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LEADING TEAMS

The New New Product Development Game

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In today's fast-paced, fiercely competitive world of commercial new product development, speed and flexibility are essential. Companies are increasingly realizing that the old, sequential approach to developing new products simply won't get the job done. Instead, companies in Japan and the United States are using a holistic method—as in rugby, the ball gets passed within the team as it moves as a unit up the field.

This holistic approach has six characteristics: built-in instability, self-organizing project teams, overlapping development phases, "multilearning," subtle control, and organizational transfer of learning. The six pieces fit together like a jigsaw puzzle, forming a fast flexible process for new product development. Just as important, the new approach can act as a change agent: it is a vehicle for introducing creative, market-driven ideas and processes into an old, rigid organization.

The rules of the game in new product development are changing. Many companies have discovered that it takes more than the accepted basics of high quality, low cost, and differentiation to excel in today's competitive market. It also takes speed and flexibility.

This change is reflected in the emphasis companies are placing on new products as a source of new sales and profits. At 3M, for example, products less than five years old account for 25% of sales. A 1981 survey of 700 U.S. companies indicated that new products would account for one-third of all profits in the 1980s, an increase from one-fifth in the 1970s.[1]

This new emphasis on speed and flexibility calls for a different approach for managing new product development. The traditional sequential or "relay race" approach to product development—exemplified by the National Aeronautics and Space Administration's phased program planning (PPP) system—may conflict with the goals of maximum speed and flexibility. Instead, a holistic or "rugby" approach—where a team tries to go the distance as a unit, passing the ball back and forth—may better serve today's competitive requirements.

Under the old approach, a product development process moved like a relay race, with one group of functional specialists passing the baton to the next group. The project went sequentially from phase to phase: concept development, feasibility testing, product design, development process, pilot production, and final production. Under this method, functions were specialized and segmented: the marketing people examined customer needs and perceptions in developing product concepts; the R&D engineers selected the appropriate design; the production engineers put it into shape; and other functional specialists carried the baton at different stages of the race.

Under the rugby approach, the product development process emerges from the constant interaction of a hand-picked, multidisciplinary team whose members work together from start to finish. Rather than moving in defined, highly structured stages, the process is born out of the team members' interplay (see Exhibit 1). A group of engineers, for example, may start to design the product (phase three) before all the results of the feasibility tests (phase two) are in. Or the team may be forced to reconsider a decision as a result of later information. The team does not stop then, but engages in iterative experimentation. This goes on in even the latest phases of the development process.

EXHIBIT 1
Sequential (A) vs. overlapping (B and C) phases of development

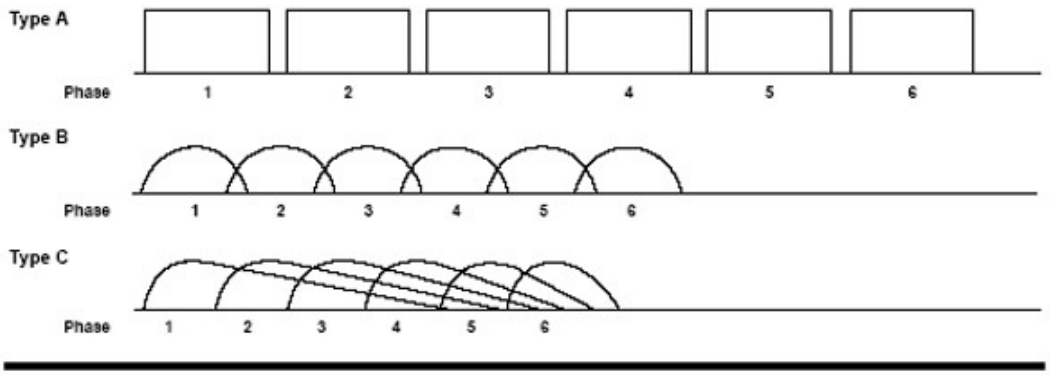


Exhibit 1 Sequential (A) vs. overlapping (B and C) phases of development

Exhibit 1 illustrates the difference between the traditional, linear approach to product development and the rugby approach. The sequential approach, labeled type A, is typified by the NASA-type PPP system. The overlap approach is represented by type B, where the overlapping occurs only at the border of adjacent phases, and type C, where the overlap extends across several phases. We observed a type B overlap at Fuji-Xerox and a type C overlap at Honda and Canon.

