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ARTICLE

Your research department's most important invention? Your company itself.

Research That Reinvents the Corporation

by John Seely Brown

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THE IDEA IN BRIEF

To prevail amid rapid and unpredictable change, your company must do more than simply invent new technologies and breakthrough products. It must reinvent the *innovation process itself*. Your research department plays a critical role. By designing cutting-edge work processes that enable your organization to innovate continuously, it can reinvent your corporation.

The Xerox Palo Alto Research Center (PARC) exemplifies this vision of research's role. PARC researchers have applied four powerful principles to reinvent not just Xerox technologies and products—but Xerox itself. No matter what *your* business, your company can do the same.

THE IDEA AT WORK

RESEARCH PRINCIPLES

1. **Study "technology in use" to improve work processes.** PARC customizes behind-the-scenes information technology to enhance work practices and "listen" to customers.

EXAMPLE:
A new software feature on Xerox's high-end copiers *predicts* machine breakdowns, calls a branch office to download its predication, and schedules a repair person to visit the site—*before* the expected breakdown. Customers never see a machine fail, and Xerox uses information generated by the software to design future generations of copiers.

2. **Harvest local innovations.** Most employees constantly improvise to handle surprises and solve problems. But these "workarounds" rarely spread beyond their local groups to benefit the larger organization. PARC's solutions? One is easy-to-use programming tools enabling employees to disseminate knowledge throughout the company. Another is revamped training methods to increase organizational learning.

EXAMPLE:
After realizing that Xerox's service reps learn more by swapping stories than through formal training, PARC began envisioning a multimedia information system—filled with annotated videoclips of useful stories that would let reps from around the world plug into Xerox's collective memory and learn from past successes and failures.

3. **"Coproduce" new technologies and work practices with partners throughout your company.** To communicate new insights so that others in your company can grasp their potential, don't simply pour knowledge into their heads. Instead, help them develop whole new mental models.

EXAMPLE:
With the advent of digital copying, Xerox had to challenge long-held assumptions about products, markets, and customer needs that the older, light-lens xerography had created. *Before* building the technology, PARC helped managers think about copiers in fresh ways. It created a video in which researchers acted out the new technology's potential, then challenged viewers to imagine additional uses for digital copying.

4. **Innovate with customers.** Research's ultimate partner? The customer. Collaborate with customers to co-produce technology and work systems they'll need in the future.

EXAMPLE:
Xerox's pharmaceutical customer, Syntex, wanted to better manage the 300,000+ drug-test report forms it collects annually. Through Xerox's Express project team, Syntex employees spent time at PARC learning about Xerox's technologies-in-progress. PARC researchers, engineers, and marketers observed *them* in action at Syntex. Results? A new document-management system that solved Syntex's problem *and* became a prototype with potential value for the entire pharmaceutical industry.

Research That **Reinvents the Corporation**

by John Seely Brown

The locus of corporate innovation has traditionally been product development. But in times of rapid and unpredictable change, the creation of individual products becomes less important than the creation of a general organizational aptitude for innovation. That's the central message of John Seely Brown's groundbreaking article "Research That Reinvents the Corporation."

Seely Brown offers a new vision for the corporate research function: Rather than focusing narrowly on developing technologies and products, R&D needs to broaden its agenda, helping companies invent new practices and processes that enhance their overall ingenuity and flexibility. Drawing on the experience of Xerox PARC – both its successes and its failures – Seely Brown offers four suggestions that are at once practical and transformative. He aims his advice at research departments, but it is equally valuable for any manager looking to build a continuously innovating organization.

It's not enough to create new products. You need to build the prototype of the continuously innovating company.

THE MOST important invention that will come out of the corporate research lab in the future will be the corporation itself. As companies try to keep pace with rapid changes in technology and cope with increasingly unstable business environments, the research department has to do more than simply innovate new products. It must design the new technological and organizational architectures that make possible a continuously innovating company. Put another way, corporate research must reinvent innovation.

