such management maxims are, at best, simplistic, and in many instances outright misleading. Ironically, in industry after industry, the original leader who was first to market with an innovative technology was unable to sustain a competitive advantage. In many instances, the leaders that eventually

emerged and prevailed, came to market late, often with less advanced technology but with a superior strategy.

Furthermore, in numerous instances, firms have achieved outstanding and comparable financial returns, competing in the same technology-intensive markets while following distinctly different strategies — some with first-to-market intent; others with low-cost/incremental improvement strategies; while others focused on revolutionary technology and new functionality. Still others succeeded by establishing new industry-wide standards, which benefited their technology and competitive positioning.

New Realities

Managers in a broad range of industries must face some new basic realities on both the technological and the competitive fronts:

- Technology markets in many instances are too large and too complex for any single company to define and control for long. Firms in a wide array of technology markets need to recognize the emerging role of the *extended enterprise* — encompassing suppliers, customers, end-users, third-party vendors, and even direct competitors — as the new competitive unit. This new model mandates fundamental changes in thinking and the capabilities needed to succeed.
- Managers of technology businesses will need to focus their efforts on excelling in one of the key dimensions: time, cost, performance, or management of the extended enterprise. The capabilities required to excel in each of these dimensions are distinct and different. Few, if any, firms can afford to develop or sustain all of the capabilities required to excel in multiple dimensions.
- While technology has clearly emerged as a means for developing *market driving capabilities,* rarely is it a sufficient core capability itself. It needs to be coupled with other key capabilities, such as customer service, distribution, manufacturing, and supplier relationships. As a result, technology-intensive organizations should not be technology-driven; rather, they must integrate the full skills of the enterprise. This requires an interdisciplinary approach to developing and executing strategy.
- Managers need to commit to a long-term strategic vision to guide their pursuit of market driving capabilities. At the same time, managers should prepare to evolve their strategies, and therefore their capabilities, as markets and technologies mature and competitors redefine the market. For example, a planned transition from a performance-based strategy to an extended enterprise strategy will be critical in many markets if the leader expects to sustain its position.

These new realities have set the stage for a new framework for understanding and developing strategies for technology-based businesses. The framework is built on two major strategic dimensions: the value the technology can provide to the end-user, and the proportion of the value the technology innovator seeks to capture. By understanding the interplay between these two dimensions, and the capabilities required to pursue the possible range of strategies, managers will be able to successfully integrate business and technology strategies. Managers will find this framework a powerful tool for understanding the competitive dynamics of existing technology markets and, more important, for developing successful strategies for current and future technology markets.

Technology Strategy under Attack

Strategic management of technology is not getting any easier. The increasing pace of technological changes has major implications for industry participants:

- Distinct product and process technologies converge into digital formats, driving ubiquity of electronic components.
- Broader applicability of technology allows standardization of components and interfaces in both hardware and software markets.
- Rapid improvements in price/performance ratios — most notably in silicon components — accelerate cycle time between successive product generations.
- Improved silicon capacity — doubling every eighteen months — increases miniaturization and functional integration.
- Technological and competitive trends drive industry players to unbundle applications and thus fragment the value-delivery chain.

These technological changes have dramatic and far-reaching implications on business strategy:

- Technology can no longer be used to segment markets; delineation across product segments (e.g., PC vs. workstation, CISC vs. RISC, home computer vs. VCR/CD player) is being blurred by converging performance.
- As a result, companies can no longer use technology to define their business, nor can they use technology as their sole means of differentiation.
- Competition over establishing standards is intensifying.
- Companies attempt to shift their value-added focus as power and value shift from system integrators to suppliers of key components (e.g., CPUs and operating systems in the PC market).
- Companies find their positions more temporary and less sustainable than ever before, especially when they fail to focus on developing market driving capabilities in sync with the technology/business strategy selected.

Conventional wisdom often has generated conflicting responses. Industry players have been urged to maximize technological innovation and be first to market. Many companies have sought to maximize technical performance to garner a proprietary position, for example, in the RISC CPU arena. Others have streamlined their operations to participate in "commodity" type competition, evidenced throughout the PC industry. These isolated responses, however, fail to deal squarely with the new realities.

Paradoxes in the Semiconductor Industry

The history of the semiconductor microprocessor market challenges technology management conventional wisdom. First-to-market, technological leap-frogging did not ensure success — Texas Instruments failed after being first to market with a 16-bit processor in 1975, due to a lack of software. Nor did technological superiority ensure success — Motorola failed to capture the IBM PC motherboard despite its performance advantage, because of incompatibility with the 8-bit infrastructure.

A key contributor to these paradoxes is the fact that microprocessor manufacturers typically control a very small fraction of the total value-added delivered to end-users. End-user value is generated throughout the value-added chain by providers of hardware, software, and services. As a result, success in this industry seems to revolve around building a strong extended enterprise that supports new technologies.

Evidently, companies in the semiconductor market can succeed using dramatically different strategies. For example, Intel has focused on aggressive management of technology transition through new product generations. Intel has maintained

backward-compatibility religiously — often at the expense of performance. In the early days of the personal computer, Intel (just like Motorola) was forced to build second-sourcing relationships to establish its architecture. While accepting this situation as a necessary evil at the beginning of the product life cycle, Intel soon shifted to the "Next Wave" model: riding the next technology wave as soon as competitors catch up with the current wave, driving technology transition by managing the entire product line.

Intel has accelerated transition by quickly obsoleting previous generations, pricing aggressively, decreasing switching costs (e.g., underpricing the 80386 in the late 1980s and the 80486 today to accelerate adoption), curtailing investment in existing technology, and minimizing life-extending support (e.g., limited support for the 80287 math coprocessor and the CMOS 80286).