This approach is essential for companies seeking to develop new products quickly and flexibly. The shift from a linear to an integrated approach encourages trial and error and challenges the status quo. It stimulates new kinds of learning and thinking within the organization at different levels and functions. Just as important, this strategy for product development can act as an agent of change for the larger organization. The energy and motivation the effort produces can spread throughout the big company and

begin to break down some of the rigidities that have set in over time.

In this article, we highlight companies both in Japan and in the United States that have taken a new approach to managing the product development process. Our research examined such multinational companies as Fuji-Xerox, Canon, Honda, NEC, Epson, Brother, 3M, Xerox, and Hewlett-Packard. We then analyzed the development process of six specific products:

- FX-3500 medium-sized copier (introduced by Fuji-Xerox in 1978)
- PC-10 personal-use copier (Canon, 1982)
- City car with 1200 cc engine (Honda, 1981)
- PC 8000 personal computer (NEC, 1979)
- AE-1 single-lens reflex camera (Canon, 1976)
- Auto Boy, known as the Sure Shot in the United States, lens shutter camera, (Canon, 1979)

We selected each product on the basis of its impact, its visibility within the company as part of a "breakthrough" development process, the novelty of the product features at the time, the market success of the product, and the access to and availability of data on each product.

Moving the Scrum Downfield

From interviews with organization members from the CEO to young engineers, we learned that leading companies show six characteristics in managing their new product development processes:

1. Built-in instability

2. Self-organizing project teams

3. Overlapping development phases

4. "Multilearning"

5. Subtle control

6. Organizational transfer of learning

These characteristics are like pieces of a jigsaw puzzle. Each element, by itself, does not bring about speed and flexibility. But taken as a whole, the characteristics can produce a powerful new set of dynamics that will make a difference.

Built-in Instability

Top management kicks off the development process by signaling a broad goal or a general strategic direction. It rarely hands out a clear-cut new product concept or a specific work plan. But it offers a project team a wide measure of freedom and also establishes extremely challenging goals. For example, Fuji-Xerox's top management asked for a radically different copier and gave the FX-3500 project team two years to come up with a machine that could be produced at half the cost of its high-end line and still perform as well.

Top management creates an element of tension in the project team by giving it great freedom to carry out a project of strategic importance to the company and by setting very challenging requirements. An executive in charge of development at Honda remarked, "It's like putting the team members on the second floor, removing the ladder, and telling them to jump or else. I believe creativity is born by pushing people against the wall and pressuring them almost to the extreme."

Self-organizing Project Teams

A project team takes on a self-organizing character as it is driven to a state of "zero information"—where prior knowledge does not apply. Ambiguity and fluctuation abound in this state. Left to stew, the process begins to create its own dynamic order.[2] The project team begins to operate like a start-up company—it takes initiatives and risks, and develops an independent agenda. At some point, the team begins to create its own concept.

A group possesses a self-organizing capability when it exhibits three conditions: autonomy, self-transcendence, and cross-fertilization. In our study of the various new product development teams, we found all three conditions.

Autonomy. Headquarters' involvement is limited to providing guidance, money, and moral support at the outset. On a day-to-day basis, top management seldom intervenes; the team is free to set its own direction. In a way, top management acts as a venture capitalist. Or as one executive said, "We open up our purse but keep our mouth closed."

This kind of autonomy was evident when IBM developed its personal computer. A small group of engineers began working on the machine in a converted warehouse in remote Boca Raton, Florida. Except for quarterly corporate reviews, headquarters in Armonk, New York allowed the Boca Raton group to operate on its own. The group got the go-ahead to take unconventional steps such as selecting outside suppliers for its microprocessor and software package.

We observed other examples of autonomy in our case studies:

- The Honda City project team, whose members' average age was 27, had these instructions from management: to develop "the kind of car that the youth segment would like to drive." An engineer said, "It's incredible how the company called in young engineers like ourselves to design a car with a totally new concept and gave us the freedom to do it our way."

- A small group of sales engineers who originally sold microprocessors built the PC 8000 at NEC. The group started with no knowledge about personal computers. "We were given the go-ahead from top management to proceed with the project, provided we would develop the product by ourselves and also be responsible for manufacturing, selling, and servicing it on our own," remarked the project's head.

