Product Development Know-How: Trading Tactics for Strategy

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NEW PRODUCT DEVELOPMENT promises opportunities to improve competitive position, increase returns on existing resources, and renew the entire organization. Unfortunately, most organizations report considerable frustration in connection with individual new product development projects. The authors suggest that much of this failure can be traced to management's tactical approach to the issue. They outline four propositions, or dimensions, along which tactical management views can be contrasted with strategic management views of new product development and technology management. *Ed.*

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ERHAPS NO AREA of organizational effort has greater promise, yet generates more disappointment, than new product development. Every organization we have encountered has its own horror stories. The following five illustrate the nature, magnitude, and variety of forms of such disappointments:

• A longtime market leader in the video recording market had established an extremely strong reputation for its technology leadership. However, when it designed its first generation of portable equipment in the mid-1970s, it discovered that two upstarts were able to match and exceed the performance of that first-generation equipment. In fact, the industry subsequently picked the basic design and format of one of those competitors as the new industry standard.

• In the early 1980s, a leader in the home appliance market found that, in spite of its outstanding reputation and history of new product features, its newly developed portable model was a tremendous disappointment. Intending to meet competitive pressures and customer desires, engineering had continued to add features, each of which added additional weight and cost to the product. The company's salesforce nicknamed this design the "aerobics model" because its weight and size guaranteed that both the salesperson and the customer would get a real workout from using it.

• A medical instruments firm thought it had identified the ideal concept for a next-generation

product. It had an excellent development team in place and had allocated sufficient resources to deliver on every detail of a well-developed plan. However, as the project proceeded and unexpected difficulties arose, it moved away from those detailed plans while adhering to its schedule and specs. In order to stay on schedule, steps were skipped, and final testing was left to the operating organization. One year after product introduction, customers continued to report that it looked like a great product—if only it worked reliably.

• A developer and manufacturer of mass storage products for the computer industry designed a breakthrough product. To ensure that its leadership position would be established rapidly and would remain secure, it not only carried out a carefully planned and orchestrated eighteen-month product development effort, but went to great lengths to protect the design: patents, legal agreements with suppliers, and trade-secret pacts with key customers. Imagine the company's chagrin when, within five days of public announcement, a competitor showed a breadboard model of a similar product; within three months this competitor was shipping the product.

• A final example comes from the machine tool industry, where one of the leading full-line contenders had systematically invested in a major R&D center, established technology exchange agreements with a wide range of suppliers, customers, and competitors, and dedicated substantial resources to

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building development engineering groups in each of its divisions. However, in spite of these efforts, it discovered that its new products failed to take full advantage of available technology and were continually bested in the marketplace by the product development efforts of several key competitors.

Do such new product development disappointments occur because the importance of product development is not recognized? Is it that insufficient or second-rate resources are dedicated to the product development effort? Is it that the people working on those product development efforts simply don't work hard enough or long enough? To anyone who has been involved in product development, the obvious answer to each of these questions is "no." Our experience indicates that the problem lies with senior managers—their expectations, the premises on which they operate, and the way in which they oversee and direct product development efforts. In particular, new product development weaknesses typically reflect, in microcosm, weaknesses in the broader area of technology management.

Most arenas of management, especially the difficult ones, rely on conventional wisdom built up over the years regarding appropriate procedures and practices—dos and don'ts that become rooted in the folklore. New product development and technology management are no exception. We have come to the conclusion that the conventional wisdom in new product development and technology management suffers from a key underlying problem: these two issues are seen in tactical rather than strategic terms. As a result, technology management and new product development remain segmented domains when they should be closely coupled, and neither manages to harness the competitive potential of technological change.

When a more strategic view is adopted, it becomes clear that these two issues represent two sides of the same coin: technology management represents the content or "state" view—management of the firm's technological assets—while new product development represents the "process" view—the deployment and enhancement of these assets through discrete actions. While an increasing proportion of firms attempt to manage their technological assets more strategically, these efforts are often frustrated by several underlying management assumptions. New product development is, in our experience, even further behind the curve: few companies even see the need for strategic management

of this key activity. As a result of these weaknesses, the two issues are often managed inconsistently, and technology and product development are isolated from the other functions of the business—from manufacturing, marketing, sales, and sometimes even from engineering.