At the Xerox Palo Alto Research Center (PARC) we've learned this lesson, at times, the hard way. Xerox created PARC in 1970 to pursue advanced research in computer science, electronics, and materials science. Over the next decade, PARC researchers were responsible for some of the basic innovations of the personal computer revolution – only to see other companies commercialize these innovations more quickly than Xerox. (See the sidebar "PARC: Seedbed of the Computer Revolution.") In the process, Xerox gained a reputation for fumbling the future and PARC for doing brilliant research but in isolation from the company's business.

That view is one-sided because it ignores the way that PARC innovations *have* paid off over the past 20 years. Still,

it raises fundamental questions that many companies besides Xerox have been struggling with in recent years: What is the role of corporate research in a business environment characterized by tougher competition and nonstop technological change? And how can large companies better assimilate the latest innovations and quickly incorporate them in new products?

One popular answer to these questions is to shift the focus of the research department away from radical breakthroughs toward incremental innovation, away from basic research toward applied research. At PARC, we have chosen a different approach, one that cuts across both of these categories and combines the most useful features of each. We call it "pioneering research."

Unfortunately, it's the rare company that understands the importance of informal improvisation, let alone respects it as a legitimate business activity.

Like the best applied research, pioneering research is closely connected to the company's most pressing business problems. But like the best basic research, it seeks to redefine these problems fundamentally in order to come up with fresh – and sometimes radical – solutions. Our emphasis on pioneering research has led us to redefine what we mean by technology, by innovation, and, indeed, by research itself. Here are some of the new principles that we have identified.

1. Research on new work practices is as important as research on new products. Corporate research is traditionally viewed as the source of new technologies and products. At PARC, we believe it is equally important for research to invent new prototypes of organizational practice. This means going beyond the typical view of technology as an artifact–hardware and software–to explore its potential for creating new and more effective ways of working, what we call studying technology in use. Such activities are essential for companies to exploit successfully the next great breakthrough in information technology – "ubiquitous computing": the incorporation of information technology into a broad range of everyday objects.

2. Innovation is everywhere; the problem is learning from it. When corporate research begins to focus on a company's practice as well as its products, another principle quickly becomes clear: Innovation isn't the privileged activity of the research department. It goes on at all levels of a company–wherever employees confront problems, deal with unforeseen contingencies, or work their way around breakdowns in normal procedures. The problem is, few companies know how to learn from this local innovation and how to use it to improve their overall effectiveness. At PARC, we are studying this process of local innovation with employees on the front lines of Xerox's business and developing technologies to harvest its lessons for the company as a whole. By doing so, we hope to turn company size, so often seen as an obstacle to innovation, into an advantage–a rich seedbed of fresh insights about technology and new work practices.

3. Research can't just produce innovation; it must "coproduce" it. Before a company can learn from the innovation in its midst, it must rethink the process by which innovation is transmitted throughout the organization. Research must coproduce new technologies and work practices by developing with partners throughout the organization a shared understanding of why these innovations are important. On the one hand, that means challenging the outmoded background assumptions that so often distort the way people see new technologies, new market opportunities, and the entire business. On the other, it requires creating new ways to communicate the significance of radical innovations. Essentially, corporate research must prototype new mental models of the organization and its business.

4. The research department's ultimate innovation partner is the customer. Prototyping technology in use, harvesting local innovation, coproducing new mental models of the organization – all these activities that we are pursuing inside Xerox are directly applicable to our customers as well. In fact, our future competitive advantage will not just depend on selling information technology products to customers. It will depend on coproducing these products with customers–customizing technology and work practices to meet their current and future needs. One role of corporate research in this activity is to invent methods and tools to help customers identify their latent needs and improve their own capacity for continuous innovation.

At PARC, we've only begun to explore the implications of these new principles. Our activities in each of these areas are little more than interesting experiments. Still, we have defined a promising and exciting new direction. Without giving up our strong focus on state-of-the-art information technologies, we are also studying the human and organizational barriers to innovation. And using the entire Xerox organization as our laboratory, we are experimenting with new techniques for helping people grasp the revolutionary potential of new technologies and work practices.

