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The Future of Paper

Offices have changed a great deal over the past century. Some of these changes have been brought about by apparently quite ordinary technology. The invention of the vertical filing cabinet, for example, radically expanded the amount of information that could be stored in any one office, contributing to the emergence of truly distributed organizations.[1] The telephone was, of course, another revolutionary technology; the PC a more recent driver of change.[2] Yet throughout these developments paper has stubbornly remained a key tool in office life. So, what will the office of the future look like? Will it be radically different and wholly paperless? Or will it be the reverse, perhaps all too familiar, filled with difficult-to-use technologies but still burdened with excesses of paper?

We think that the office of the future will be a very different place than it is today. New technologies will continue to be developed and will find their own niche in the office of the future. Some will have a huge effect; others will have very little. Similarly, the role of paper will continue to evolve and change. In some arenas it will disappear; in others it will persist or even assume more importance. There will be changes, too, in work practices and organizational processes, and these will leverage the opportunities innovative technologies can provide. Finally, there will continue to be changes in the way office spaces are used, in the patterns of work, and in where and when people do their work. This will spark new technologies and ways of working as well as more fundamentally changing our concept of what an office is.

But what can we say more specifically about the role of paper in the office of the future? It is at this point that we revisit the questions we posed at the beginning of this book: How much paper will there be in the office of

the future? Is a mix of paper and digital technologies inevitable? What will the role of paper be in five, ten, or twenty years? As we said at the outset of the book, rather than resort to trend analyses, we have tried to answer such questions by looking at the underlying reasons why people continue to use paper in the face of digital technologies. To do this we have covered many different aspects of paper use and looked at many different kinds of workplaces. What we found is that there are three kinds of reasons that people stick with paper despite the burgeoning of digital devices populating today's modern offices:

1. *The coevolution of paper and work practices.* Paper and work practices have coevolved over the years, and changing these long-standing work patterns within existing social, technological, and cultural infrastructures is difficult.
2. *The need for better design of digital alternatives.* Many digital alternatives to paper are inadequately designed for the tasks at hand and for accomplishing the goals people are trying to achieve. Thus, paper often does the job better and enables people to work around the problems posed by technological alternatives (many of which were originally introduced to replace paper).
3. *The affordances of paper.* Paper has particular affordances that make it the best choice for some tasks at hand and that will likely continue to make it the preferred medium for certain work tasks in the foreseeable future.

Each of these reasons allows us to say something more substantial about the status of paper in the office of the future. Although it is very difficult to pinpoint *when* changes will occur, what we have discovered about paper use lets us say something about *what kinds* of changes we expect and what *preconditions* are necessary before these changes can take place.

Coevolution of Paper and Work Practices

Much of this book has been about the difficulties organizations have in bringing about change in a desired direction. One or two of the workplaces we have looked at have undertaken change very effectively; but most have found the transformations much slower to effect than they had expected. Most have also found the process a painful one. Those instigating move-

ments toward a paperless office have often found themselves disappointed when expectations have fallen short. Those affected by these initiatives have, at best, found their work compromised and, at worst, seen the efficiency, productivity, and even safety of their existing processes undermined.

Looking at so many different work settings allows us to point to two important issues here, corresponding to two of the major themes we have explored in this book, namely, (1) that getting rid of paper often assumes a symbolic role in office life, one that can get in the way of understanding the real underlying problems that may exist; and (2) that the role of paper in office life needs to be understood as having coevolved with work practices and thus as being hard to disentangle and alter.

Both issues are about complexities and interdependencies. To unravel them, and to make the path to change a smoother one, fortunately we have seen that there are practical steps that organizations can take:

• *Dispel the myths.* First and most important, some of the myths surrounding the office of the future need to be dispelled. The idea that there are always benefits to going paperless is one such myth. There need to be clear-cut reasons for making changes, based on a good understanding of the existing social, physical, and technological infrastructures already in place in any given work setting. Change for the sake of change is hugely problematic. Going paperless for the sake of "out with the old, in with the new" is destined to end in failure.

• *Understand the broader picture.* Second, there needs to be better recognition that office environments are not just about old and new technologies such as paper and desktop computers. Of central importance here is that office environments revolve around people and the ways people share informational artifacts and know-how. This includes the interdependencies of different forms of information, one supporting the use of another, and so on. Offices are ecologies, and when well designed and maintained, they are ecologies that thrive, allowing people to work more effectively both within their confines and elsewhere (at home or on the move). Often there is a failure to recognize the importance of looking at this broader picture when trying to select the technologies and design the organizational processes of the office of the future.