Over the last decade or so, purely tactical and segmented views of technology management and new product development have become an increasingly serious competitive handicap, and the future promises even greater pressure in this arena. As competition internationalizes and intensifies, product design life cycles shorten relentlessly. As the rate of technological change accelerates and technologies merge and diverge (sometimes with startling consequences), demands on development resources increase and the risks of failure become more damaging competitively. While these challenges are often thought to be characteristic of only high-tech firms, virtually every industry is becoming more technology-intensive and is increasingly subject to these same forces.

In the sections that follow, we examine how five key elements of technology management and new product development are treated in the traditional tactical, segmented model, and contrast those with how they are treated in the emerging strategic, integrated model. We then outline the implications of this strategic, integrated model for management and identify some levers that management can use to shift from the old to the new model in their own organization.

Technology Management and New Product Development

Our detailed study of more than two dozen companies faced with new technology challenges has led us to identify five key elements of both technology management and new product development:

- The assignment of management responsibilities.
- The role of functional departments.
- The nature of planning.
- The means of protecting competitive advantage.
- The link between technology management and new product development.

Each of the companies we studied can be described by situating its approach to these five elements along a continuum ranging from the tactical and compartmentalized to the strategic and integrated. The former approach hinders the use

of technology in developing a sustainable competitive advantage. Approaches on the latter end of the spectrum not only take greater advantage of the technology's potential, but also better position the organization to use it to strengthen and enhance other aspects of its competitive advantage.

The Assignment of Management Responsibilities

The conventional, tactical, segmented approach assigns responsibility for technology management almost exclusively to technical specialists. This approach assumes that new products are derived from new technology, that product development projects are "engineering" projects, and that the flow is basically in one direction—from the R&D laboratory to the marketplace. Thus, the job of the R&D department is to select, develop, and apply technology. The job of other departments within the company—often referred to as "downstream" departments—is to manufacture, sell, deliver, and service the product. The earlier example of the video recording equipment firm indicates some of the limitations of this perspective.

The major risk of this approach is that the organization loses sight of its competitive realities, loses touch with its customers, and ends up making suboptimal tradeoffs, applying inappropriate criteria in the allocation of resources, and failing to take full advantage of the technological capability it has.

A more strategic and integrated view recognizes that technology both drives and is driven by all the other elements of the business strategy. In technology management, this implies that decisions on technological investment and its application to products, markets to be served, and the distribution channels to be used are considered complementary; they should therefore be made by the entire management team. The market can and should have as much effect on the firm's technological direction as does the laboratory. Instead of delegating market analysis to the marketing department, the development engineer should keep one foot in the marketplace to facilitate the two-way flow of information so essential to the successful application of technology to new products.[1]

In new product development, this more strategic approach implies that development projects should be headed by business managers, not technical specialists. Clearly, in technology-intensive firms, such business managers should have an ex-cellent understanding of the technical issues. But their focus should encompass not only the technology but also the business and the market. Similarly, project team members should be evaluated on their contribution to business objectives, not only to technical results as viewed from their area of specialization. Some of Hewlett-Packard's divisions have attempted to capture this spirit by evaluating product development efforts not only on performance and time to manufacturing release, but also on what they call the "break-even period"—the time from project inception to the point at which sufficient sales have been generated to recover all the development and manufacturing ramp-up costs.

Another example of this more strategic perspective on responsibility for technology and product development is the Honda Motor Company. Although significantly smaller than its major U.S. and Japanese competitors, Honda has effectively focused its resources, combined its technological capabilities with other functions, and integrated technology with other dimensions of its competitive strategy. The R&D people remain aware of the marketplace, customers, and competition because they spend up to two months each year in the field with customers. In addition, those outside of the R&D function are selected, trained, and guided to consider their interaction with the technology and to take responsibility for using available technologies. Car development projects give the project manager substantial responsibility and authority over functional resources.

The Role of Functional Departments

The conventional, tactical view here is that competitive advantage derives primarily from product technology as manifested in product specifications and performance characteristics. This view is the assumption behind the "build the better mousetrap" syndrome. It fails to recognize that customers' buying motivations turn on far more than just product performance specifications, as likewise does a firm's competitive advantage. Along with this conventional wisdom goes the separation of technology responsibility by subfunction in the organization.