The result: important contributions to Xerox's core products but also a distinctive approach to innovation with

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implications far beyond our company. Our business happens to be technology, but any company – no matter what the business – must eventually grapple with the issues we've been addressing. The successful company of the future must understand how people really work and how technology can help them work more effectively. It must know how to create an environment for continual innovation on the part of all employees. It must rethink traditional business assumptions and tap needs that customers don't even know they have yet. It must use research to reinvent the corporation.

Technology Gets Out of the Way

At the foundation of our new approach to research is a particular vision of technology. As the cost of computing power continues to plummet, two things become possible. First, more and more electronic technology will be incorporated in everyday office devices. Second, increased computing power will allow users to tailor the technology to meet their specific needs.

Together these trends lead to a paradoxical result. When information technology is everywhere and can be customized to match more closely the work to be done, the technology itself will become invisible. The next great breakthrough of the information age will be the disappearance of discrete information-technology products. Technology is finally becoming powerful enough to get out of the way.

Consider the example of the photocopier. Ever since Chester Carlson first invented xerography some 50 years ago, the technology of photocopiers has been more or less the same. In a process somewhat similar to photography, a light-lens projects an image of the page onto a photoreceptor. The image is then developed with a dry toner to produce the copy. But information technology is transforming the copier with implications as radical as those accompanying the invention of xerography itself.

Today our copiers are complex computing and communications devices. Inside Xerox's high-end machines are some 30 microprocessors linked together by local area networks. They continuously monitor the operations of the machine and make adjustments to compensate for wear and tear, thus increasing reliability and ensuring consistent, high copy quality. Information systems inside our copiers also make the machines easier to use by constantly providing users with information linked to the specific tasks they are performing. (See the sidebar "How Xerox Redesigned Its Copiers.") These innovations were crucial to Xerox's success in meeting Japanese competition and regaining market share during the past decade.

PARC: Seedbed of the Computer Revolution

Former Xerox CEO C. Peter McColough created the Palo Alto Research Center (PARC) in 1970 to perform basic research in computing and electronics and to study what McColough called "the architecture of information" – how complex organizations use information. PARC hired some of the best computer scientists in the world and gave them virtually unlimited funding to pursue their ideas.

The scientific payoff from PARC was immediate. Throughout the 1970s, PARC researchers produced a series of fundamental innovations in computer technology that would prove to be the building blocks of the personal computer revolution: bit-map display computer screens that make easy-to-use graphic interfaces possible, local area networks for distributed computing, overlapping screen windows, point-and-click editing using a mouse, and Smalltalk, the first object-oriented programming language.

Xerox never became a dominant player in the personal computer industry. But PARC's research has nevertheless directly fed the company's strategic businesses. PARC developed the first prototype of laser printing in 1973. By 1990, laser printing was a several-billion-dollar business at Xerox. And PARC's innovations in local area networks and its distinctive computer interface designs have been successfully incorporated into Xerox copiers and printers, an innovation that was crucial to the company's successfully meeting the challenge from Japanese competition in the 1980s.

Whereas PARC scientists of the 1970s had a technical vision, today the center is increasingly focusing on the interrelationships between technology and work. In 1990, anthropologists, sociologists, linguists, and psychologists complement PARC's traditional research staff of computer scientists, physicists, and engineers. And much of the center's computer science research emphasizes how information technology can be used to support effective group collaboration – a field known as "computer-supported cooperative work."

–Robert Howard

***Robert Howard** was an associate editor of HBR when this article was published.*

But these changes are only the beginning. Once copiers become computing devices, they also become sensors that collect information about their own performance that can be used to improve service and product design. For example, Xerox recently introduced a new standard feature on our high-end copiers known as "remote interactive communication" or RIC. RIC is an expert system inside the copier that monitors the information technology controlling the machine and, using some artificial-intelligence techniques, predicts when the machine will next break down. Once RIC predicts a breakdown will occur, it automatically places a call to a branch office and downloads its prediction, along with its reasoning. A computer at the branch office does some further analysis and schedules a repair person to visit the site *before* the expected time of failure.

For the customer, RIC means never having to see the machine fail. For Xerox, it means not only providing better service but also having a new way to listen to our customer. As RIC collects information on the performance of our copiers – in real-world business environments, year in and year out – we will eventually be able to use that information to guide how we design future generations of copiers.