Before we look at what this means for the office of the future, let us say more about what we mean by the broader picture. Here it is helpful to revisit what an office is and what it consists of.

What Is an Office?

Throughout this book we have looked at various elements of office environments, though, of course, with a bias toward looking at paper. In our approach, we have attempted to look at the bigger picture—to look not only at the specific ways in which office workers use the tools they have to hand and at the tasks they do but also to consider how these practices have come to be, how they fit into the larger social and cultural milieu, and what these practices mean to people. This approach contrasts with much of the work on office and factory life that took place in the early and middle twentieth century. This work was focused on measuring and improving the performance of specific tasks.[3] Since then, other people have looked at offices in a much more holistic way, recognizing that offices are in fact complex systems, involving much more than simple processes with inputs and outputs.[4] They are made up of social fabrics and subtle arrays of tools and technologies. They are as much anthropological phenomena as they are cognitive, and though they are based on processes and rules, they are pervaded by moral codes.[5]

In various ways, all this research has shown that effective offices of the present day are not simply a function of the way an office environment is laid out or the various information tools and technologies in the office (whether they be paper or digital media). Nor are they simply a function of the people who populate an office or the work processes they engage in. They are a product of the *interaction* of these things. There are many ways in which this is so, but here we want to highlight three key concepts that help to explain how.

Information Ecologies This is a term for the way different forms of information are made useful by their interdependence with other forms of information. By way of a simple example, consider how it is that a Post-it note may have no value in itself until it is attached to another document. Interdependence need not be physically embodied in this way, however. A report may only have meaning through reference to prior reports. Al-

though these reports may be stored in nearby files, the nature of this relation may exist very much in the minds of the people using those reports. Having read the prior reports, they take account of what was said before in order to interpret what is currently before them. The relations between informational resources are therefore often spread out over time. These relations create strands of activity and meaning.

The relations between various kinds of information may not only be of concern to any one person at any one moment in time, however. There is also the relation between the information one person is using and information other people may be using. Here, particular kinds of informational artifacts help create and maintain that interrelation. For instance, all the activities related to some set of reports may be prioritized by a work plan pinned to an office wall. This chart may indicate what needs to be done today and what needs to be done tomorrow, or whose responsibility is one report and whose is another. The meaning of the various reports and all the to-do jobs associated with them are reflected by and given meaning by this chart. At the same time, the chart itself derives meaning from the objects it refers to. Such charts and the documents to which they refer are thus codependent, though they may never be physically attached to each other.

Interactional Affordances of Artifacts Information ecologies are dependent upon the interactional affordances that office artifacts provide. We have talked a great deal about the affordances of paper. For example, the affordances of a paper report include the fact that it allows flexible navigation and supports the cross- referencing of one report against other reports that may be laid alongside each other on a desk. There are many other interesting artifacts in offices, too, each with its own set of affordances. For example, the affordances of a physical wall chart are that it has a persistent presence and that it is usually of a size and in a location that means it can be seen at a glance anytime by the people who most care about its contents. The affordances of whiteboards support the display of easily modifiable markings to enable participants to sketch out and jointly view the issues at hand for all to see when meetings are held.

Offices are, then, replete with artifacts whose affordances are coopted to help achieve particular ends. Each type of artifact has its own set of affordances, including various interactive, computer-based technologies. An

office environment consists of a mix of the advanced and the mundane; of objects that are flexible and portable (such as paper documents); and of environments and objects that are more fixed (such as meeting spaces and the tools and fixtures they contain). An office is a fusion of artifacts, technologies, and spaces.

Communities of Practice Finally, we turn to the concept of communities of practice. This refers to the informal human networks of information exchange and collaboration that help individuals know what their colleagues are doing and that enable them to collaborate and engage in team work. Communities of practice do this by allowing and indeed ensuring the development of disparate sets of skills that can be marshaled in flexible and typically informal ways to produce successful action. Such communities may spread out well beyond the confines of a particular office—and indeed most often do—and include individuals and groups elsewhere in an organization and even between and across organizations. For example, a community of practice may range from the vast community of researchers that constitute Silicon Valley or the much smaller but equally competitive community of racing car manufacturers in England. People can also be in more than one community.

