

**CHANGING THE GAME OF CORPORATE RESEARCH:  
LEARNING TO THRIVE IN THE FOG OF REALITY**

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fog of reality pp. 95-110**

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**Technological Innovation**

**Oversights and Foresights**

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## INTRODUCTION: SETTING MY SIGHTS

In the context of corporate research, questions of foresight and oversight are always present. But there are different ways to address them. From a theoretical point of view, many of the issues are clear. From a practical point of view, however, attempts to discern unfolding technological and social trajectories are always clouded by what I call "the fog of reality." What I'd like to do in this paper is take the practical rather than theoretical road and address the topic of foresight and oversight from my practical experience of life in the fog.

In particular, I'd like to talk about ways in which the fog is getting thicker. This is because the game of corporate research is itself changing even as we play it. (One of the changes, as I hope to make clear, is that we in the labs can no longer afford to regard the rest of the corporation as the opposing team!) Rapid and continuous changes are making it inevitable that we not only learn to live with the fog of reality, but that we learn to thrive on it--and I'll try to suggest some ways we're trying to do that.

From my own experience, however, I don't think oversight and foresight can be discussed without first introducing another "sight" and that is "hindsight."

Corporate research is a ripe field for Monday morning quarterbacks telling the players what they should have seen and done. So a good deal of what I want to talk about is not just the difference between foresight and oversight, but also between foresight and hindsight, between looking through the fog and looking back when the fog has cleared.

## WORKING IN THE FOG

Inevitably, one of the problems of coming from the Xerox Corporation's Palo Alto Research Center (PARC) is that hindsight has already declared our biggest oversight. The Monday morning quarterbacks already know what we fumbled and when. We invented the personal computer and didn't know it.

Rather than try to duck this accusation, let me take it as a useful place to start. Looking again at this well-known story as more of the fog is lifting, we can perhaps begin to see not so much a different story (I don't want to be accused of trying to rewrite history) but some intriguing issues different from those that made headlines and book titles. These issues, in turn, raise some interesting questions about foresight and oversight and, in particular, about when oversight becomes foresight.

The first thing that needs to be said (and this is not just corporate false modesty) is that Xerox did not invent the personal computer. Others did that, and they deserve the credit for doing so. What Xerox did, and it does deserve credit for this, is invent distributed computing. In one way you could say Apple was heading for one goal while Xerox was heading for quite another. Both, unfortunately, were judged by the same standard.

The confusion between the two is understandable. About the time Apple's Lisa first appeared, Xerox introduced the first version of the Star, which in many ways was the precursor of both the Lisa and the Mac. Apart from similarities in the technology, both introductions also had in common that they were minor disasters. With radical innovation that's not surprising. But what is instructive is the different ways the two corporations responded to their failures. Apple looked

at their flawed machine, then went through several iterations until they emerged with a successful Macintosh, with which they went on to make history. Xerox looked at their flawed machine, then went through several managers, and in the process made a very different sort of history.

But to understand the story twelve years later, you have to separate the two very different technologies each corporation was looking at. Or perhaps it would be better to say you need to separate the two very different ways each corporation looked at what appeared to be very similar technologies.

Apple looked at its neat little box and its individual user and through several iterations tried to make the two increasingly compatible. Xerox, meanwhile, struggled on with its notion of distributed computing. We were focused on environments that would enable people not simply to work alone, but, though alone, to also be able to work collaboratively. We didn't aim to have individuals isolated in cubicles and offices working on "his" or "her" computer, but to have them--even though they might be isolated in a cubicle or on the other side of the world for that matter--working both individually and collectively on a distributed network. Now, some dozen years later, our original views of client-server and networking architectures are allowing that to happen.

The technological demands of these architectures were an incredible challenge. But it was not the only challenge. A major part of the problem was that while we could at least see the technological challenge, for a long time we couldn't see the other challenge that kept these technologies from the market. Apple, in a way, cleared the fog to expose our oversight--but our oversight was not what people think it was. What we had failed to see was not the personal

computer revolution, but the fact that the innovative products we were creating challenged conventional practices, in particular, conventional buying practices.