Self-transcendence. The project teams appear to be absorbed in a never-ending quest for "the limit." Starting with the guidelines set forth by top management, they begin to establish their own goals and keep on elevating them throughout the development process. By pursuing what appear at first to be contradictory goals, they devise ways to override the status quo and make the big discovery.

We observed many examples of self-transcendence in our field work. The Canon AE-1 project team came up with new ideas to meet the challenging parameters set forth by top management. The company asked the team to develop a high-quality, automatic exposure camera that had to be compact, lightweight, easy to use, and priced 30% lower than the prevailing price of single-lens cameras. To reach this ambitious target, the project team achieved several firsts in camera design and production: an electronic brain consisting of integrated circuits custom-made by Texas Instruments; modularized production, which made automation and mass production possible; and reduction in the number of parts by 30% to 40%. "It was a struggle because we had to deny our traditional way of thinking," recalled the head of the AE-1 team. "But we do that every day in the ongoing parts of our business," responded another Canon executive. The entire organization makes daily, incremental improvements to strengthen what the president calls "the fundamentals": R&D, production technology, selling prowess, and corporate culture.

The Honda City project team also achieved a breakthrough by transcending the status quo. The team was asked to develop a car with two competitive features for the youth segment: efficiency in resources and fuel, and uncompromising quality at a low price. The team's natural instinct was to develop a scaled-down version of Honda's best-selling Civic model. But after much debate, the team decided to develop a car with a totally new concept. It challenged the prevailing idea that a car should be long and low and designed a "short and tall" car. Convinced that an evolution toward a "machine minimum, human maximum" concept was inevitable, the team was willing to risk going against the industry norm.

Cross-fertilization. A project team consisting of members with varying functional specializations, thought processes, and behavior patterns carries out new product development. The Honda team, for example,

consisted of hand-picked members from R&D, production, and sales. The company went a step further by placing a wide variety of personalities on the team. Such diversity fostered new ideas and concepts.

While selecting a diverse team is crucial, it isn't until the members start to interact that cross-fertilization actually takes place. Fuji-Xerox located the multifunctional team building the FX-3500—consisting of members from the planning, design, production, sales, distribution, and evaluation departments—in one large room. A project member gave the following rationale for this step: "When all the team members are located in one large room, someone's information becomes yours, without even trying. You then start thinking in terms of what's best or second best for the group at large and not only about where you stand. If everyone understands the other person's position, then each of us is more willing to give in, or at least to try to talk to each other. Initiatives emerge as a result."

Overlapping Development Phases

The self-organizing character of the team produces a unique dynamic or rhythm. Although the team members start the project with different time horizons—with R&D people having the longest time horizon and production people the shortest—they all must work toward synchronizing their pace to meet deadlines. Also, while the project team starts from "zero information," each member soon begins to share knowledge about the marketplace and the technical community. As a result, the team begins to work as a unit. At some point, the individual and the whole become inseparable. The individual's rhythm and the group's rhythm begin to overlap, creating a whole new pulse. This pulse serves as the driving force and moves the team forward.