It's never enough to just tell people about some new insight. Rather, you have to get them to experience it in a way that evokes its power and possibility.

RIC is one example of how information technology invisible to the user is transforming the copier. But the ultimate conclusion of this technological transformation is the disappearance of the copier as a stand-alone device. Recently, Xerox introduced its most versatile office machine ever – a product that replaces traditional light-lens copying techniques with digital copying, where documents are electronically scanned to create an image stored in a computer, then printed out whenever needed. In the future, digital copiers will allow the user to scan a document at one site and print it out somewhere else – much like a fax. And once it scans a document, a copier will be able to store, edit, or enhance the document – like a computer file – before printing it. When this happens, the traditional distinction between the copier and other office devices like computers, printers, and fax machines will disappear – leaving a flexible, multifunctional device able to serve a variety of user needs.

What is happening to the copier will eventually happen to all office devices. As computing power becomes ubiquitous – incorporated not only in copiers but also in filing cabinets, desktops, white boards, even electronic "Post-it Notes" – it will become more and more invisible, a taken-for-granted part of any work environment, much as books, reports, or other documents are today. What's more, increased computing power will make possible new uses of information technology that are far more flexible than current systems. In effect, technology will become so flexible that users will be able to customize it ever more precisely to meet their particular needs – a process that might be termed "mass customization."

We are already beginning to see this development in software design. Increased computing power is making possible new approaches to writing software such as object-oriented programming (developed at PARC in the 1970s). This technique makes it easier for users to perform customizing tasks that previously required a trained programmer and allows them to adapt and redesign information systems as their needs change. From a purely technical perspective, object-oriented programming may be less efficient than traditional programming techniques. But the flexibility it makes possible is far more suited to the needs of constantly evolving organizations.

Indeed, at some point in the not-too-distant future – certainly within the next decade – information technology will become a kind of generic entity, almost like clay. And the "product" will not exist until it enters a specific situation, where vendor and customer will mold it to the work practices of the customer organization. When that happens, information technology as a distinct category of products will become invisible. It will dissolve into the work itself. And companies like ours might sell not products but rather the expertise to help users define their needs and create the products best suited to them. Our product will be our customers' learning.

Harvesting Local Innovation

The trend toward ubiquitous computing and mass customization is made possible by technology. The emphasis, however, is not on the technology itself but on the work practices it supports. In the future, organizations won't have to shape how they work to fit the narrow confines of an inflexible technology. Rather, they can begin to design information systems to support the way people really work.

That's why some of the most important research at PARC in the past decade has been done by anthropologists. They have studied occupations and work practices throughout the company – clerks in an accounts-payable office who issue checks to suppliers, technical representatives who repair copying machines, designers who develop new products, even novice users of Xerox's copiers. This research has produced fundamental insights into the nature of innovation, organizational learning, and good product design.

We got involved in the anthropology of work for a good business reason. We figured that before we went ahead and applied technology to work, we had better have a clear understanding of exactly

how people do their jobs. Most people assume – we did too, at first – that the formal procedures defining a job, or the explicit structure of an organizational chart, accurately describe what employees do, especially in highly routinized occupations. But when PARC anthropologist Lucy Suchman began studying Xerox accounting clerks in 1979, she uncovered an unexpected and intriguing contradiction.

When Suchman asked the clerks how they did their jobs, their descriptions corresponded more or less to the formal procedures of the job manual. But when she observed them at work, she discovered that the clerks weren't really following those procedures at all. Instead, they relied on a rich variety of informal practices that weren't in any manual but turned out to be crucial to getting the work done. In fact, the clerks were constantly improvising, inventing new methods to deal with unexpected difficulties and solve immediate problems. Without being aware of it, they were far more innovative and creative than anybody who heard them describe their "routine" jobs ever would have thought.