### Changing practice

Now that, I think, is a wild enough claim that I need to spend a little time justifying it. And for that I'm going to take a relatively long detour back to where (for Xerox) it all began, with Chester Carlson and the invention of xerography.

For a long time it looked as if that technology also wasn't going to get out the door. Even though it was extremely powerful, no one could really see a huge market for it. The story is fairly well known now, told as another example of corporate oversight on the part of some big corporations--RCA, IBM, A.B. Dick, Kodak-- who were offered and turned down the photocopier patent. Given the market analysis, their rejection is actually understandable. What's almost inconceivable now is the market analysis. Put together by Arthur D. Little, it could see little value in the photocopier in that the authors decided there wasn't a market for more than a few thousand machines. Reading the report today is simply shocking. How could they have been so befogged?

We need to understand, though, that if we have trouble seeing back into Arthur D. Little's world view to understand their monumental oversight, they had far more trouble seeing forward to our world view--a world view that takes for granted the inescapable usefulness of copiers in every office and on almost every street corner. We know the value of the copier. We copy résumés, agendas,

minutes, portfolios, theses, tax forms, letters, checks, and on and on. Why couldn't they see that? Hadn't there always been copies?

Well, copying goes back for millennia--classical literature wouldn't exist today with out it. But all the studies of the copier were, you might say, filtered through carbon paper. That's what copiers hoped to replace. Moreover, where people simply typed and copied simultaneously with carbon, the new machine would expect them first to type and then to copy. That didn't seem like a step forward.

What no one saw--how could they?--was that the copy machine wouldn't just be used for making a copy of an original. It would be used for making copies of copies and copies of copies of copies and so on. If people had continued to make copies of originals, market growth for Carlson's machine would have been a simple linear progression (some coefficient times the number of originals being generated). What Arthur D. Little and the various potential manufacturers couldn't see was that if, on the other hand, people started to make copies of copies, the progression would be exponential. The number of copies and the copier market would explode. And that's what happened. People started to see the power of copying for supporting collaborative group work, and this process--in effect a process of midcasting--has changed the way people work together around documents. Since it couldn't happen with carbons, no one could see it coming. The Xerox copier, in effect, was invented for an office that didn't yet exist, an office that the machine itself would have to bootstrap.

And here, rather circuitously, I've come around to the question of buying patterns. People don't buy machines for practices that don't exist. They can't be

expected to. They will respond to recognized needs, and even to unrecognized ones, but not to needs that don't exist. So Carlson's copier in fact had to rely on not one, but two profound innovations. One was the copier itself, a technological innovation. The other was how it was put into circulation, a marketing innovation quite as profound.

Haloid, who bought the patent (and later renamed themselves Xerox), elected to take their return from use fees instead of trying to sell into a reluctant market. Each time a copier was used, they made money. And, as we now know, copiers were widely used. But before that was known, this marketing innovation allowed people "in the fog" to take a chance on the machine at minimal cost. It didn't take a leap of faith, unreasonable foresight, or monumental risk. So the machines were able to make it into offices and from there into both technological and marketing history.

Both stories are frequently told. But one is usually told in a technological arena, and the other in a marketing one. It seems to me crucially important to have the two together. It was the synergy of technological and marketing foresight that made Xerox possible. Foresight is not the purview of research labs, it is a co-production of the research arm and the marketing arm together.

From units to systems

To return from this long digression to the point I was making, distributed computing met similar barriers. To buy a system for a practice that at the time did not yet exist took a monumental act of faith and an investment of a quarter of a



million dollars to get the first few workstations plus file server plus print server plus a Local Area Network to connect them all. Back in 1982, there were very few people prepared for that kind of experiment. In contrast, with a couple of thousand dollars, you could get a Mac up and running. Now, a dozen years later, all the costs have fallen dramatically. No one would think about buying a computer system that was not basically networked. Once again a change in technology has helped people to change the way they work.

So, I want to suggest, foresight and oversight begin to blend in subtle and interesting ways. Distributed computing was a foresight whose value is only now becoming understood. The oversight part of that foresight was incompatibility in buying patterns, something "Mac in a box" circumvented.