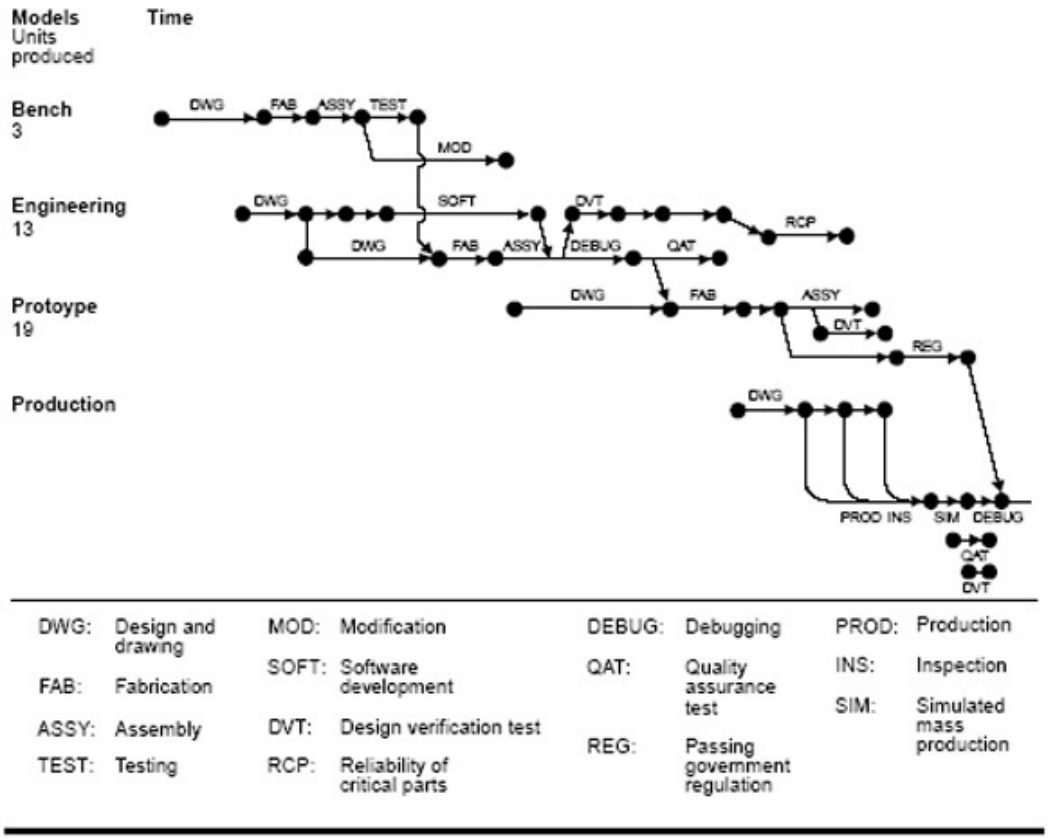
But the quickness of the pulse varies in different phases of development. The beat seems to be most vigorous in the early phases and tapers off toward the end. A member of Canon's PC-10 development team described this rhythm as follows: "When we are debating about what kind of concept to create, our minds go off in different directions and list alternatives. But when we are trying to come to grips with achieving both low cost and high reliability, our minds work to integrate the various points of view. Conflict tends to occur when some are trying to differentiate and others are trying to integrate. The knack lies in creating this rhythm and knowing when to move from one state to the other."

Under the sequential or relay race approach, a project goes through several phases in a step-by-step fashion, moving from one phase to the next only after all the requirements of the preceding phase are satisfied. These checkpoints control risk. But at the same time, this approach leaves little room for integration. A bottleneck in one phase can slow or even halt the entire development process.

Under the holistic or rugby approach, the phases overlap considerably, which enables the group to absorb the vibration or "noise" generated throughout the development process. When a bottleneck appears, the level of noise obviously increases. But the process does not come to a sudden halt; the team manages to push itself forward.

Fuji-Xerox inherited the PPP system (see type A in Exhibit 1) from its parent company, but revised it in two ways. First, it reduced the number of phases from six to four by redefining some of the phases and aggregating them differently. Second, it changed the linear, sequential system into the so-called “sashimi” system. Sashimi is slices of raw fish arranged on a plate, one slice overlapping the other (see Exhibit 2.)

EXHIBIT 2
Fuji-Xerox's product development schedule



DWG:	Design and drawing	MOD:	Modification	DEBUG:	Debugging	PROD:	Production
FAB:	Fabrication	SOFT:	Software development	QAT:	Quality assurance test	INS:	Inspection
ASSY:	Assembly	DVT:	Design verification test	REG:	Passing government regulation	SIM:	Simulated mass production
TEST:	Testing	RCP:	Reliability of critical parts				

Exhibit 2 Fuji-Xerox’s product development schedule

The sashimi system requires extensive interaction not only among project members but also with suppliers. The FX-3500 team invited them to join the project at the very start (they eventually produced 90% of the parts for the model). Each side regularly visited the other’s plants and kept the information channel open at all times. This kind of exchange and openness—both within the project team and with suppliers—increases speed and flexibility. Fuji-Xerox shortened the development time from 38 months for an earlier model to 29 months for the FX-3500.

If sashimi defines the Fuji-Xerox approach, then rugby describes the overlapping at Honda. Like a rugby team, the core project members at Honda stay intact from beginning to end and are responsible for combining all of the phases.

In the relay-like PPP system, the crucial problems tend to occur at the points where one group passes the project to the next. The rugby approach smooths out this problem by maintaining continuity across phases.