Advanced Micro Devices (AMD), on the other hand, has focused on delivering timely and cost-competitive improvements to existing designs. It has been extremely competitive in offering performance upgrades, such as speed upgrades, improved packaging, and lower voltage, within Intel's design, and has been seeking extension of existing generations (e.g., CMOS versions, math coprocessor support, and highly integrated MPUs for the 80286). With solid delivery skills in production and market access, AMD has excelled as a "fast follower," gaining against Intel. For example, AMD achieved 30 percent market share in the 80386 market within nine months.

In reality, there was a symbiotic relationship between Intel and AMD, which allowed both firms to pursue successfully their distinct strategies (market driving innovation vs. fast follower) and efficiently focus on a subset of capabilities. Even more important, the relationship gave strength and resilience to the entire extended enterprise. For example, it allowed second- and third-tier PC suppliers to expect a steady flow of components at rapidly declining prices.

As a result, Intel's recent rift with AMD may prove a liability to both companies, because they may have to become more alike to survive. For example, Intel may need AMD more than it would ever admit. With a potentially weaker AMD, Intel has to commit to dual-prong technology spending — product line proliferation to satisfy niche markets, and accelerated product life cycles to fend off new threats. As a result, Intel — facing challenges to its entire extended enterprise from alternative architectures, such as Personal Communication Devices, Unix-based workstations, or the PowerPC alliance — is committing to a very fast (possibly untenable in the long run) pace of technological change.

The experience of Intel and AMD indicates that success in semiconductor markets should be linked primarily to effective management of the extended enterprise — not to technological wizardry or fast time-to-market per se. In this environment, radically different strategies may coexist and may even create a powerful symbiotic equilibrium. Disruption of this equilibrium may harm the entire extended enterprise in the long term. Most important, the most dramatic threats and opportunities emanate not from individual, direct competitors, but from entirely new architectures and their extended enterprises.

A New Imperative

How can this iconoclastic case jibe with the traditional approach to technology management? Can technology strategy be properly integrated with business strategy? Or is winning in technology-based industries merely a result of a roll of the dice? How can anyone successfully manage or even anticipate the evolution of these markets?

The case of the semiconductor industry is not unique. Upon careful examination, many success stories of the 1980s were not driven by singular excellence in product technology, but rather by an ingenious redefinition of the supply chain and effective management of the new extended enterprise. Most of the dramatic U.S. high-tech successes, such as Microsoft, Intel, and Sun Microsystems, stemmed from evolutionary technologies that offered a low-cost standard and thus fueled the trends of standardization and unbundling. Undeniably, this strategy was also at the root of many Japanese success stories, in the machine tool industry for instance.

In general, many product and service providers have found that the most effective strategy is based on establishing standards and opening their architecture, even though that may involve giving up some control and some value-added to other extended enterprise participants. This proportional loss of value is generally compensated by faster market penetration.

A new set of imperatives is emerging, not as obvious as the traditional approach perhaps, but much more powerful:

- Understand the role of technology and competitive forces throughout the extended enterprise.
- Link technological parameters with key drivers of business strategy through a differentiated approach.
- Build market driving capabilities consistent with the desired technology/business position.
- Deploy capabilities according to shifting technology and business positions.

The following discussion looks in more detail at the key technology and business issues resulting from the new paradigm.

Framework for Strategic Technology Management

The new technological and competitive realities require a new approach to technology management, one that puts technology in a strategic context and allows for differentiated responses. More important, substantial technological and competitive uncertainties no longer allow management to chart a clear "strategy," making it imperative instead to define an overall "vision" as a guide to pursuing market driving capabilities. A three-step process can be used (see below).

The Three-Step Framework
for Strategic Technology Management

1. *Understand the Business Value of Technology.* Map specific product/technology opportunities along two dimensions — the potential value to the end-user and the proportion of that value sought by the innovator.

2. *Define Product Strategies.* Discuss the implications of each intersection along those two dimensions — minor redesign, performance upgrade, proprietary/bundled architecture, or major redesign.

3. *Determine Key Success Factors.* Trace the key success factors dictated by each intersection — cost-based competition, time-based competition, value-based competition, or extended enterprise competition.

Step 1: Understand the Business Value of Technology

The first step in forging a close link between technology and business strategy should be to determine the business implications of each technology opportunity. Based on recent experience across a broad range of industries, we identified a useful method for thinking about the way technological trends affect markets. It starts with mapping technology opportunities/markets along two primary dimensions, which define the business requirements of technology strategy:

- *Value of technology.* How much value can the application of the technology create for the end-user?
- *Value-capture target.* What proportion of the value created can the innovator capture?

These dimensions have important business implications. For example, opportunities associated with a "low" value of technology are more "evolutionary" in nature and offer more limited potential. Yet they require less of an investment in persuading and educating the end-user (who may be either external to the organization — in the case of product/service technology — or internal to it — in the case of process and other technologies). The reverse is true for a "high" value of technology, where the potential is substantial, yet unleashing it requires fine-tuning the technology to end-user needs and investing in end-user access and education.

The value created through the technology needs to be split among the innovator, the end-user, and other members of the extended enterprise. Opportunities allowing "high" value-capture targets are to be pursued essentially on an individual basis, permitting the innovator to reap most of the rewards but preventing the fast market growth associated with broad support.

Opportunities with "low" value-capture targets are more challenging to implement and offer proportionally less benefit to the innovator, although they may prompt faster market expansion. For other extended enterprise participants, such opportunities offer the most rewards, but also require more costly adjustments. The more limited a company's capture target (due to a fragmented value-added chain), the more dependent it is on other members of the extended enterprise to accommodate the technology, and the higher the members' switching costs.

Step 2: Define Product Strategies

These two dimensions — the potential value of the technology and the proportion of this value sought by the innovator — can be used to map specific product/technology opportunities and to draw some implications (see Exhibit 1).

Positions in the lower left-hand corner of Exhibit 1 offer low value as well as low capture targets. They can be regarded as a *minor redesign,* providing small, incremental improvements whose benefits are diffused throughout the extended enterprise. These are "commodity" products, such as most OEM/nonbranded products, over-the-counter versions of ethical drugs, and some of today's PCs. Toyota generally applies this strategy in the automotive industry.