Where we go from here

The essence of these stories is that business is always conducted in this "fog of reality." You're forever aiming at targets you can't see, or you don't understand, or that change as a result of things you do. Even in this fog, however, two things stand out as centrally important issues. I will try to develop them in the rest of this paper.

The first is that living productively in the fog, developing foresight when you can't see ahead, is a collective, collaborative, "co-evolutionary" process. It involves collaboration within the corporation. Research isn't going to do it alone. And it involves collaboration beyond the corporation--with suppliers and customers and all the people whose changing practices are the fundamental grist

to Xerox's research mill. This, as I'll explain in the next section, requires an understanding of the complex interplay of formal and informal processes and great deal of listening from researchers--people who are often more inclined to gather an audience than to join one.

The second point is that the challenge of research is dramatically increasing because the reality we are trying to navigate now is subject to an ever-accelerating pace of change. Consider, only as an illustration, that when the Lisa and the Star were being developed, information was being processed at more or less 1 Mips. By 1994 the rate was 100 Mips, and within the next two years we may well see 1,000 Mips processing. The corporation and corporate research have to keep pace. So the "Great Challenge," which I take up in the penultimate section, involves corporate research in changing and reinventing the corporation and itself.

#### FROM "ACROSS THE TRANSOM" TO CROSSING THE TRANSOM

There's an old, well-known model of the relation of corporate research to the corporation. Essentially, it says, researchers develop a new technology, preferably in a well-funded lab, then chuck it across the transom with a note that says, in effect, "The ball's in your court now--and here's the bill."

For researchers this is a pretty comfortable position. If anything goes wrong, it's blamed on the corporation. Perhaps that's why the story that Xerox invented the personal computer but failed to market it has lasted so long. As my account of the development of the copier shows, although I am a researcher, this

isn't a position I subscribe to. Anything chucked across the transom should be chucked right back with the original note attached.

Within this model, which we all know enough to ridicule as brain dead, is a serious core that persists despite the ridicule. That is the belief that research's relations with the corporation are mediated through explicit, formal exchanges either in the form of requests from the corporation or the technological "push" from researchers. These are also passed across the transom, but people are not.

In Xerox, for example, such formal exchanges took place in annual "gap closure" meetings, when the two sides got together and contemplated the distance between them before returning to their separate spheres. Because these meetings were always struggles over power and turf conducted with varying amounts of passive-aggressive behavior, the gaps were almost impossible to close. The result was very little technology came out, and the serious money seemed to go to those who wrote books about our failure to make money from our own technology.

As a first step in improving relations between research and the rest of the corporation, we learned to cross the transom regularly ourselves. A Technology Decision-Making Board, made up of the presidents of the business divisions and members of the research and technology centers, now meets once a month. This board--chaired by Mark Myers, Senior Vice President of Corporate Research & Technology and a member of the Corporate Office--provides a context for formal discussions having to do with portfolio balancing, how to decide what technology platforms to build, how to allocate resources, and so on. This attempt to straddle the transom has been an important change, but it has only addressed the formal

aspects of interaction between the labs and the business divisions. It was necessary, but not sufficient for real change. (For an account of the formal structures, see Myers and Rosenbloom, in press.)

At the heart of the new relationship is the understanding that, for real exchange back and forth, we need mechanisms to bring out the informal too. When the informal insights, understandings, and world-views of each side are allowed to emerge, you can really start something going.

To understand this, let me use a table designed by Susan Stucky of the Institute for Research on Learning to illustrate our sense of what knowing or understanding really involves.

*Distributed intelligence*

Knowledge	Individual	Group
Explicit	Concepts Procedure Rules of thumb	"Best practices" War stories Business processes
Tacit	Intuition Know-how / expertise Common sense Good judgment	Work practices Core competencies Communities of practice*

\*Communities of practice refers to the social fabric that emerges from sharing a task over a period of time.

As the table suggests, knowledge has both explicit and implicit components. Equally, intelligence has both individual and group characteristics. One of the problems with much of the education system of the past hundred years is that it has put most of its money on the top left quadrant, individual, explicit knowledge. Thus it has focused almost exclusively on concepts and procedures. Similarly, instruction and workplace learning has looked at explicit rules and the like.