The Auto Boy project proceeded with much overlapping across phases as well. Canon's design engineers stayed alert throughout the process to make sure their design was being converted into what they had in mind. The production people intruded onto the design engineers' turf to make sure that the design was in accord with production scale economies.

The overlapping approach has both merits and demerits. Greater speed and increased flexibility are the "hard" merits. But the approach also has a set of "soft" merits relating to human resource management. The overlap approach enhances shared responsibility and cooperation, stimulates involvement and commitment, sharpens a problem-solving focus, encourages initiative taking, develops diversified skills, and heightens sensitivity toward market conditions.

The more obvious demerits result from having to manage an intensive process. Problems include communicating with the entire project team, maintaining close contact with suppliers, preparing several contingency plans, and handling surprises. This approach also creates more tension and conflict in the group. As one project member aptly put it, "If someone from development thinks that 1 out of 100 is good, that's a clear sign for going ahead. But if someone from production thinks that 1 out of 100 is not good, we've got to start all over. This gap in perception creates conflict."

The overlapping of phases also does away with traditional notions about division of labor. Division of labor works well in a type A system, where management clearly delineates tasks, expects all project members to know their responsibilities, and evaluates each on an individual basis. Under a type B or C system, the company accomplishes the tasks through what we call "shared division of labor," where each team member feels responsible for—and is able to work on—any aspect of the project.

Multilearning

Because members of the project team stay in close touch with outside sources of information, they can respond quickly to changing market conditions. Team members engage in a continual process of trial and error to narrow down the number of alternatives that they must consider. They also acquire broad knowledge and diverse skills, which help them create a versatile team capable of solving an array of problems fast.

Such learning by doing manifests itself along two dimensions: across multiple levels (individual, group, and corporate) and across multiple functions. We refer to these two dimensions of learning as "multilearning."

Multilevel learning. Learning at the individual level takes place in a number of ways. 3M, for example, encourages engineers to devote 15% of their company time to pursuing their "dream." Canon utilizes peer pressure to foster individual learning. A design engineer for the PC-10 project explained, "My senior managers and some of my colleagues really study hard. There is no way I can compete with them in the number of books they read. So whenever I have time, I go to a department store and spend several hours in

the toy department. I observe what's selling and check out the new gadgets being used in the toys. They may give me a hint or two later on."

Learning is pursued emphatically at the group level as well. Honda, for example, dispatched several members of the City project team to Europe for three weeks when the project reached a dead end at the concept development phase. They were told simply to "look around at what's happening in Europe." There they encountered the Mini-Cooper—a small car developed decades ago in the United Kingdom—which had a big impact on their design philosophy.

While it was developing the PC-10 copier, Canon team members left the project offices to hold a number of meetings in nearby hotels. In one of the early meetings, the entire project team broke up into subgroups, each with a representative from the design team and the production team. Each subgroup was told to calculate the cost of a key part and figure out ways of reducing that cost by one-third. "Since every subgroup faced the same mandate and the same deadline, we had no choice," recalled one project member. Learning took place in a hurry.

Learning at the corporate level is best achieved by establishing a company-wide movement or program. Fuji-Xerox, for example, used the total quality control (TQC) movement as a basis for changing the corporate mentality. TQC was designed to heighten the entire organization's sensitivity toward simultaneous quality and productivity improvement, market orientation, cost reduction, and work simplification. To achieve these goals, everyone in the organization had to learn the basics of techniques like statistical quality control and value engineering.

Hewlett-Packard embarked on a four-phased training program in marketing as part of the corporation's aim to become more market-oriented. The company now brings in top academics and business consultants to spread the marketing message. It also applies techniques borrowed from the consumer packaged goods industry, such as focus group interviews, quantitative market research, and test marketing. Further, the company has created a corporate marketing division to accelerate what one insider calls "the transition from a company run by engineers for engineers to one with a stronger marketing focus."

Multifunctional learning. Experts are encouraged to accumulate experience in areas other than their own. For instance:

- All the project members who developed Epson's first miniprinter were mechanical engineers who knew little about electronics at the start. So the leader of the project team, also a mechanical engineer, returned to his alma mater as a researcher and studied electrical engineering for two years. He did this while the project was under way. By the time they had completed the miniprinter project, all the engineers were knowledgeable about electronics. "I tell my people to be well-versed in two technological fields and in two functional areas, like design and marketing," the leader said. "Even in an engineering-oriented

company like ours, you can't get ahead without the ability to foresee developments in the market."