Positions in the upper left-hand corner offer low value with high capture targets. They can be regarded as *performance upgrade* technologies, which

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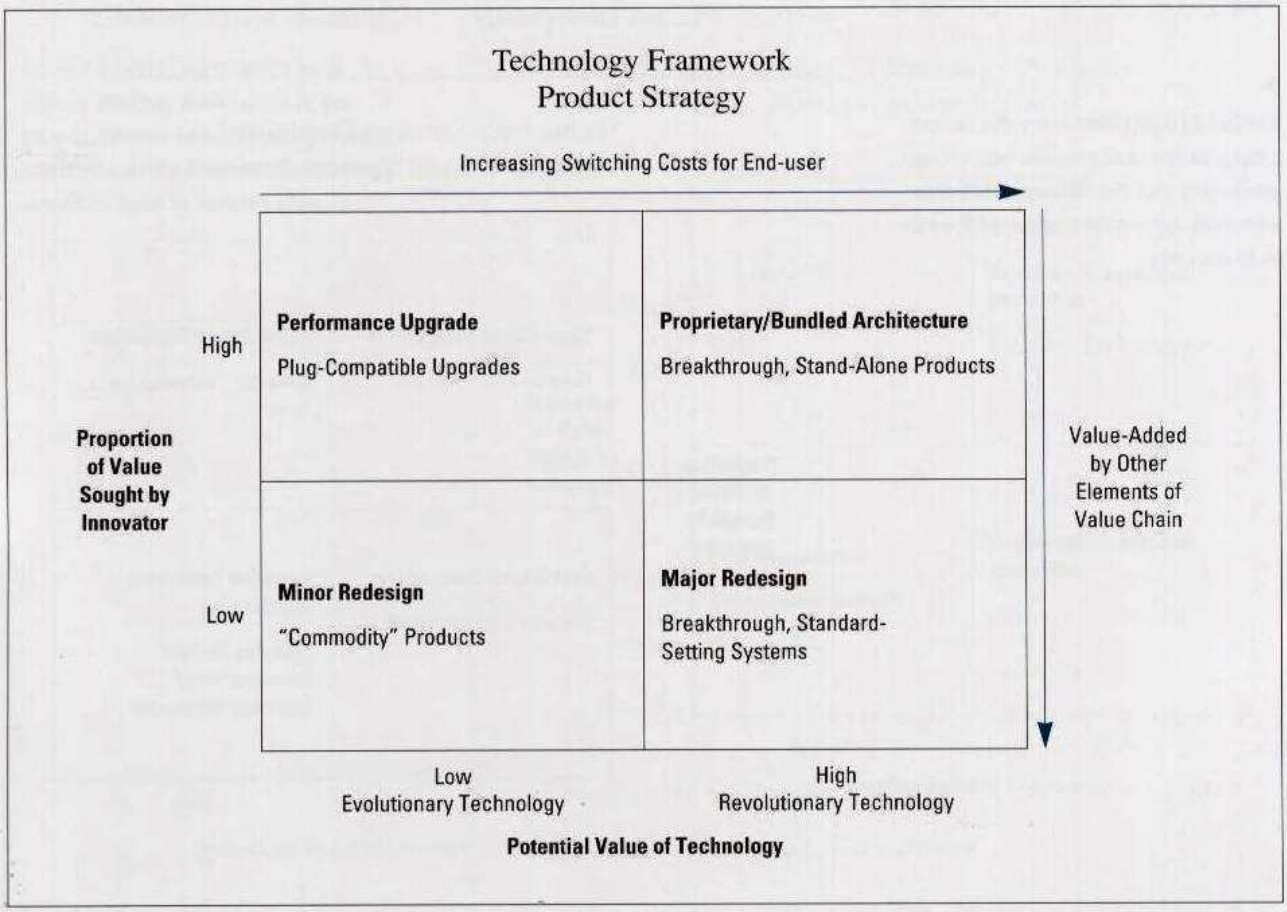
Exhibit 1 (right) maps specific product or technology opportunities along the two primary dimensions of technology strategy — the technology's potential value and the proportion of this value sought by the technology innovator.

offer incremental value, yet require limited adjustments from other extended enterprise participants. Most consumer products come under this rubric, as do many high-tech, plug-compatible, end-user products, such as computer add-ons and microprocessor speed upgrades. In automobiles, Honda is such a player.

Positions in the upper right-hand corner offer high value as well as high capture targets. They can be regarded as *proprietary/bundled architecture,* breakthrough and stand-alone products, which, by virtue of "closed architecture," allow the innovator to capture most of the value. Many entrepreneurial and intrapreneurial examples fit into this category, including the first Xerox copier, Apple's Macintosh, early CAD systems, and 3M's Post-it™ Notes. This category also includes examples of proprietary control over key delivery systems, such as American Airlines' SABRE (as used in the early 1980s) and American Hospital Supply's ASAP systems. In the automotive market, Mercedes-Benz and BMW are clear examples.

Finally, positions in the lower right-hand corner offer high value yet low capture targets. They can be regarded as a *major redesign,* a breakthrough standard-setting innovation whose implementation is contingent upon support from the rest of the extended enterprise. One of the best examples of such innovation would be a new generation of computer microprocessor chip, which is all but useless to the end-user without compatible DRAMs, glue chips, computer system, peripherals, operating system, and applications software. Additional examples include the original IBM PC, fiber-optic wire, aspartame (NutraSweet®), and Teflon.



Step 3: Determine Key Success Factors

The segmentation of technology positions presented in Exhibit 1 is not intended merely to provide an interesting taxonomy. As can be seen in Exhibit 2, each segment has its own unique characteristics and thus requires managers to develop differentiated approaches.