That's starting to change. People are beginning to notice the role of the group or social mind. They are starting to see how intelligence is distributed throughout a work team, for instance. As a consequence, explicit group characteristics such as "Best practices", or "War stories", and business processes are gaining more and more attention. That's progress.

But there's further to go. We need also to start to take into account the tacit and informal nature of knowledge. In individuals this goes by names like "intuition," "know-how," or "good judgment," and collectively it's found in work practices, core competencies, and the collective, communal center of these, which I call the "community of practice" using a powerful notion developed by learning researchers over the last few years (Lave and Wenger, 1991). It's a term for the social network, often quite unnoticed, that binds together a work group, whose members gradually come to develop an implicit, informal but shared and coordinated sense of what it is they do.

Where we believe we have started to break some new territory is in realizing that for any formal structure to work, it has to be complemented by informal structures shared in groups like this. Indeed, the formal and informal are not really separate but part of a reciprocating cycle in which people continually make some work practices explicit while they implicitly reinterpret some "war stories" and the like. In other words, Figure 1 represents a dynamic process, not a static state.

From this view of active knowing rather than static knowledge, we've come to see that technology transfer has much more to do with how to get a constellation of interlocking communities of practice--communities of practice of

researchers, communities of practice of developers, and communities of practice of end users--to develop shared understanding of each others' emerging insights. For this, they need to attend to the implicit assumptions behind each other's informal practices, which are revealed in ongoing conversations rather than formal pronouncements.

### Attending to conversations

How does this fit with innovative research? Well, we believe that, given the accelerating pace of change, every market is an emerging market. There are no fixed markets to be mapped, only emerging markets that are continually being shaped by co-evolving emerging technologies. Our job is to be there as those markets evolve, to learn to recognize them even before they recognize themselves because we can't afford to wait for the clarity of hindsight as we construct linkages between emerging markets and emerging technologies. We allow technologies to shape the markets and the markets to shape the technologies.

Attending to the informal is, thus, particularly important. Getting a sense of the informal allows us to understand changing practice as it emerges long before it has been codified and made formal and explicit. So one of our goals has been to develop ways of doing this.

One way, we've discovered, is to engender ongoing informal conversations between research and the business divisions. You can do this, for instance, by focusing on practices around "boundary objects"--objects shared by two communities. Conversations about these reveal both shared and distinct attitudes.

And you can do it by trying to elicit the critical questions about the emerging markets and the emerging technologies. What are the sustainable competitive edges? What are the market feedback mechanisms? What are the forms of co-evolution? How would a certain technological insight enable us to see aspects of the emerging market? How do certain things in the emerging market help us reevaluate certain things being done in technology?

For this sort of research, we bring to the table a profoundly diverse body of people. At PARC, we run the gamut, we like to say, from atoms to culture, from people developing new materials to people developing new cultural understandings. So, as well as computer scientists, we have physicists and mathematicians and logicians and linguists and historians and sociologists and anthropologists.

With this array, of course, we've already got some fairly profound, multidimensional conversations going within PARC. These form around a problem space rather than an abstract desire to collaborate. The problem rather than the collaboration being the issue, this tends to bootstrap the participants beyond the methodological barriers that impede interdisciplinary collaboration on many campuses. At PARC, the increasing spirit of interested and willing interdisciplinary cooperation is probably one of the most striking and productive changes of the last decade.

A second real asset of this diversity is that the very culture we work in is itself an emergent one, not a dominant one. In a lot of corporations that have turned their attention to "culture," what you actually have is a demand for conformity. That's what Gideon's research (1992), for example, showed. These

corporations don't really open themselves up to emergent cultural practices, to the formation of new communities of practice. What they do instead is expect everyone to join the dominant culture. This quashes radical departures rather than sparks them.

### Quality listening

Perhaps a surprising motor for turning researchers into sophisticated listeners of emergent conversations was the movement for Total Quality Management. At Xerox we had a company wide program called "Leadership Through Quality"--widely known as LTQ (though one version of the culture insisted we weren't supposed to abbreviate it). I know of little that is less popular than trying to impose "quality" on researchers. We tend to feel that we know what quality is and to resent anyone trying to tell us how to achieve it.