- The team working on NEC's PC 8000 consisted of sales engineers from the Electronic Devices Division. They acquired much of the know-how to develop the company's first personal computer by putting together TK 80, a computer kit, and introducing it on the market two years in advance of the PC 8000; and by stationing themselves for about a year, even on weekends, at BIT-IN, an NEC service center in the middle of Akihabara, talking with hobbyists and learning the user's viewpoint.

These examples show the important role that multilearning plays in the company's overall human resource management program. It fosters initiative and learning by doing on the part of the employees and helps keep them up to date with the latest developments. It also serves as a basis for creating a climate that can bring about organizational transition.

Corporate Rugby Scores

Some companies are already making headway in speeding up new product development:

A new copier—the 9900—took Xerox three years to develop, whereas the company spent more than five years developing a comparable earlier model.

A portable Brother printer—the EP-20—was developed in less than two years. It took the company more than four years to develop an earlier model.

One of John Sculley's top priorities, when appointed president of Apple in 1984, was to cut the company's product development time from 3.5 years down to one year.

Other organizations are beginning to add flexibility to product development:

Black & Decker recently unveiled 50 new power tool products at the National Hardware Show in Chicago to compete more effectively with Japanese power tool makers.

When Yamaha threatened its leadership position in the Japanese market in 1982, Honda unleashed some 30 new motorcycle models within a six-month period.

IBM broke from its tradition of designing everything internally and used a microprocessor designed by Intel Corporation and a basic operating system designed by

Subtle Control

Although project teams are largely on their own, they are not uncontrolled. Management establishes enough checkpoints to prevent instability, ambiguity, and tension from turning into chaos. At the same time, management avoids the kind of rigid control that impairs creativity and spontaneity. Instead, the emphasis is on "self-control," "control through peer pressure," and "control by love," which collectively we call "subtle control."

Subtle control is exercised in the new product development process in seven ways:

1. Selecting the right people for the project team while monitoring shifts in group dynamics and adding or dropping members when necessary. "We would add an older and more conservative member to the team should the balance shift too much toward radicalism," said a Honda executive. "We carefully pick the project members after long deliberation. We analyze the different personalities to see if they would get along. Most people do get along, thanks to our common set of values."

2. Creating an open work environment, as in the case

Microsoft Corporation to develop its personal computer.

of Fuji-Xerox.

3. Encouraging engineers to go out into the field and listen to what customers and dealers have to say. “A design engineer may be tempted to take the easy way out at times, but may reflect on what the customer had to say and try to find some way of meeting that requirement,” noted an engineer from Fuji-Xerox.

4. Establishing an evaluation and reward system based on group performance. Canon, for example, applied for patents for products from the PC-10 project on a group basis.

5. Managing the differences in rhythm throughout the development process. As mentioned earlier, the rhythm is most vigorous in the early phases and tapers off toward the end.

6. Tolerating and anticipating mistakes. Engineers at Honda are fond of saying that “a 1% success rate is supported by mistakes made 99% of the time.” A Brother executive in charge of R&D said, “It’s natural for young engineers to make a lot of mistakes. The key lies in finding the mistakes early and taking steps to correct them immediately. We’ve taken steps to expedite the trial production cycle for that reason.” A 3M executive noted, “I believe we learn more from mistakes than from successes. That’s not to say we should make mistakes easily. But if we do make mistakes, we ought to make them creatively.”

7. Encouraging suppliers to become self-organizing. Involving them early during design is a step in the right direction. But the project team should refrain from telling suppliers what to do. As Xerox found out, suppliers produce better results when they have the problem explained to them and are allowed to decide how to furnish the parts.

Transfer of Learning

The drive to accumulate knowledge across levels and functions is only one aspect of learning. We observed an equally strong drive on the part of the project members to transfer their learning to others outside the group.

Transfer of learning to subsequent new product development projects or to other divisions in the organization takes place regularly. In several of the companies we studied, the transfer took place through “osmosis”—by assigning key individuals to subsequent projects. A Honda executive explained, “If the factory is up and running and the early-period claims are resolved, we dismantle the project team, leaving only a few people to follow through. Since we have only a limited number of unusually able people, we turn them loose on another key project immediately.”