- Minor redesigns do not offer tremendous profitability to the innovator, yet they are moderately attractive for the rest of the value chain. With little ability to differentiate, this "commodity" segment's focus is necessarily on *cost-based competition.* Companies are required to develop strong delivery skills (e.g., the ability to access markets quickly and inexpensively). These skills are enhanced by the company's ability to drive standardization, resulting in a lower cost position because of shared resources. For example, IBM's PC AT benefited from using outsourced standard parts and leveraging IBM's marketing and sales muscle.

- Performance upgrades offer moderate profitability for the innovator, and generally are marginally attractive for other chain participants. Because this segment is quite attractive, technology is often the only entry barrier, and support by other chain participants is not critical, it is likely to attract many new entrants. As a result, this segment promotes *time-based competition.* Winners are typically good "fast followers" who focus on small, incremental steps, cautious investment programs, and access to off-the-shelf technology (possibly adding enhanced features). Consumer products, with their competitive nature, epitomize this segment.

- Proprietary/bundled architecture presents a highly lucrative opportunity (in terms of dollar margin per unit) for the innovator, with only moderate profitability for other chain participants. This is where the most innovative technology emerges, and where most high-tech start-ups occur. Lack of broad support from other chain participants in this segment, however, typically dictates much slower market growth and limits ultimate market potential.

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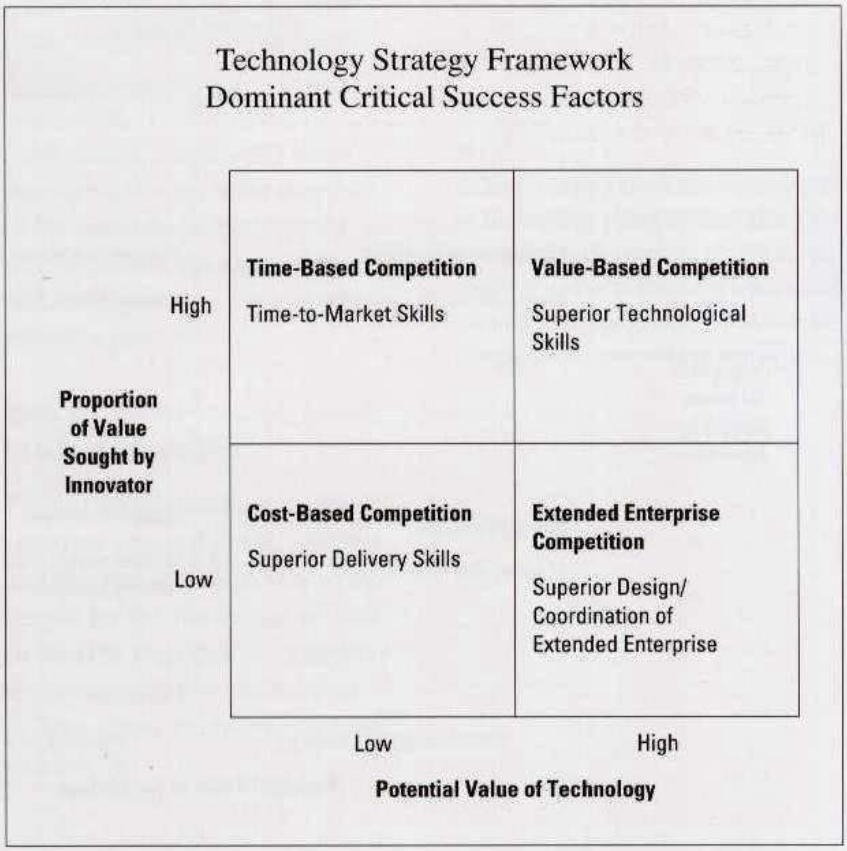
Exhibit 2 (right) illustrates the unique characteristics of specific technology strategies and the differentiated management approaches required if each is to succeed.



Apple's Macintosh provides an example. Moreover, because of a lack of broad market support, this position is not sustainable in the long term. Alternative architectures are likely to emerge, which would spread benefits more evenly across the extended enterprise.

This segment, therefore, is driven by *value-based competition,* or the ability to bring superior technological value to the end-user. The innovator has to be an "evangelist," educating the end-user to the benefits of the new technology. Time-to-market is rarely an issue, because the technology offers unique benefits not available from any other existing/emerging technology. Once the technology is established, however, the innovator must act quickly to maximize the value of the opportunity. Sooner or later this "jackpot" will be displaced by a more mundane architecture.

- Major redesigns present a high-risk, high-reward opportunity. If successfully implemented, they could create a thriving market with strong barriers against new entrants. Successful implementation, however, requires well-orchestrated cooperation by all extended enterprise participants, at the expense of sacrificing a good proportion of the value created. This is clearly *extended enterprise competition.*

The critical elements of success are a crystal-clear understanding of user needs and the ability to build complementary capabilities throughout the extended enterprise. Creating and fostering motivation among other chain participants is often key. Time-to-market is hardly an issue. Indeed, a premature introduction may be counterproductive. Innovators typically must create standardization to increase the breadth of applications, and compatibility to minimize switching costs. As a result, technological innovation is not the primary success factor. The importance of reconciling divergent needs typically dictates adopting less revolutionary technological standards. Once