Suchman concluded that formal office procedures have almost nothing to do with how people do their jobs. People use procedures to understand the goals of a particular job – for example, what kind of information a particular file has to contain in order for a bill to be paid – not to identify the steps to take to get from here to there. But to reach that goal – actually collecting and verifying the information and making sure the bill is paid – people constantly invent new work practices to cope with the unforeseen contingencies of the moment. These informal activities remain mostly invisible, since they do not fall within the normal, specified procedures that employees are expected to follow or managers expect to see. But these work arounds enable an all-important flexibility that allows organizations to cope with the unexpected, as well as to profit from experience and to change.

If local innovation is as important and pervasive as we suspect, then big companies have the potential to be remarkably innovative – if they can somehow capture this innovation and learn from it. Unfortunately, it's the rare company that understands the importance of informal improvisation, let alone respects it as a legitimate business activity. In most cases, ideas generated by employees in the course of their work are lost to the organization as a whole. An individual might use them to make his or her job easier and perhaps even share them informally with a small group of colleagues. But such informal insights about work rarely spread beyond the local work group. And because most information systems are based on the formal procedures of work, not the informal practices crucial to getting it done, they often tend to make things worse rather than better. As a result, this important source of organizational learning is either ignored or suppressed.

At PARC, we are trying to design new uses of technology that leverage the incremental innovation coming from within the entire company. We want to create work environments where people can legitimately improvise and where those improvisations can be captured and made part of the organization's collective knowledge base.

One way is to provide people with easy-to-use programming tools so they can customize the information systems and computer applications that they work with. To take a small example, my assistant is continually discovering new ways to improve the work systems in our office. She has more ideas for perfecting, say, our electronic calendar system than any researcher does. After all, she uses it every day and frequently bumps up against its limitations. So instead of designing a new and better calendar system, we created a programming language known as CUSP (for customized user system program) that allows users to modify the system themselves.

We've taken another small step in this direction at EuroPARC, our European research lab in Cambridge, England. Researchers there have invented an even more-advanced software system known as Buttons – bits of computer code structured and packaged so that even people without a lot of training in computers can modify them. With Buttons, secretaries, clerks, technicians, and others can create their own software applications, send them to colleagues throughout the corporation over our electronic mail network, and adapt any Buttons they receive from others to their own needs. Through the use of such tools, we are translating local innovation into software that can be easily disseminated and used by all.

New technologies can also serve as powerful aids for organizational learning. For example, in 1984, Xerox's service organization asked us to research ways to improve the effectiveness of its training programs. Training the company's 14,500 service technicians who repair copying machines is extremely costly and time consuming. What's more, the time it takes to train the service workforce on a new technology is key to how fast the company can launch new products.

The service organization was hoping we could make traditional classroom training happen faster, perhaps by creating some kind of expert system. But based on our evolving theory of work and innovation, we decided to take another approach. We sent out a former service technician, who had since gone on to do graduate work in anthropology, to find out how reps actually do their jobs – not what they or their managers say they do but what they really do and how they learn the skills that they actually use. He took the company training program, actually worked on repair jobs in the field, and interviewed tech reps about their jobs. He concluded that the reps learn the most not from formal training courses but out in the field – by working on real problems and discussing them informally with colleagues. Indeed, the stories tech reps tell one another – around the coffeepot, in the lunchroom, or while working

together on a particularly difficult problem–are crucial to continuous learning.

In a sense, these stories are the real "expert systems" used by tech reps on the job. They are a storehouse of past problems and diagnoses, a template for constructing a theory about the current problem, and the basis for making an educated stab at a solution. By creating such stories and constantly refining them through conversations with each other, tech reps are creating a powerful organizational memory that is a valuable resource for the company.

As a result of this research, we are rethinking the design of tech rep training–and the tech rep job itself–in terms of lifelong learning. How might a company support and leverage the storytelling that is crucial to building the expertise not only of individual tech reps but also of the entire tech rep community? And is there any way to link that expertise to other groups in the company who would benefit from it–for example, the designers who are creating the future generations of our systems?

One possibility is to create advanced multimedia information systems that would make it easier for reps and other employees to plug in to this collective social mind. Such a system might allow the reps to pass around annotated video clips of useful stories, much as scientists distribute their scientific papers, to sites all over the world. By commenting on one another's experiences, reps could refine and disseminate new knowledge. This distributed collective memory, containing all the informal expertise and lore of the occupation, could help tech reps – and the company–improve their capacity to learn from successes and failures.