Knowledge is also transmitted in the organization by converting project activities to standard practice. At

Canon, for example, the Auto Boy project produced a format for conducting reviews that was used in later projects. One team member recalled, “We used to meet once a month or so to exchange notes on individual subprojects in progress and once in three months or so to discuss the project from a larger perspective. This pattern later became institutionalized into the monthly and quarterly progress reviews adopted from the PC-10 minicopier project.”

Naturally, companies try to institutionalize the lessons derived from their successes. IBM is trying to emulate the personal computer development project—which was completed in 13 months with outside help—throughout the company.

At Hewlett-Packard, the personal computer group is reprogramming the way the entire company develops and sells new products. In the past, the company was famous for designing a machine for a particular customer and charging a premium price. But it recently engineered its ThinkJet—a quiet inkjet printer—for low-cost mass production and priced it low. Within six months of its introduction, the printer captured 10% of the low-end market. Hewlett-Packard began to apply what it had learned from designing and pricing ThinkJet to its minicomputer line. Within months of putting ThinkJet on the market, the company introduced a minicomputer system for a broad corporate audience at a modest price.

But institutionalization, when carried too far, can create its own danger. Passing down words of wisdom from the past or establishing standard practices based on success stories works well when the external environment is stable. Changes in the environment, however, can quickly make such lessons impractical.

Several companies have tried to unlearn old lessons. Unlearning helps keep the development team in tune with the realities of the outside environment. It also acts as a springboard for making more incremental improvements.

Much of the unlearning is triggered by changes in the environment. But some companies consciously pursue unlearning. Consider these examples:

- Epson’s target is to have the next-generation model in development stages as a new model is being introduced on the market. The company tells its project teams that the next-generation model must be at least 40% better than the existing one.

- When Honda was building the third-generation Civic model, its project team opted to scrap all the old parts and start anew. When the car made its debut before the public, all the new parts were displayed right next to the car at the request of the project members. The car won the 1984 Car of the Year Award in Japan.

- Fuji-Xerox has refined its sashimi approach, first adopted for the FX-3500. Compared with that effort, a

new product today requires one-half of the original total manpower. Fuji-Xerox has also reduced the product development cycle from 4 years to 24 months.

Some Limitations

Some words of caution are in order. The holistic approach to product development may not work in all situations. It has some built-in limitations:

- It requires extraordinary effort on the part of all project members throughout the span of the development process. Sometimes, team members record monthly overtime of 100 hours during the peak and 60 hours during the rest of the project.

- It may not apply to breakthrough projects that require a revolutionary innovation. This limitation may be particularly true in biotechnology or chemistry.

- It may not apply to mammoth projects like those in the aerospace business, where the sheer project scale limits extensive face-to-face discussions.

- It may not apply to organizations where product development is masterminded by a genius who makes the invention and hands down a well-defined set of specifications for people below to follow.

Some limitations also stem from the scope of our research. Our sample size was limited to a handful of companies, and our findings were drawn, for the most part, from observing how the development process was managed in Japan. General conclusions, therefore, must be made with some caution. But as new approaches to product development gain acceptance in the United States, the difference between the two countries may not be so much a difference of kind as a difference of degree.

Managerial Implications

Changes in the environment—intensified competition, a splintered mass market, shortened product life cycles, and advanced technology and automation—are forcing managements to reconsider the traditional ways of creating products. A product that arrives a few months late can easily lose several months of payback. A product designed by an engineer afflicted with the "next bench" syndrome—the habit of designing a product by asking the coworker on the next bench what kind of a product he or she would like—may not meet the flexible requirements of the marketplace.

The Sport of Rugby

One of the charms of the Rugby Union game is the infinite variety of its possible tactics. Whatever tactics a team aims to adopt, the

To achieve speed and flexibility, companies must manage the product development process differently. Three kinds of changes should be considered.

First, companies need to adopt a management style

> first essential is a strong and skilful [*sic*] pack of forwards capable of winning initial possession from the set pieces. For, with the ball in its hands, a team is in a position to dictate tactics which will make the best use of its own particular talents, at the same time probing for and exposing weaknesses in the opposing team. The ideal team has fast and clever half-backs and three-quarters who, with running, passing, and shrewd kicking, will make sure that the possession won by the forwards is employed to the maximum embarrassment of the opposing team.

that can promote the process. Executives must recognize at the outset that product development seldom proceeds in a linear and static manner. It involves an iterative and dynamic process of trial and error. To manage such a process, companies must maintain a highly adaptive style.