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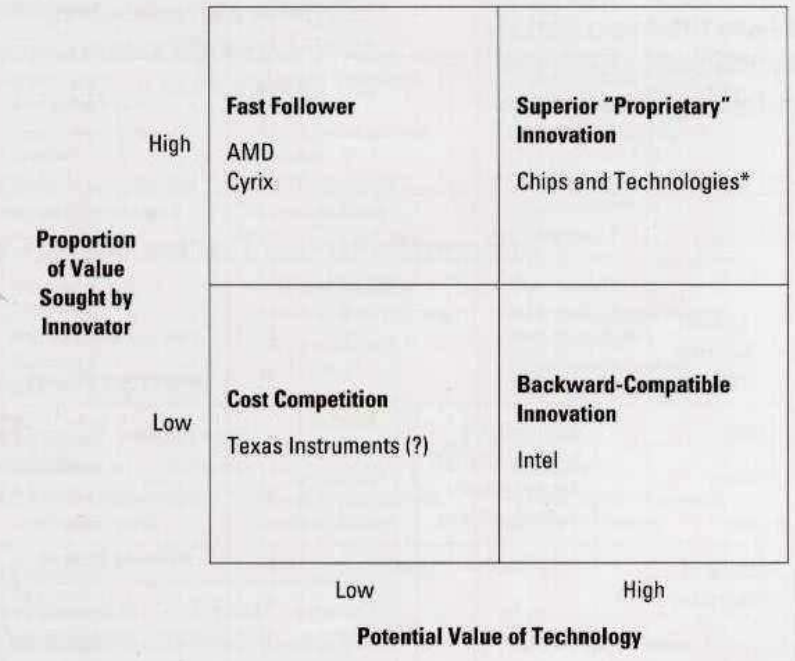
Exhibit 3 (right) applies the technology strategy framework to the semiconductor industry and provides examples of the business/technology positions held by various players.

Sample Business/Technology Positions in the Microprocessor Industry



* Largely unsustainable strategy in current environment

the chain has been established, the key challenge is effective management of the resultant "monopoly."

Implementation Challenges

As the above discussion illustrates, this framework offers managers the ability to review technology within a strategic context and to identify — within broad categories — the types of basic capabilities required. The framework is useful for strategic thinking, as it establishes early on an overall vision of product focus and competitive dynamics. Exhibit 3, page 9, applies the framework to the semiconductor case discussed earlier and helps explain the market dynamics.

The framework presented in this *Viewpoint* also forces managers to address directly one of the basic challenges of technology management: discerning the true strategic position of each technology opportunity — the value of the technology to end-users, and how much of this value can be captured.

Managers who fail to articulate their technological visions, or who misjudge technology positions along these dimensions, expose their firms to substantial risks. Service companies, for instance, often overestimate the value of technology, because productivity, output, and the value of information technology are hard to measure in a service environment. As a result, many service companies tend to overinvest in technology and fail to capture commensurate competitive advantages.

In terms of value-capture targets, companies often underestimate their reliance on the acceptance of the technology by other members of the extended enterprise, and introduce superior technology to the market without the infrastructure to support it. Such moves result in lackluster market growth. AMD's 29K micro-processor is one such example.

Another strategic miscalculation would be to force on the market an innovation that runs counter to existing technological and competitive dynamics. For example, IBM's attempts to force a shift of the PC market to proprietary technology (by way of Microchannel Architecture or OS/2) have had limited commercial success so far because of strong support for "open architectures."

Once managers clearly understand the strategic implications of the technology opportunity, they should use their insight to focus their organizations on the appropriate market

Exhibit 4 (below) diagrams the two activity streams within which managers must focus their market driving capabilities.

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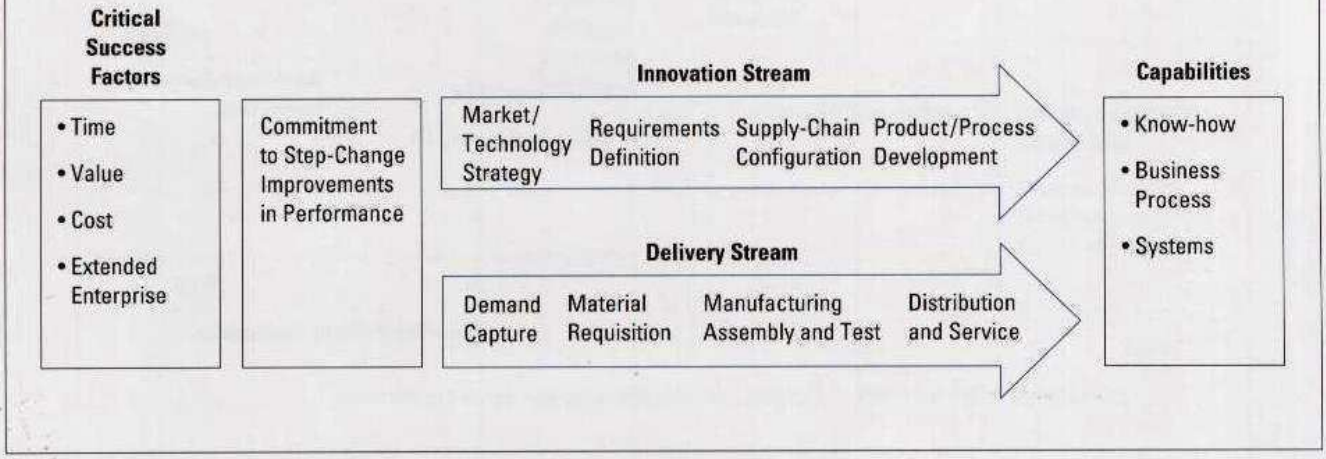
Business/Technology Position Driving Capability Focus



driving capabilities — the unique know-how, systems, and processes the business can leverage better than its competitors and partners. Targeting these capabilities, which reside in two basic activity streams and cut across the traditional functional organization (see Exhibit 4), is the key to making the transition from an overall vision to implementation.

To support the transition, the technology management framework allows a first-cut approximation of the priorities that businesses should use in building capabilities in accordance with the technological and strategic roles they are targeting.

These priorities dictate entirely different organizations and entirely different sets of capabilities. The organizational capabilities required to shave the last penny off a commodity OEM part, for example, in Cooper Tire & Rubber, are quite different from the capabilities required to bring to market the hottest new revolutionary technologies, for example, in various "skunkworks" organizations, including Lockheed's and Apple's (in developing the Macintosh). A fast follower pursuing incremental feature improvement, such as AMD in the microprocessor market, has investment and management priorities distinctly different from those of an innovator seeking to establish new industry-wide standards, such as Intel. Exhibit 5 outlines these and other salient differences across the various strategies.