Coproducing Innovation

Our approach to the issue of tech rep training is a good example of what we mean by pioneering research. We started with a real business problem, recognized by everyone, then reframed the problem to come up with solutions that no one had considered before. But this raises another challenge of pioneering research: how to communicate fresh insights about familiar problems so that others can grasp their significance.

The traditional approach to communicating new innovations–a process that usually goes by the name of "technology transfer"– is to treat it as a simple problem of transferring information. Research has to pour new knowledge into people's heads like water from a pitcher into a glass. That kind of communication might work for incremental innovations. But when it comes to pioneering research that fundamentally re-

How Xerox Redesigned Its Copiers

In the early 1980s, Xerox's copier business faced a big problem. Service calls were increasing, and more and more customers were reporting that our newest copiers were unreliable. The complaints couldn't have come at a worse time. We had been late to recognize market opportunities for low- and midrange copiers, and Japanese competitors like Canon were cutting into our market share. Now Xerox's reputation for quality was at stake.

After interviewing some customers, we discovered that unreliability was not the real problem. Our copiers weren't breaking down more frequently than before; in fact, many of the service calls were unnecessary. But customers were finding the copiers increasingly difficult to use. Because they couldn't get their work done, they perceived the machines as unreliable.

The source of the problem was our copier design. Traditionally, Xerox technology designers–like most engineers–have striven to make machines idiot proof. The idea was to foresee all the possible things that could go wrong, then either design them out of the system or provide detailed instructions of what to do should they occur.

But as we kept adding new functions, we had to add more and more information, usually stored on flip cards attached to the machine. The copiers became so complex that it was harder for the new user to figure out how to do any particular task. To learn a new operation meant a time-consuming search through the flip cards. And whenever something went wrong – a paper jam, say, or a problem with the toner – the machines would flash a cryptic code number, which would require more flipping through the cards to find the corresponding explanation.

In many instances, users would encounter some obstacle, not be able to find out how to resolve it, and simply abandon the machine in mid-procedure. The next user to come along, unaware of the previous problem, would assume the machine was broken and call a repair person.

We had to make radical changes in copier design, but it was difficult to sell that message within the company. The idea that there might be serious usability problems with our machines met with resistance in the Xerox development organization that designs our copiers. After all, they had tested their designs against all the traditional human-factors criteria. There was a tendency to assume that any problems with the machines must be the users' fault.

When researchers from PARC began to study the problem, we discov-

ered that the human-factors tests used by the development group didn't accurately reflect how people actually used the machines. So, a PARC anthropologist set up a video camera overlooking one of our new copiers in use at PARC, then had pairs of researchers (including some leading computer scientists) use the machine to do their own copying. The result was dramatic footage of some very smart people, anything but idiots, becoming increasingly frustrated and angry as they tried and failed to figure out how to get the machine to do what they wanted it to do.

The videos proved crucial in convincing the doubters that the company had a serious problem. Even more important, they helped us define what the real problem was. The videos demonstrated that when people use technology like a copier, they construct interpretations of it. In effect, they have a conversation with the machine much as two people have a conversation with each other. But our traditional idiot-proof design provided few cues to help the user interpret what was going on.

We proposed an alternative approach to design. Instead of trying to eliminate trouble, we acknowledged that it was inevitable. So the copier's design should help users manage trouble – just as people manage and recover from misunderstandings during a conversation. This meant keeping the machine as transparent as possible by making it easy for the user to find out what is going on and to discover immediately what to do when something goes wrong.

Xerox's most recent copier families – the 10 and 50 series – reflect this new design principle. Gone are the flip cards of earlier machines. Instead, we include enough computing power in the machines to provide customized instructions on the display panel linked to particular procedures or functions. The information the user receives is immediately put in the context of the task he or she is trying to perform. The new design also incorporates ideas from PARC's research on graphical user interfaces for computers. When something goes wrong, the display panel immediately shows a picture of the machine that visually indicates where the problem is and how to resolve it.