But if you go to the essence of what the quality movement is really about, you get an interesting meeting between quality and research. For the corporation in general, Leadership Through Quality was profoundly valuable because it taught it to listen to its customers. After a while we researchers also found we too could gain invaluable insights by listening to our customers--both in and out of the corporation. What they had to say taught us a lot and kept us grounded in the real world. Indeed, our customers are often sources of innovations quite as insightful as anything we do on our own. Moreover, their innovations tend to be practical and useful.

What emerged was a transposition from LTQ to QTL<sup>4</sup>:



Quality through

Linking to the world

Listening through that linkage

Learning through that linkage, and then

Leading.

We couldn't offer to lead without first being prepared to listen, and so it became increasingly important to develop ways to listen. We approached this through something we call "listening through participation."

Listening through participation

We have developed several approaches to this. One has been through anthropology which has as one of its primary methods participant observation. Several of our researchers have undertaken this sort of study and have developed rich and productive understandings of what our customers do and how we can support them.

Another is Interaction Analysis, a method we are developing in which a diverse group of researchers come together to try to make sense out of interactions and practices captured on video. This is an interestingly reciprocal method. A 30 second video fragment of a user-computer interaction is a powerful tool for bringing diverse points into productive friction, sparking genuine collaboration and co-evolution among the body of researchers. And, out of the co-evolving ideas, a rich insight into the practice captured on the video can emerge.

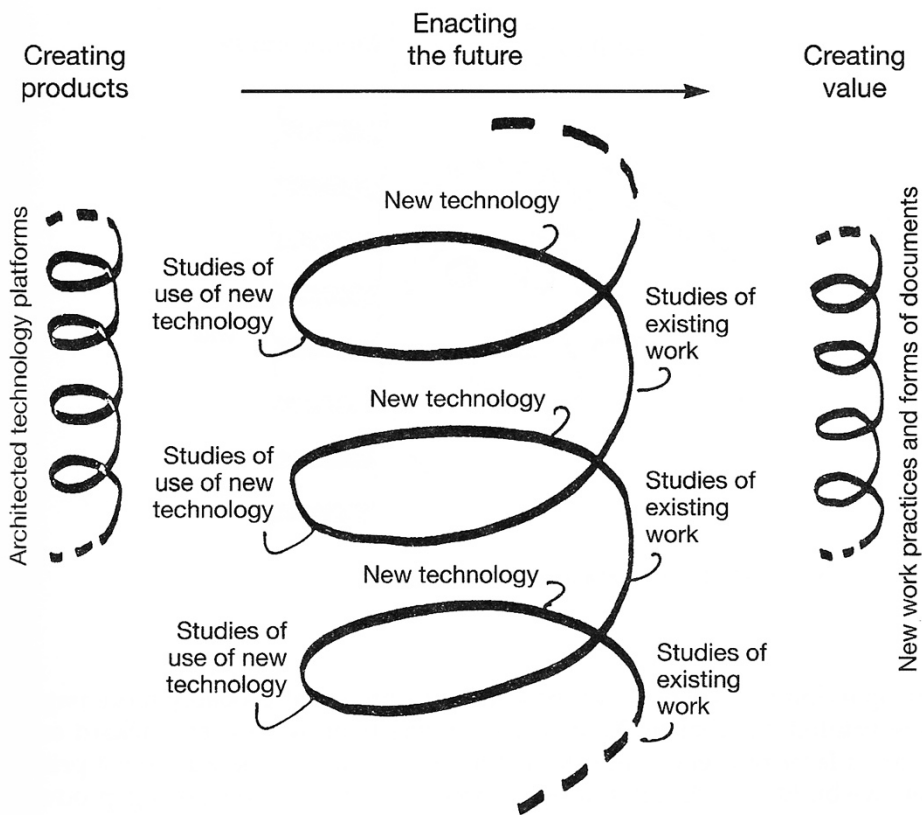
But there are other ways to listen. A third particularly interesting way exploits some of the increased computer power that we have on our platforms today. Instead of just adding feature, after feature, after feature, we try to build truly scalable and flexible platforms.