Exhibit 5 (below) charts important organizational and capabilities differences among various technology strategies.
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Implementation Challenges:
Core Capabilities Required to Support Strategy

	Cost-Based Competition	Time-Based Competition	Value-Based Competition	Extended Enterprise Competition
Mission Statement	Cost Leader	Fast Follower	"Evangelist"	Standard-Setter
Core Capabilities	• Low cost/lean production • Timely ramp-up • Streamlined infrastructure • Market access	• Short product development cycle • Tight cross-functional coupling • Customer understanding • Competitive marketing	• Dramatic technology innovation • Tight cross-functional coupling • Risk management • Channel building • "Experimental" marketing	• Strategic alliance management • Tight cross-organizational coupling, motivation • Management of "monopoly," once established • Staying power
Technology Development	• Clear objectives • Driven by customer requirements/spec • Process innovation key • Emphasis on standardization	• Incremental feature introduction • Product technology can be outsourced • Customer providing input	• Unbridled innovation • Driven by long-term vision • Continued stream • Step change	• New standards • Major technological changes, yet subject to conflicting needs • Cooperation technology/ market development
Key External Interfaces/ Issues	• Market access (to customer's engineering/ purchasing)	• Market access • Customer communication to determine needs	• User "education" • Managed evolution into standard platform	• Alliance key • Reduced switching costs for extended enterprise
Key Internal Interfaces	• Manufacturing/logistics	• Engineering/ manufacturing	• Marketing/engineering	• All
Dominant Functional Area	• Operations	• Marketing/engineering	• Engineering	• Top management vision

Aligning the Organization with Technology Strategy

A case study based on recent Booz·Allen client work demonstrates the implementation challenges of strategic technology management and the application of the framework to one of the key current management challenges — improving engineering effectiveness.

The client, a manufacturer of electromechanical industrial products, found itself competing in a cyclical, capital-intensive, technology-driven market, while having to offer excellent cost-control and time-to-market. As a result, it launched an aggressive initiative to reduce engineering cycle time.

As a first step, the manufacturer segmented its engineering operations into three critical activities: project definition (the process by which commitment to accomplish a particular engineering task or project is determined), activity management (the process by which accomplishment of the set result is managed), and activity execution (the process by which resources are pooled and managed to support tasks). A variety of tools were then used to address each of these areas.

To understand the demands placed on its management processes, the manufacturer segmented its engineering projects using the technology-management framework as illustrated in Exhibit 6. (Note that the segmentation was performed relative to the manufacturer's average technology-value and value-capture position.) As the exhibit shows, process characteristics varied dramatically by segment,

▶ **Exhibit 6 (right) shows how the manufacturer of electromechanical industrial products described in the case example on this page segmented its engineering projects using the technology-management framework.**

Program Management Process Framework

Value-Capture Target*	Low Evolutionary Technology	High Revolutionary Technology
High	**Internal R&D Project** • Few tollgates • Project engineer in charge • Shared resources	**Highly Complex, Long-term Program** • Rigorous technically driven tollgates • Project engineer in charge • Dedicated resources
Low	**Minor Deviations from Current Product Designs** • Formal, customer-oriented tollgates • Requisition engineer in charge • Shared resources	**Customer Needs/ Technology Integration** • Rigorous, multiple tollgates • Senior engineer in charge of technical issues • Program manager in charge of overall program • Dedicated resources

Potential Value of Technology*

* Relative to manufacturer's average position

allowing the manufacturer to determine the optimal process per project and to set clearly differentiated performance and tracking guidelines.

The ability to differentiate across technology programs and to optimize processes had dramatic effects on engineering productivity — improving cost, time, and quality performance simultaneously. Valuable human and capital resources, which had previously been tied up in performing and tracking mundane tasks, were freed up, reducing applied time and increasing resource availability. The manufacturer's effective engineering capacity expanded, allowing it to support a heavier load of complex, high-value-added projects. Better control and synchronization of projects allowed further cycle-time reduction. The quality of output also improved, because the company could better ensure the appropriate level of customer interaction in defining specifications and measuring compliance.

Once the required performance guidelines for each process had been defined, the company launched an external benchmarking survey to identify specific high-priority issues within each area. Flowcharts of engineering processes uncovered common problems across projects: multiple hand-offs of data, re-creation of data throughout the process, inefficient methods of design reuse, and systems incompatibilities. Key engineering processes were redesigned, resulting in applied time savings of up to 50 percent.

The manufacturer also implemented a stronger process for management and control across businesses. The process is driven by well-defined check points (tollgates), empowering the organization by delineating team members' roles and responsibilities, clarifying work priorities, and removing the need for day-to-day intervention by management. The new system coordinates decision-making processes and major groups working within the organization. It also allows for easier training of less experienced engineers by institutionalizing "memory" and clearly defining engineers' roles, responsibilities, and methods.

Overall, as a result of this aggressive program, the manufacturer realized dramatic improvements in engineering capabilities — reducing applied time by 30 to 50 percent, and elapsed time by 30 to 40 percent.

Industry Dynamics: Consumer Electronics

As the preceding cases demonstrate, understanding the strategic implications of relative technology positions and linking them to business strategy are critical. However, managers must also understand the shift of products and technologies across segments over time — e.g., the way "open systems" architectures typically displace proprietary product positions, drive commoditization, and squeeze profit margins by shifting value from producers to the end-user. They must manage the evolution of technology development and business strategy to maximize financial returns to the extended enterprise, recognizing the way value is shared across the various partners. An interesting demonstration of the dynamics of technology positions can be found in the consumer electronics market.

Historically, consumer electronics players have used a variety of strategies. For example, Sony has been the commercialization leader, employing an aggressive R&D strategy, bringing several new technologies to market first, and enjoying upscale positioning and premium pricing. Therefore, it generally played in the value-based competition segment. On the other hand, Matsushita/JVC has been a fast follower, excelling in delivery skills, employing a defensive R&D strategy (which earned it the title *maneshita* — imitator), and often becoming market share leader through lower pricing at later stages of the product life cycle. It was

thus generally positioned in the time-based competition segment (see Exhibit 7).