The results of these changes have been dramatic. Where it once took 28 minutes on average to clear a paper jam, it takes 20 seconds with the new design. And because such breakdowns are easier to fix, customers are more tolerant of them when they occur.

defines a technology, product, work process, or business problem, this approach doesn't work.

It's never enough to just *tell* people about some new insight. Rather, you have to get them to experience it in a way that evokes its power and possibility. Instead of pouring knowledge into people's heads, you need to help them grind a new set of eyeglasses so they can see the world in a new way. That involves challenging the implicit assumptions that have shaped the way people in an organization have historically looked at things. It also requires creating new communication techniques that actually get people to experience the implications of an innovation.

To get an idea of this process, consider the strategic implications of digital copying for a company like Xerox. Xerox owes its existence to a particular technology – light-lens xerography. That tradition has shaped how the company conceives of products, markets, and customer needs, often in ways that are not so easy to identify. But digital copying renders many of those assumptions obsolete. Therefore, making these assumptions explicit and analyzing their limitations is an essential strategic task.

Until recently, most people at Xerox thought of information technology primarily as a way to make traditional copiers cheaper and better. They didn't realize that digital copying would transform the business, with broad implications not just for copiers but also for office information systems in general. Working with the Xerox corporate strategy office, we've tried to find a way to open up the corporate imagination – to get people to move beyond the standard ways they thought about copiers.

One approach we took a couple of years ago was to create a video for top management, which we called the "unfinished document." In the video, researchers at PARC who knew the technology extremely well discussed the potential of digital copying to transform people's work. But they didn't just talk about it; they actually acted it out in skits. They created mock-ups of the technology and then simulated how it might affect different work activities. They attempted to portray not just the technology but also the technology in use.

We thought of the unfinished document as a conceptual-envisioning experiment – an attempt to imagine how a technology might be used before we started building it. We showed the video to some top corporate officers to get their intuitional juices flowing. The document was unfinished in the sense that the whole point of the exercise was to

get the viewers to complete the video by suggesting their own ideas for how they might use the new technology and what these new uses might mean for the business. In the process, they weren't just learning about a new technology; they were creating a new mental model of the business.

Senior management is an important partner for research, but our experiments at coproduction aren't limited to the top. We are also involved in initiatives to get managers far down in the organization to reflect on the obstacles blocking innovation in the Xerox culture. For example, one project takes as its starting point the familiar fact that the best innovations are often the product of "renegades" on the periphery of the company. PARC researchers are part of a company group that is trying to understand why this is so often the case. We are studying some of the company's most adventuresome product development programs to learn how the larger Xerox organization can sometimes obstruct a new product or work process. By learning how the corporation rejects certain ideas, we hope to uncover those features of the corporate culture that need to change.

Such efforts are the beginning of what we hope will become an ongoing dialogue in the company about Xerox's organizational practice. By challenging the background assumptions that traditionally stifle innovation, we hope to create an environment where the creativity of talented people can flourish and pull new ideas into the business.

Innovating with the Customer

Finally, research's ultimate partner in coproduction is the customer. The logical end point of all the activities I have described is for corporate research to move outside the company and work with customers to coproduce the technology and work systems they will need in the future.

It is important to distinguish this activity from conventional market research. Most market research assumes either that a particular product already exists or that customers already know what they need. At PARC, we are focusing on systems that do not yet exist and on needs that are not yet clearly defined. We want to help customers become aware of their latent needs, then customize systems to meet them. Put another way, we are trying to prototype a need or use before we prototype a system.

One step in this direction is an initiative of Xerox's Corporate Research Group (of which PARC is a part) known as the Express project. Express is an experiment in product delivery management designed to commercialize PARC technologies more rapidly by directly involving customers in the innovation process. Based at PARC, the project brings together employees from one of our customers (the Palo Alto–based pharmaceutical company Syntex) with a small team of Xerox researchers, engineers, and marketers into a single organization.

Syntex's more than 1,000 researchers do R&D on new drugs up for approval by the Food and Drug Administration. The Express team is exploring ways to use core technologies developed at PARC to help the pharmaceutical company manage the more than 300,000 case-report forms it collects each year. (The forms report on tests of new drugs on human volunteers.) Syntex employees have spent time at PARC learning our technologies in progress. Similarly, the members of the team from Xerox have intensively studied Syntex's work processes – much as PARC anthropologists have studied work inside our own company.