The home appliance firm, whose engineering group added every conceivable bell and whistle to its first-generation portable unit, is an example of this conventional view. In that organization, de-

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sign engineering was given free rein in selecting, developing, and applying product technology without regard for its implications or interactions with other functions of the business. Not only did the product miss the target in the marketplace, but the other functions found that the product technology selected by design engineering severely constrained their ability to manufacture, deliver, and service the product efficiently.

By contrast, our research suggests that the most powerful and sustainable competitive advantages derive from integrating product, process, and support technologies. For new product development, the strategic approach means that the downstream functions are all actively involved in each phase of product development rather than responding to upstream efforts when the results of those are "thrown over the wall."[2] When product design pays attention to how the product will be manufactured and takes advantage of existing or developing process and support capabilities, and when the design of new processes and new field services is geared to new product plans in the design lab, the firm is likely to capture truly superior performance, quality, and cost advantages. A well-integrated approach to technology is far more defensible and sustainable—more difficult for competitors to match successfully—than is an approach to technology that emphasizes product, process, or field service dimensions alone.

For the broader issue of technology management, this more strategic approach implies that the role of the functions is not simply to "support" the R&D strategies, nor even merely to support a predefined business strategy, but to stimulate, refine, and possibly redirect both the R&D and the business strategies. The result should be a jointly defined and collaboratively implemented cluster of functional and business strategies that reinforce one another, each making the most appropriate use of opportunities in all three areas of product, process, and support technology.

A good example of the contrast between the conventional (tactical) and the progressive (strategic) views of this element comes from what has traditionally been a mundane and low-tech field—forest products and building components. Most producers of wood joists leave design (that is, product technology) to the architect and require their own manufacturing to respond with such a great variety of output that improvements in process technology become almost impossible. The salespeople are order-takers, selling a commodity and offering little in the way of applications engineering. Trus Joist Corporation, however, has chosen quite a different approach with considerable success. This company developed proprietary joists with laminated support pieces that offer superior performance at a premium price. They designed their manufacturing plants to incorporate proprietary process technology geared to those joists and their component materials. In addition, the firm staffs its field salesforce with technically qualified people, equips them with CAD systems so they can work with architects and engineers and add significant technical value, and links those CAD systems directly to their computerized, in-plant production planning system. The result: margins well above the industry average and rapid sales growth during both the boom and bust parts of the construction industry cycle.

The Nature of Planning

The conventional view is that a firm's technology plan should be worked out in detail and agreed to throughout the organization, and that deviations should be assiduously avoided. The organizational structure and the assets implied by the firm's long-range plan should be defined in detail and put in place with some sense of permanence. This view of technology planning, organizational design, and capabilities is static. It implies that one can define in considerable detail the relevant "environment" and then optimize within it—a view that holds for fewer and fewer industries, and in virtually none of the more technology-intensive industries.

The development problems described earlier for the medical instruments firm can be traced in large part to top management's adherence to this conventional view of planning. With a clear concept of the product and the specifications, management considered the only challenges to be delivering on schedule and within budget. While the project started with tremendous enthusiasm and quickly gained momentum, management's inability to accept the need for some midcourse corrections and its strict adherence to the original schedule (with only limited regard for whether all the tasks had been completed) eventually led people to cut too many corners. It was hardly a surprise when the sales results indicated that the product had been

introduced before being fully completed.

The more strategic view does not abandon technology planning, but it does alter it substantially. Evidence from our work and that of others suggests that it is preferable to set a general sense of direction for technology evolution rather than to tackle the impossible—and inhibiting—task of preprogramming exactly how the technological future of the company is to unfold. As one observer aptly put it, strategic planning should aim to provide the company with a compass and a directional heading, not a detailed itinerary.[3] In a dynamically evolving environment, any detailed itinerary quickly becomes obsolete. With a compass approach, it is possible to think much further into the future, even in dynamic environments, enabling the organization to tackle long lead-time issues such as the development of new in-house capabilities in emergent technologies.

The longer-term thinking permitted by a compass approach facilitates the strategic management of development projects via the creation of product generation maps.[4] These enable the company to step back and contemplate successive generations of products, the general direction of their evolution, and the selection of development projects that operationalize and refine the technology strategy. These maps also provide project managers with a broader contextual understanding, enabling them to make appropriate midcourse corrections when unexpected opportunities or roadblocks arise, and facilitate senior executives managing across product generations.