General technological trends, such as digitization and miniaturization, however, have brought forth such issues as standards, compatibility, and complementary software to the consumer electronics industry. These have forced both major competitors to participate in the major redesign arena, establishing standards and building an extended enterprise. Being first to market could no longer ensure success, nor could technological superiority do the trick. This change has been demonstrated in several product areas during the last decade.

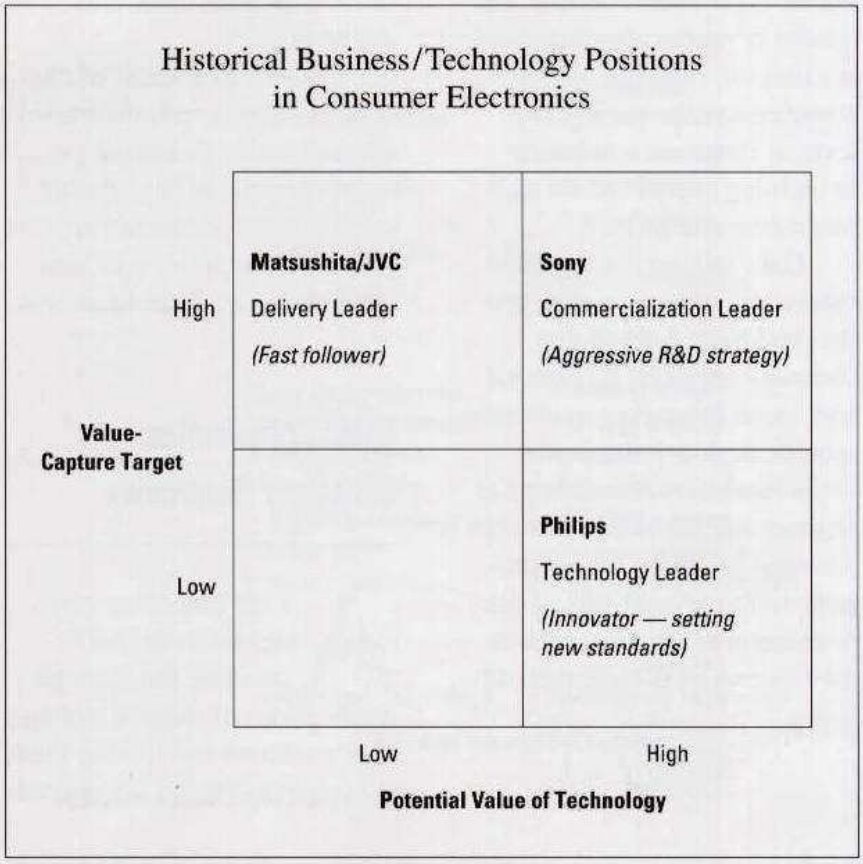
Sony was first to introduce a consumer VCR in the mid-1970s, using its technologically superior Betamax format — establishing a de facto standard by being first to market. However, Sony maintained the technology proprietary and sought to capture most of the value by refusing to license technology, sell components, or provide systems to other companies.

Matsushita/JVC was late to the market with the VHS format, but it corrected a major deficiency of the Betamax format. It offered longer tape-recording time, making the product more appropriate for delivering movies. Matsushita/JVC established VHS as a standard by consciously relinquishing portions of the potential value — licensing extensively to about a dozen Japanese companies, selling key components, building systems for non-Japanese companies such as Magnavox and Zenith, and actively penetrating film studios to ensure video software availability. Finally, VHS's higher penetration drove the cost-conscious video rental stores to abandon Betamax, forcing Sony to concede defeat in 1988.

Ironically, Sony has internalized lessons learned in the VCR market and completely reversed the situation in the camcorder market. Matsushita created the video camcorder market with its VHS and VHS-C formats, while Sony was three years late with an 8mm format incompatible with all video decks. Sony's technology, however, aimed at reducing the key technological barriers: size, weight, and recording time. It offered camcorders three times smaller and lighter than VHS-C models, with four times the recording time.

More important, Sony drove penetration by promoting standardization — forming an international consortium of one hundred manufacturers to set standards, making its technology widely available by licensing and selling key components to competitors, and, for the first time ever, becoming a subcontractor (to Fuji and Kyocera). Sony's approach spurred market

Exhibit 7 (below) demonstrates historical business/technology positioning in the consumer electronics industry. ▼