Practice is always versatile. If the technology supporting practice is equally adaptable, it's possible to develop incremental and reciprocal changes in both practice and technology that spiral upwards in exciting ways. You start by honoring the existing practice with the scalable technology. This technology allows practice to change in both expected and unexpected ways thus establishing a new practice. The new practice in turn requires new technological support which a truly scalable platform should be capable of providing.

What you really have here is three spirals, as I've tried to show in Figure 2. Both work practice and the technology platform are being constantly modified in situ.

Emerging technology platforms linked to emerging work practices together enact something fundamentally new. And, as the right-hand side of Figure 2 suggests, this is where we believe value is really created. From this co-evolutionary perspective the researcher's challenge becomes not the invention of the future from outside, but its enactment from within.

Such a view of the development of technology and work practice can change conventional practices in many ways and calls for innovative responses. Let me just take one as an example. Consider the conventional contracts that govern relations between employers and employees or businesses and suppliers. They are usually written in a carefully prescriptive language specifying exactly



what is expected at exactly what point in time. But this has two problems. In the first place, a contract is a "boundary object," which will have slightly different interpretations in each of the communities it concerns. It is thus almost impossible to be precise, for what may be precision in one community may not be in another. In the second place, if you look at Figure 2 again, you can see that what was specified when the contract was written, is probably no longer exactly suitable at the time when the contract is executed, by which time the whole relationship will have advanced one turn along the spiral.

As I noted earlier, the challenge for research, and for the corporation in general, given the accelerating pace of change, is not simply to change technology

or to change work practices or contractual arrangements, but to change ourselves. This is what I call The "Great Challenge."

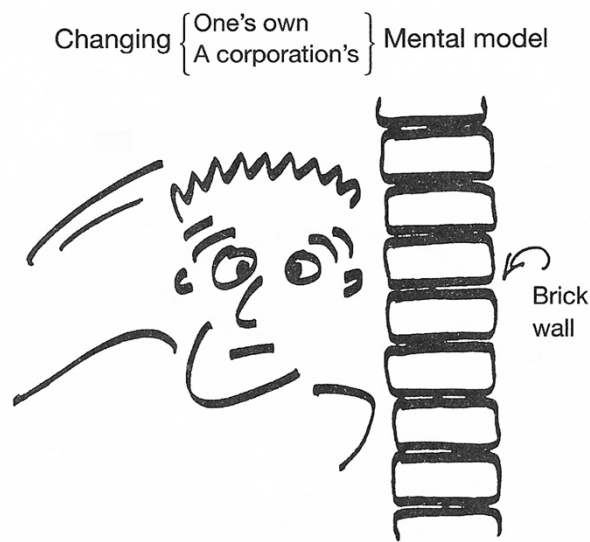
## THE "GREAT CHALLENGE"

Technology transfer for radical innovations turns, I believe, on the ability to change our preconceptions, to revise our mental models, to reframe the world. The corporation has to be able to do this, and so do its employees, from top to bottom. Let me talk first about changing the employees, individually, then I'll talk about the challenge to change presented by the group mindset.

### Changing mental models

From a cognitive science point of view, changing mental models is a very real challenge. Your mental model determines how you perceive the world. In so doing, it excludes alternatives and tends to make new concepts conform to the old rather than adapting the old to the new.

Before talking about how to change, though, let me first give an example of why it needs to be done. As I noted, Xerox's prosperity was founded not on the number of machines sold, but basically on the number of pieces of paper that cycled through the machines. In that way, we are like razor-blade companies, producing razors, but making money on the blades. We do something similar with paper and toner and service, and we're very good at it. Consequently, that's how we see the market--in terms of keeping paper moving through machines.



This view of the world has also helped us to focus on the "high end" of the market, because that's where people move high volumes of paper. Many people don't even know we make laser printers. Yet probably more pages are printed per year by Xerox laser printers than by Hewlett Packard and Canon laser printers combined. It's not widely known because most printers we build wouldn't fit through most doors. Our printers are big, production-grade printers, printing at over a hundred pages a minute. This is good for us because the more pages printed, the more money we make - on printing supplies.