One firm that has adopted this progressive perspective is Chaparral Steel.[5] Chaparral, originally a mini-mill focusing on low-end construction products, but now a relatively full-line producer of forging steels and structural shapes as well as construction products, has achieved its success in large part because of its technology strategy.[6] That strategy, however, has not been driven by a detailed master plan of each element of technology that was needed and how it would be acquired. At Chaparral, teams consisting of managers, engineers, supervisors, and first-line employees regularly visit customers, competitors, suppliers, and universities to learn of technological needs and opportunities. The technology strategy is thus driven largely by exploring and understanding the possibilities, selecting the key opportunities, and then pursuing those aggressively on a broad front.

Pushing the idea of cross-functional synergy to an extreme, Chaparral has no separate R&D or engineering function, not because it relies solely on vendors, but because the entire workforce is actively involved in development and improvement projects. (This approach also presupposes a high level of integration of technology strategy with other strategies, in particular human resource strategy.) The result is a continuous stream of experiments on products, processes, and delivery services that represent the application of enhanced and improved technologies. While Chaparral has a superbly effective technological strategy, no detailed document outlines discrete steps of that strategy. Rather, Chaparral has a sense of direction and a dedication to energetic and creative pursuit of that direction.

The Means of Protecting Competitive Advantage

The tactical, segmented view of this element is that technology advantage must be guarded closely and the best means for doing so is through patents and trade secrets. A surprising number of technology-based companies become preoccupied with building barriers through patents, and, when patents are unobtainable, through trade secrets. While patents can be an important competitive factor in some industries (such as chemicals), in many other industries (including most high-tech industries), neither patents nor trade secrets remain a significant deterrent for long.[7] Indeed, when tested in court, roughly half of all patents are found to be invalid.

The point is not that patents and trade secrets are useless, but that they are likely to be more valuable as a tactical defense than as a strategic offense; confusing the latter with the former can be dangerous. The mass storage firm cited previously, developing the first generation of a new product concept, went to great lengths to keep that product concept secret and signed contracts that it felt would protect the firm and guarantee the proprietary nature of its sources of supply. Unfortunately, it discovered upon product introduction at a national trade show that the concept was significantly easier to imitate than anticipated, and that the detailed proprietary contract arrangements did not cover every eventuality. An ethos of defensive secrecy had led the organization to turn its attention inward; senior managers had thus overestimated the gen-

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ius of their own design and attributed their future competitive advantage to a subset of the physical product's characteristics. We have found that the most secretive companies often have the least to be protective of, and their concern with preventing leaks tends to erect barriers against the flow of new ideas and technology into and within the firm.

The more strategic view of the source of competitive advantage focuses on continuously renewed know-how and capabilities that allow the firm to outdistance competitors. Security in technological advantage or product superiority is not in having a contract, patent, or trade secret, but in having the underlying capabilities and enhancing, strengthening, and extending them faster than your competitors.

A good example of the power of this approach applied to the new product development area comes from the same mass storage company described previously. The firm did discover that its contracts and trade secrets failed to protect its new product concept. But it also discovered that the capabilities it had developed in refining that concept—capabilities that included consistently high product and service quality, low-cost manufacturing, and integrated functions capable of moving quickly to develop the next-generation product—stood the firm in good stead even after competitors had introduced look-alike products. Three years later, there were more than forty competitors in the marketplace, but the firm still held two-thirds of the market because it was able to introduce a series of refinements and enhancements that outpaced the competitors' offerings.

Chaparral Steel, the mini-mill mentioned earlier, offers an excellent example of this approach applied to the broader question of technology management. It encourages visits by other steel producers with, of course, the understanding that those visits will be reciprocated. Chaparral believes that its know-how, built up over a number of years and diffused throughout the organization, gives it a significant advantage in discerning valuable new ideas, adopting and adapting them rapidly, and then extending and refining them over time. Thus, while it does not reveal all of its understanding and knowledge to its competitors, Chaparral has no qualms about showing competitors around the mill, since most of them are less equipped to realize the technology's full potential. Those competitors tend to

stumble or at least move more slowly when copying its technology, since they lack the know-how—the infrastructure of capabilities—that Chaparral has worked so hard to build.