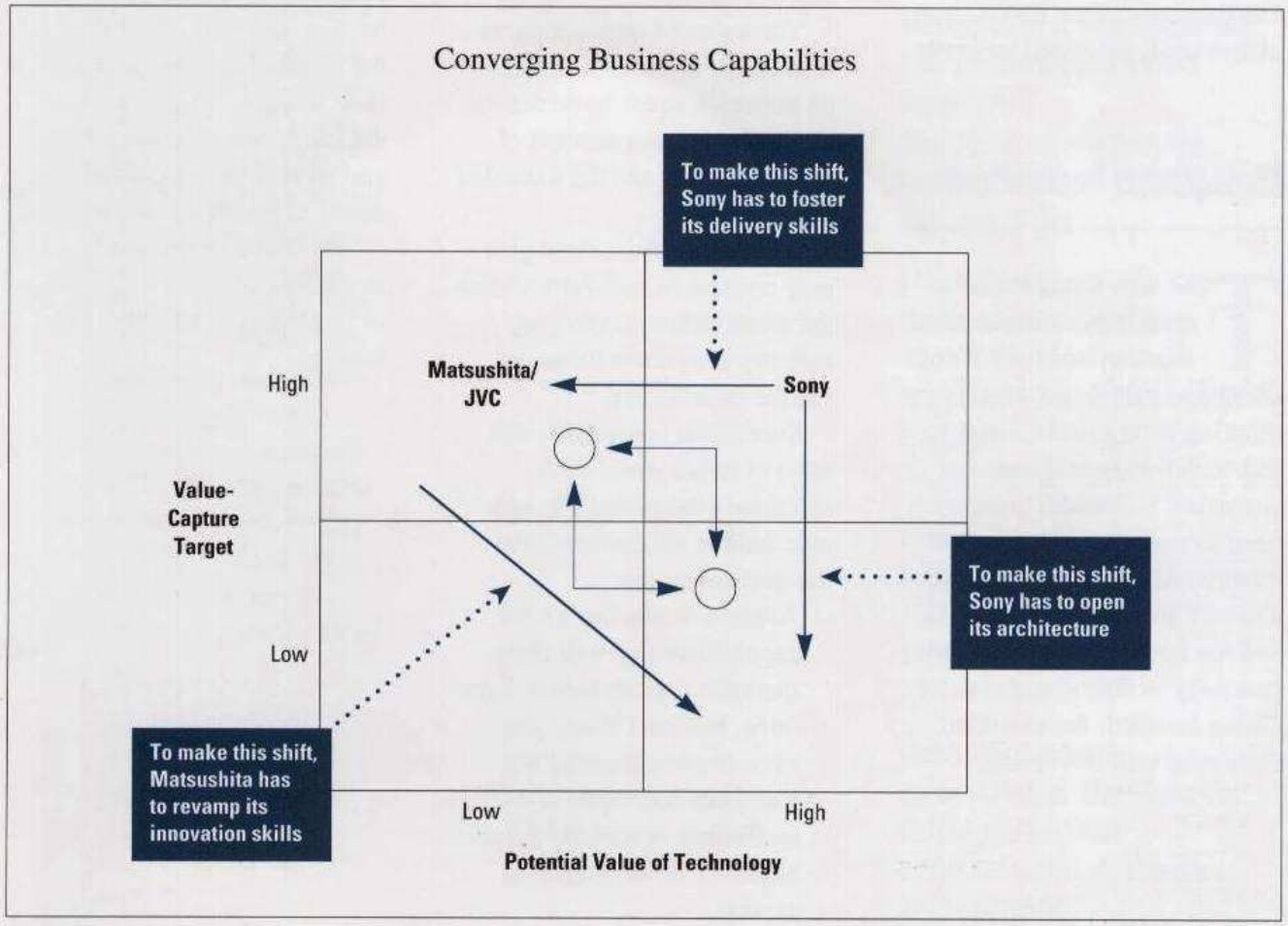
growth of 25 to 30 percent and attracted other producers (including Hitachi, Toshiba, Sharp, Canon, and RCA) to shift to the 8mm standard.

Sony has also combined its camcorder entry with a frontal attack on the VHS VCR market, initiating aggressive price cutting and severely damaging Matsushita/JVC, in an attempt to obsolete the existing technology. This strategy could be a prelude to a possible revitalization of the VCR market by a broad offering of 8mm decks, aided by Sony's offering of extensive movie and music software in the new format.

These two cases support the observations made earlier: neither time-to-market nor technological superiority can ensure success. Sony was defeated in the VCR market despite a much earlier entry, and Matsushita is currently losing in the camcorder market in spite of a three-year lead over Sony. Betamax lost to VHS even though it was inherently technologically superior, while the 8mm format is making progress despite incompatibility with most of the installed base and technological inferiority to the S-VHS format.

The business capabilities required to succeed in the consumer electronics market are converging (see Exhibit 8). Companies need to excel at both building extended enterprises and managing the time-based competition likely to ensue after standards are established. Clearly, these two distinct approaches would not be applied in the same market segment simultaneously, but rather consecutively. Both major players seem to be well on their way to

Exhibit 8 (below) diagrams how the capabilities of major players in consumer electronics are shifting and converging in line with required product/technology positions.
▼



enhancing their capabilities in accordance with the technological imperatives, building a more balanced set of delivery and innovation skills.

More broadly, the recent events in this industry demonstrate that the key success factor in today's environment is the ability to build and maintain a strong extended enterprise around the core technology: establishing a standard (by licensing, selling key components, and accepting OEM arrangements); using open, not proprietary, architectures; and ensuring software availability. And, most important, they underline the very fast pace of change and the need to build and deploy market driving capabilities to avoid the destruction of seemingly protected positions.

Management Implications

The new environment challenges conventional wisdom and traditional, albeit successful, patterns. New thinking is required on how to link technology and business strategies. Successful companies need to come up with a set of creative strategies. Technology markets are frequently too big and too complex for any single company to define and control. Going forward, the extended enterprise will increasingly define the competitive unit, giving rise to an increased emphasis on explicit and implicit cooperation along the value chain.

The prominent examples of strategic management of technology outlined above have a number of key implications for business and technology management:

- Linking technology and business strategies will be critical to success across a broad range of industries.
- Technology development, commercialization, and management are ongoing processes requiring reaction to changing business and technological conditions. Approaches should be differentiated across segments and over time.
- The value of technology, as well as the methods to unleash its potential, needs to be defined within the broader context of end-user needs and the extended enterprise.
- Multiple distinct strategies may coexist successfully within the same industry, allowing industry players to focus on unique capabilities.
- Successful companies will have to target sustainable extended enterprises and provide unique capabilities into the desired chains:
  - Achieve leadership in the capabilities that will drive markets, cutting across functions, business units, and even organizational lines.
  - Eliminate non-value-added, inefficient, or undifferentiated elements of the business system.
- More than ever, technology strategy must be an integral part of the firm's business strategy. Both must be developed through the combined efforts of a cross-functional top-management team.

Strategic management of technology is not easy; recent case studies have demonstrated the extent of the challenge and presented many paradoxes. However, it is still possible — and certainly critical — to successfully link business and technology strategies. Successful players will review their business and technology capabilities within the broad framework of their extended enterprises, will explicitly link their technology positions to their targeted capabilities, and will effectively use the targeted capabilities to drive their markets. Following this approach will require dramatic and sometimes painful adjustments in strategy and operations — yet it will be the primary key to success across a broad range of industries in the 1990s and beyond.

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