This way of thinking about our market is profound. It determines the machines we build, the way we service them, the toner and paper we provide, the business units we develop, the research we do, and on and on.

What happens, though, if the market and the technology change but we don't see it? This is likely to happen because between the fog on the one hand and our mental models on the other, we don't have the distinctions to even describe the change.

Consider changes in technology. When we come up with a new kind of copier, the questions we know to ask are: "How many pages per minute and what's the copy quality?" So these are the questions we ask about digital copiers regardless of whether they are the crucial questions.

Now consider our customers. They, like everyone else, are drowning in paper. The extreme examples are well known. The manuals for airplanes weigh several tons, those on aircraft carriers actually make a significant difference to the ship's displacement. But even in more down-to-earth circumstances, people want to get out from under the paper burden. They want only the information they need, not all the information they get. Essentially they're looking to have the phone book without having to take all the pages they'll never need. Intuitively, they recognize that paper makes a great interface, but a burdensome storage medium.

In this context, the digital copier could become a very powerful new platform. With light-lens copiers, you copy first, then distribute. But digital copiers change that. The first step is to scan. With scanned, digital text you can distribute over a network before copying--or what now becomes, in effect, printing. You can store in digital form rather than on paper and you need only print to read. For a scan-distribute-store-print process, it no longer makes sense to think of customer needs solely in terms of image quality and number of pages printed.

That's just one difference. Once you've got digital copy from scanning, there are many other things you can do with it. In particular, a range of powerful new computational as well as distributing and printing services can be added. For

example, software is now becoming available that will allow you to summarize a pile of scanned articles, articles you once would have just copied. That's a wonderful way to deal with the flood of paper. But it no longer submits the copier to the old paradigms. Using summarizing software, for every 25 pages you put in, you may come out with only one. If you end up with only four percent of the paper you would otherwise have had to read and file, you will probably be very happy. But if we at Xerox continue to ask "How many pages at what kind of quality?" we shall be very unhappy. The digital copier requires us to rethink our conception of our market and how we provide value to the customer.

Now you would think that would be an easy idea to get across, but it is in fact a profound ontological shift and very difficult to see from the how-many-pages-and-what-kind-of-quality mindset. Changing these mental models is very hard. Indeed, over the past few years I've come to feel that organizational learning is relatively trivial. The real challenge is organizational forgetting. Moving a corporation built on light-lens copiers into the era of digital copying requires a lot of forgetting.

So it is becoming increasingly clear (despite the fog) that an important part of our job in research is to help change mental models, to envision what new work practices will be, and to determine where new markets will be emerging. And we have to do this quickly, because the markets are already changing.

### Fostering organizational forgetting

One strategy for fostering organizational forgetting is something we call the "open ended video document." Here we ask four or five scientists who have developed a radical new technology to act out a new work practice enabled by that technology and we videotape their "skit." On the same video, the same group then discusses what they have done. What was key to the new work practice? How did the technology enable it? And similar questions. This process is then repeated several more times where yet more new work practices are envisioned and reflected on.

The idea is to use this video document as an intuition pump to help both push and pull people into the mental model behind the new technology. For example, we took it to one of the most senior executive vice-presidents of the company, and asked him to watch the tape and then to create a scenario of how he personally would use the technology--essentially to add his own skit to complement the three on the video. The document was to pump his intuition to help him produce his own ideas in his own way. And then we did the same thing singly and in groups with others in the company. What we wanted was to help each participant enact new practices, to envisage what working with this technology would be like. And we hoped to reach beyond intellectual analysis to draw out instinctive responses based on personal practice and intuitions.

As an example of another strategy, we tried to get members of the corporation to think not only of the notion of trends but also of the notion of discontinuities. Here we asked business division presidents what "destabilizing events" they intended to introduce over the course of the year. They were also



asked to predict what destabilizing events they were likely to encounter. With both these examples, our intent was to break the standard framework, to ask people to think in fundamentally new ways, and to provoke insights into new practices. We felt that new distinctions could allow latent insights to emerge, rather as the seeding of a solution precipitates crystals to form.