The Link between Tech Management and New Product Development

The final element of the conventional view considers technology management as largely separable from new product development efforts. The machine tool company cited in our introduction is illustrative. That company defined clear and distinct roles for its central development lab and for each of its divisional engineering departments. The R&D lab was charged with developing "breakthroughs" that the operating divisions were expected to capitalize on and adapt to. The goal was to build the technical knowledge and the asset base that would be needed over the next decade and then to let the day-to-day operations, including product development, draw on that reservoir of knowledge.

This firm discovered, however, that the emergence of flexible manufacturing systems, computer integrated design, new manufacturing technologies, and foreign competition sharply altered the demands on the company. More interaction among divisions was required. Systems capabilities, not just individual equipment design strengths, became essential in the new environment. Computer hardware and software knowledge could no longer simply be purchased. In addition, the substantial investments made in the R&D labs with hopes of breakthroughs rarely gave quite the results anticipated; even when success was achieved in the lab, the operating divisions rarely took full advantage of it. Eventually the company's slow response in changing its structure and perspective on technology management, and the latter's disjunction from day-to-day operations, led to the demise of several major divisions.

The more strategic perspective on this element sees technology management as a learning process—one that requires an iterative and interactive exchange with product development and manufacturing operations. Just as an individual's approach to problems is altered by learning—identifying new areas of interest, opening new avenues of inquiry, and even changing self-perceptions—learning can have a similarly profound impact on an organization. New problems and op-

portunities become tractable; the relevant next piece of learning to be pursued is redefined; and the organization changes its self-perception and goals. These are positive events in the organization's life, and should be accepted and encouraged accordingly. The tactical approach to technology management isolates it from the learning opportunities associated with day-to-day operations and new product development activities.

Because of the significance of this final element of the model, it is useful to expose two myths nurtured by the tactical perspective. The first is that the shattering discovery, the clever acquisition, the great patent, or the blockbuster product is the primary type of advantage that can be provided by technology management. Strategy is reduced to a few bold actions. A much more appropriate perspective on technology's competitive role is the old football adage used by Woody Hayes of Ohio State: three yards and a cloud of dust is a more reliable game plan than one built upon spectacular long passes.

Understandably, managers worry that revolutionary technologies will make their technology strategy obsolete overnight, to say nothing of their products and facilities. Three factors should, however, alleviate this concern. First, such technological discontinuities occur very infrequently. Second, they are almost always discernible by systematic scanning and technology forecasting many years before they reach the marketplace. Third, and most important, nothing can substitute for the continuous incremental enhancement of capabilities: chance favors the prepared mind.

The second myth is that superior technological capabilities can be acquired like other tangible assets, by taking over a company with an interesting portfolio of patents or by hiring a platoon of creative geniuses. The capabilities that can provide competitive advantage are built, not acquired. If you can buy it, so can your competitor. Moreover, such assets cannot be fully exploited unless the company has the necessary infrastructure in place to accept the new technology and weave it into existing capabilities.[8]

All of our earlier examples of the strategic perspective involved this interactive learning view of technology management and product development. For firms like Trus Joist, Honda, and Chaparral, development projects do not simply draw on existing technical capabilities and assets—they are

viewed as integral to *extending* technological capabilities. They capitalize on existing strengths and overcome potential weaknesses and competitive threats. Thus technology management simultaneously interacts with, coexists with, and is inseparable from day-to-day operating management. Here the rubber meets the road and a firm's technology strategy (the projected growth path for its technical capabilities) and its development projects can contribute to a solid and defensible competitive advantage.

Implications and Recommendations for General Management

The goal for the organization and its managers is to build a path for continued enhancement of the firm's competitive advantage. The more intensively and extensively the organization can use technology—the more important technology becomes as a source of sustainable competitive advantage—the greater the need for enlightened management of technology and of new product development. But the shift from the tactical, segmented to the strategic, integrated perspective involves profound organizational changes. General managers should be aware that this is not a matter of minor reorientation and retuning.

The following five recommendations for management activity and behavior correspond to the five elements described earlier. While each is discussed individually in this section, their real power comes only when they are integrated effectively.

The first implication is that *top management must be more deeply involved*. The understandable reluctance of nontechnical top managers to engage in resolving key technical issues—their tendency to delegate to those they judge to be more technologically sophisticated—must be resisted. Technology management and product development are part of the substance of strategy. This is not to argue that top managers must get involved in every technical detail, but rather that they must wrestle with the basics of the technologies affecting the business. Those basics have a profound impact on management's agenda and focus. Good general management cannot be separated from good technology management.