Instead of pouring knowledge into people's heads, you need to help them grind a new set of eyeglasses so they can see the world in a new way.

Once the project team defined the pharmaceutical company's key business needs and the PARC technologies that could be used to meet them, programmers from both companies worked together to create some prototypes. One new system, for example, is known as the Forms Receptionist. It combines technologies for document recognition, document interchange and translation, and intelligent scanning to scan, sort, file, and distribute Syntex's case reports. For Syntex, the new system solves an important business problem. For Xerox, it is the prototype of a product that we eventually hope to offer to other customers in the entire pharmaceutical industry.

We are also treating Express as a case study in coproduction, worth investigating in its own right. The Express team has videotaped all the interactions between Xerox and Syntex employees, and developed a computerized index to guide the team through this visual database. And a second research team is conducting an in-depth study of the entire Xerox-Syntex collaboration. By studying the project, we hope to learn valuable lessons about coproduction.

One of the most interesting lessons we've learned from the Express project so far is just how long it takes to create a shared understanding among the members of such product teams–a common language, a sense of purpose, and a definition of goals. This is similar to the experience of many interfunctional teams, which end up reproducing inside the team the same conflicting perspectives the teams were designed to overcome in the first place. We believe that the persistence of such misunderstandings may be a serious drag on product development.

Thus a critical task for the future is to explore how information technology might be used to accelerate the creation of mutual understandings within work groups. The ultimate goal of this process would be to build what might be

called an "envisioning laboratory" – a powerful computer environment where Xerox customers would have access to advanced programming tools that they could use to quickly model and envision the consequences of new systems. Working with Xerox's development and marketing organizations, customers could try out new system configurations, reflect on the appropriateness of the systems for their business, and progressively refine and tailor them to match their business needs. Such an environment would be a new kind of technological medium. Its purpose would be to create evocative simulations of new systems and new products before actually building them.

The envisioning laboratory does not yet exist. Still, it is not so far-fetched to imagine a point in the near future when major corporations will have research centers with the technological capability of, say, a multimedia computer-animation studio like Lucasfilm. Using state-of-the-art animation techniques, such a laboratory could create elaborate simulations of new products and use them to explore the implications of those products on a customer's work organization. Prototypes that today take years to create could be roughed out in a matter of weeks or days.

When this happens, phrases like "continuous innovation" and the "customer-driven" company will take on new meaning. And the transformation of corporate research – and the corporation as a whole – will be complete.

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ARTICLES

"Building an Innovation Factory"

Andrew Hargadon and Robert I. Sutton

Harvard Business Review, May–June 2000
Product No. 6102

This article also emphasizes continuous innovation, focusing on what the authors call "knowledge brokering"—using old ideas as raw material for new ideas in wholly different contexts. The key to knowledge brokering is systematically generating and testing fresh ideas. How? First, capture good ideas by investigating multiple markets and industries and observing how people use proven technologies and products. Then, imagine new uses for these "old" ideas. Finally, quickly put promising concepts to the test, making sure to catch mistakes early and make improvements. The article describes how Design Continuum, Ideo, and Idealab have incorporated this systematic innovation. The Reebok Pump sneaker exemplifies the success of this process: Design Continuum applied pump technology from medical products (inflatable splints and intravenous bags) to create best-selling basketball shoes.

"Customers as Innovators: A New Way to Create Value"

Stefan Thomke and Eric von Hippel

Harvard Business Review, April 2002
Product No. 9640

This article expands on Xerox PARC's research principle, "innovate with customers." Thomke and von Hippel present examples of several companies that have adopted a new, seemingly counterintuitive, approach to the R&D process: They enable customers to design their own products by equipping them with high-tech but user-friendly tool kits that let them do computer simulations and rapid prototyping. Customers can run several experiments quickly and inexpensively. Companies can meet customers' demands for custom products, complete product designs more rapidly, and manufacture final products correctly the first time around.