Because projects do not proceed in a totally rational and consistent manner, adaptability is particularly important. Consider, for example, situations where:

- Top management encourages trial and error by purposely keeping goals broad and by tolerating ambiguity. But at the same time, it sets challenging goals and creates tension within the group and within the organization.

- The process by which variety is amplified (differentiation) and reduced (integration) takes place throughout the overlapping phases of the development cycle. Differentiation, however, tends to dominate the concept development phase of the cycle, and integration begins to take over the subsequent phases.

- Operational decisions are made incrementally, but important strategic decisions are delayed as much as possible in order to allow a more flexible response to last-minute feedback from the marketplace.

Because management exercises subtle forms of control throughout the development process, these seemingly contradictory goals do not create total confusion. Subtle control is also consistent with the self-organizing character of the project teams.

Second, a different kind of learning is required. Under the traditional approach, a highly competent group of specialists undertakes new product development. An elite group of technical experts does most of the learning. Knowledge is accumulated on an individual basis, within a narrow area of focus—what we call learning in depth.

In contrast, under the new approach (in its extreme form) nonexperts undertake product development. They are encouraged to acquire the necessary knowledge and skills on the job. Unlike the experts, who cannot tolerate mistakes even 1% of the time, the nonexperts are willing to challenge the status quo. But to do so, they must accumulate knowledge from across all areas of management, across different levels of the organization, functional specializations, and even organizational boundaries. Such learning in breadth serves as the necessary condition for shared division of labor to function effectively.

Third, management should assign a different mission to new product development. Most companies have treated it primarily as a generator of future revenue streams. But in some companies, new product development also acts as a catalyst to bring about change in the organization. The personal computer project, for example, is said to have changed the way IBM thinks. Projects coming out of Hewlett-Packard's personal computer group, including ThinkJet, have changed its engineering-driven culture.

No company finds it easy to mobilize itself for change, especially in noncrisis situations. But the self-transcendent nature of the project teams and the hectic pace at which the team members work help to trigger a sense of crisis or urgency throughout the organization. A development project of strategic importance to the company, therefore, can create a wartime working environment even during times of peace.

Changes affecting the entire organization are also difficult to carry out within highly structured companies, especially seniority-based companies like the ones commonly found in Japan. But unconventional moves, which may be difficult to pull off during times of peace, can be legitimized during times of war. Thus management can uproot a competent manager or assign a very young engineer to the project without encountering much resistance.

Once the project team is formed, it begins to rise in stature because of its visibility ("we've been hand-picked"), its legitimate power ("we have unconditional support from the top to create something new"), and its sense of mission ("we're working to solve a crisis"). It serves as a motor for corporate change as project members from a variety of functional areas begin to take strategic initiatives that sometimes go beyond the company's conventional domain and as their knowledge gets transferred to subsequent projects.

The environment in which any multinational company—from the United States or Japan—operates has changed dramatically in recent years. The rules of the game for competing effectively in today's world market have changed accordingly. Multinationals must achieve speed and flexibility in developing products; to do so requires the use of a dynamic process involving much reliance on trial and error and learning by doing. What we need today is constant innovation in a world of constant change.

1. Booz Allen & Hamilton survey reported in Susan Fraker, "High-Speed Management for the High-Tech Age," *Fortune,* March 5, 1984, p. 38.

2. See, for example, Ilya Prigozine, *From Being to Becoming* (San Francisco, Calif.: Freeman, 1980); Eric Jantsch, "Unifying Principles of Evolution," in Eric Jantsch, ed., *The Evolutionary Vision* (Boulder, Colorado: Westview Press, 1981); and Devendra Sahal, "A Unified Theory of Self-Organization," *Journal of Cybernetics,* April-June, 1979, p. 127. See also Todao Kagono, Ikujiro Nonaka, Kiyonari Sakakibara, and Akihiro Okumura, *Strategic vs. Evolutionary Management: A U.S.-Japan Comparison of Strategy and Organization* (Amsterdam: North-Holland, 1985).

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