At a minimum, technical literacy is essential for all top managers. It is not enough for general managers to be able to classify their organizations'

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technology portfolios into broad categories such as base, key, and pacing. (This schema, proposed by A.D. Little, distinguishes between base technologies that are common to most industry players, key technologies that determine relative competitive performance, and pacing technologies that might become tomorrow's keys.[9]) Useful as such a classification is, too many critical decisions hinge on a more detailed understanding of the business and economic implications of the specific technologies upon which the company builds its competitive advantage and strategies. These include the parameters of those technologies, their applications, their current and potential links to other technologies, and forecasts of the direction and pace of evolution of these and related technologies.

A particularly important area for senior management involvement is new product development. Extensive and systematic participation in the preproject phase of a product development effort is probably the single most important area where senior management can put its involvement in technology into operational practice. The pre-project phase is often neglected but is always critical to the project's success. It is the phase that builds the appropriate knowledge base and defines the technology and product maps.[10]

During the project itself, senior management must stay sufficiently in tune to help reassess, redirect, or reinforce strategic imperatives as it conducts periodic project reviews. Furthermore, if these reassessments lead to modifications in the schedule, performance, or cost objectives of the new product development effort, senior management must expect and require the regrouping of detailed activities and tasks so those modified objectives can be achieved.

The second recommendation is that *top management focus particular attention on managing the boundaries or interfaces between the key functional areas of the business.* When strategy development is a participative process, when know-how is diffused throughout the organization, and when responsiveness to a rapidly changing environment requires the telescoping of activities, the key challenge facing general management is to ensure a high level of integration across the functions of the business— research, engineering, marketing, sales, manufacturing, and customer service. These horizontal linkages (all the way down to the lowest levels of the organization) enable the organization to gain the

full potential from its technological opportunities without slowing to a snail's pace.

Technology management and product development are team sports, not individual events, and as team sports they are more like basketball than a relay race. Effective product development efforts rarely look like baton passing; much more often, they are like a basketball team moving together, passing the ball as all players advance, continually redefining strategy, executing plays, and effecting coordination. All the functions are extensively involved in and share responsibility throughout the new product development effort. The team character of effective technology management derives from the superiority of an integrated, multidimensional, multifunctional strategy over strategies based on narrow technical prowess of a single type. No function can be viewed as a second-class citizen in such an organization.

The ability to work together effectively is a formidable competitive asset and one that is exceedingly difficult to imitate, whether that ability is exhibited in the form of shorter product development cycles, new products with superior performance and quality attributes, or lower product costs due to designs that facilitate producibility and serviceability.

The third recommendation is that *management should view objectives as deriving from capabilities, not the other way around.* The traditional view of strategic planning is that first objectives are set, then detailed strategies are defined, and finally the required resources are allocated.

In a dynamic, technology-intensive environment, the more effective sequence for strategic planning is just the reverse.[11] It starts with the development of capabilities (more than just financial resources) that are embedded in the organization and superior to those of competitors. These become the source of competitive advantage—not just defensive barriers, but offensive capabilities—and serve to differentiate a company from its competitors. Next, the match between these capabilities and the opportunities in the market are explored as they emerge. Line managers well down in the organization are empowered to identify new market opportunities and apply or develop capabilities for meeting them. Finally, the company's expectations—its objectives—derive from this evolving strategy built on organizational capabilities; these objectives are viewed as mileposts indicating prog-

ress along the way, not welcome signs indicating arrival at a final destination.

This third recommendation points directly to our fourth: *general management should view its job as helping the organization to build capabilities*. These capabilities include technological competencies, organizational skills, and the network of linkages upstream (with vendors), horizontally (with competitors), and downstream (with customers). They are a much stronger source of competitive advantage than are patents, closely guarded trade secrets, and contractual relationships. When embedded and diffused throughout the organization, such capabilities are the core of sustainable competitive advantage. It is the development of these capabilities that should be uppermost in managers' minds, not simply the protection and utilization of yesterday's assets or proprietary knowledge.

One key type of capability is the firm's ability to organize new product and process development projects. Senior managers should regularly audit this capability and ensure that the whole organization knows the importance of continual improvement in the management of the development process.