#### Fostering changes in the group mindset

These strategies were aimed primarily at changing individuals and their mental models. When we began to work on the corporate organizational architecture, however, we discovered that we needed to focus attention beyond the individual. Here we were interested in perhaps the least understood quadrant of Figure 1, the bottom right-hand segment that represents the tacit knowledge and expertise of the group. This knowledge and expertise is informal in the extreme. It is also, I would contend, a crucial contributor to the creation of value. I suspect the reason that so many attempts at corporate re-engineering fail is that they focus almost exclusively on the formal, on the explicit, and fail to grasp the group mindset at its implicit level.

These methods I have described are in themselves relatively slight and I am not trying to maintain that either individually or collectively they have irretrievably altered all mental models or the corporation's mindset. The "great challenge," getting the corporation to understand a radical innovation, is still a challenge. What I hope I have suggested is the nature of the challenge and the sorts of ways we have tried to meet it. More importantly, I hope I have indicated that it must increasingly become part of the research effort to meet this challenge-

-both by helping others to change their conceptual lenses, and by allowing them to change ours. It may well be that in times of constant change we need to focus our research effort on how to foster organizational change and forgetting as well as on providing technological innovation. For in the face of constant change, we need to change constantly, and for this we need to develop a multiplicity of methods to help bend and break old frames built for old conditions.

#### CONCLUSION: BECOMING "REFLECTIVE PRACTITIONERS"

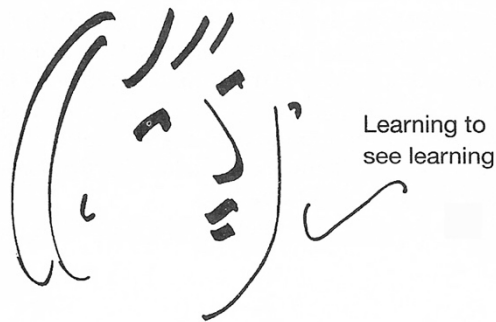
In our case, the frame we need to break is the "document company" as a company for (re)producing (conventional) documents. Instead, we need to see documents themselves as technology around which work happens and value gets produced and begin from there the seamless merging of the paper and digital worlds. This will involve moving from just delivering hardware artifacts to also supporting social artifacts.

Undergoing this transformation involves changing one's conceptual eyeglasses to move from the left-hand column to the right-hand column in the next image.

Making this change has involved a new expansion of our research activity into "soft" issues. It has also involved being prepared to change ourselves. Not long ago, Chris Argyris wrote a paper called "Too Smart to Learn" (1991). Without reading beyond the title it helped me understand both our assets and our limitations. It also reminded me that we, as researchers, need to become what

Don Schön, Argyris's colleague, calls "reflective practitioners" (1983)--able continually to reflect and change our own practice as well as that of others.

Learning	→	Learning and <i>un</i> learning
Thinking  doing	→	Thinking ∫ doing
Individual learning	→	Collective learning
Strategic plans	→	Strategic intent and core competency
Making products	→	Making sense
Communicating	→	Listening



### Changing our eyeglasses

Promoting radical change is part of our agenda, but so is co-evolution, which cannot happen if we are not willing to evolve ourselves. Without using our insights to help others break their framing assumptions, the corporation isn't going to be in business. Without opening ourselves to have our own frames broken, corporate research is not going to be in business. As I tried to suggest with the story of the first copier, the two form a symbiotic relation, and real foresight--insights and innovations that come to have real consequences--is a co-production. We're all working in the fog, we've all got to keep our feet upon the ground. By putting them on different bits of the ground while supporting each other, we should get maximum collective traction.

In closing, I'd like to quote John Ruskin (1856-60), art and architecture critic and early champion of many painters, including Turner, when few had the foresight to see more than fog in his paintings. It captures, I think, the essence of what it's like living in the "fog of reality," and gets to the core idea of insight that emerges between the oversight of some and the foresight of others.

#### On Seeing Clearly

The greatest thing a human soul does in this world is to see something and to tell what it saw in a plain way. Hundreds of people can talk for one who can think, but thousands can think for one who can see. To see clearly is poetry, prophecy, and religion--all in one. (Vol. III)

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