Firms that see strategy as building capabilities rather than the means for achieving pre-specified objectives have another important advantage over their competitors: they can attract the right kind of people. The organization that is focused on developing capabilities can offer greater challenges, helping its people grow and develop to their full potential over an extended time period.

Our fifth recommendation is that a *top priority for management is to foster, encourage, and support learning*. As a new technology is developed and exploited by the company, the management of this technology will initially involve more art than science. General management must, on the one hand, be prepared to live with the ambiguity inherent in such art, and at the same time organize to encourage its gradual transformation into science. This transformation typically requires some redefinition of the role of technical personnel, and sometimes involves major organizational restructuring.

The transition from art to science in process technologies presents management with some particularly important challenges. It has the potential either to empower employees by extending their capabilities or to de-skill them by using technol-

ogy to routinize tasks that formerly required the exercise of judgment. Unless management gets comfortable with the idea of extended worker capabilities, the temptation is strong to go the de-skilling route. Recent research suggests, however, that the empowering route is typically much more effective in augmenting organizational capabilities and building competitive advantage.[12]

Learning occurs faster in an atmosphere that fosters an expectation of change—where change is the rule rather than the exception—and where sensible risk taking is rewarded rather than punished. This truth implies the need for a considerable change in performance evaluation procedures, especially the evaluation of profit centers and divisional management. The traditional approach of basing a division manager's income primarily on the annual profit performance of that division explains, perhaps more than any other factor, the attraction of the dramatic "big step" technology breakthrough. Even when top management is convinced of the importance of continual small-step enhancements, these improvements are unlikely to take place until incentives are changed.

Development projects should be viewed not only as an opportunity to apply what the organization and its members have learned in the past, but also as an opportunity for new learning. To achieve this learning, general management must systematically examine and support the opportunities for team member learning, project management learning, and, perhaps most important, organizational learning across a number of projects. Taking advantage of across-project opportunities for learning requires that each project have as a key objective the development of new technical know-how and new organizational capabilities, not just the delivery of a defined product or process by a certain date.

Learning itself must not be myopic and self-centered. Conscious efforts should be focused on assessing technology both inside and outside the organization. Extremely important is a vigilant effort to combat the all-too-prevalent "not invented here" syndrome—without falling into the other trap of "anybody's but ours."

Getting Started

Our research suggests that the five elements characteristic of the strategic, integrated model constitute a foundation for effective technology manage-

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ment and new product development. But how can an organization make the transition from a more tactical, segmented approach to this new model? Recognizing the need for a significant change is only part of the challenge. Developing and adhering to a plan for achieving that change is equally if not more challenging, especially since pressures to make near-term technology choices, deliver on current development projects, and meet short-term performance objectives, have never been greater for most organizations. While each organization must assess its own environment, its motivations for change, and its collective will to follow through, we have identified eight steps that appear to be essential to getting started.[13]

• Stimulating and motivating the need for fundamental change by focusing attention on competitor and customer demands as well as internal opportunities and ambitions.

• Developing a directional vector—a compass heading—for the firm's technology strategy.

• Preparing a projects plan, showing the way in which a set of projects might be used to operationalize that technology strategy and apply the organization's technical capabilities.

• Selecting an important development project that can serve as a credible demonstration to the organization of the new model in action.

• Aligning expectations and performance measures for that demonstration project with the new model.

• Using the organizational learning from the demonstration project to stimulate and seed complementary efforts elsewhere in the organization.

• Modifying and acquiring tools, procedures, and infrastructural systems that reinforce the new model and discourage the old one.

• Anticipating and preparing for changes in decision-making procedures, organization structure, and career paths to fit the new model.

These steps can get an organization started, but long-term success in adopting the strategic, integrated model requires, above all, recognizing that the new model is much less of a "model" than the old, tactical, segmented one. While the tactical model easily lends itself to fairly universal prescriptions about how to manage technology and projects, the learning focus of the new model means that every organization needs to develop its own approach. The management style implied by the new approach requires a delicate and difficult

balancing act between conflicting pressures—between delegation and centralization, between boldness and ambiguity, between discipline and opportunism, and even between order and disorder.[14] To strike the appropriate balance and adapt it over time is truly the art of strategic technology and project management. ■

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