Crucially, the patterns of collaboration that these communities support are not adequately captured in such things as process charts or formal descriptions of work responsibilities. Communities of practice go beyond and underscore such formal descriptions. The value of a community ranges from providing and propagating anything from arcane kinds of know-how within a group of workers to the support of the most mundane knowledge. For example, membership may provide access to the latest thinking on a subject, made available through coffee room talk, e-mail, or other forms of communication. Membership may also provide resources for an individual to turn to when some technology they depend upon fails. Someone can usually be found who can provide the right assistance to get things working again. This is not always the same person, with one or two people being good at some kinds of problems and others being expert at other sorts of problems. This is one of the reasons that communities of practice take time to develop and one of the reasons why their dissolution can be so consequential for organizations.

Revising Our Vision of the Future

These concepts label what interacts in effective office environments. Informational artifacts support and confer meaning on each other; tools and technologies are used as resources whose affordances serve a wide range of purposes; and people are networked, often informally, in ways that leverage their expertise and know-how. It is important to point this out because offices of the future will have to do the same. The only difference is that they will have to do so with a new set of tools and processes in place.

Unfortunately, many visions of the future fail to take these complexities into account. It is quite common, for example, to hear the notion of an office reduced to a flow of information—a description that encompasses only the interfaces necessary to input and output information as well as the tools to manage it. Recently, we have heard many of the mobile equipment manufacturers propagating this kind of view. For instance, we have been told by one company that the digital office of the future will need support for only two basic things: a window on information (something that allows access, manipulation, and storage) and a means of managing personal information while in the office or on the move. As this company saw it, such an office needed only two kinds of technology: powerful laptops (with long-lasting batteries and lightweight, flexible screens) and communications-enabled PDAs (palm-top computers). The laptop would serve as the information window, and the PDA would enable individuals to manage their personal affairs (including address book, diary, expenses) and communication with colleagues. This technology would be enabled by real-time connectivity through a wireless network.

Such a vision (and many others like it) is much too focused, much too simple. An office is not simply an interface to information but, as we have said, an interactive amalgam of information, people, and artifacts working harmoniously together. As such, an effective office consists of a much broader array of tools than a collection of PDAs and laptops could ever provide. It encompasses an information environment that spreads out around the desk and the office walls. It consists of artifacts that support not only an individual's immediate needs but also the needs of teams of people (such as the use of wall charts and whiteboards). It also consists of combinations of tools and artifacts used in conjunction with one another

in artful ways. For example, it may mean combining the use of computers to create and manipulate information with the use of paper-based notes, articles, and documents to support cross-referencing and complex navigation. And it involves having access to those who know about work processes and who can assist when they break down (including when technology fails or when new technology is introduced).

So how does change occur? As we have seen, one of the problems of trying to move toward a paperless office is that doing so often involves negatively affecting the interdependencies between various informational artifacts. Sometimes it also undermines the ability of people to work together. It is no wonder that these attempts fail. But because they have failed does not mean change is not possible. It would be wrong to think that these communities of practice, the information ecologies, and the affordances these depend upon cannot be altered. A better view is that they need to be altered and developed in beneficial ways. New interactive technologies can offer better support for work and for office environments. They can do so not by disrupting the already existing information ecologies, but by reinforcing and developing those ecologies.

We have seen that knowledge workers, for instance, interweave their reading, writing, and thinking activities to create information spaces. These can be enhanced by new digital technologies such as e-books, which, if properly designed, will allow those individuals to more effectively get to grips with the information they have at hand. We have seen also how technologies can enhance communities of practice by offering affordances that were not hitherto available. Consider the example of the account managers we discussed in chapter 2. These individuals found that they were able to more effectively participate in their community (focused in the bids and sales department) by accessing online discussion groups and through having daily contact via e-mail. Prior to the introduction of portable equipment and remote access, these individuals were separated from their community when they were out hunting sales prospects. In a sense, they were rather like eighteenth-century sailors who would disappear for weeks on end and then return either with bounty—a sales prospect—or an empty hold when no sales prospects arose. New technologies can therefore effect change for the better even in well-ingrained work practices (although not always in the ways expected).

We have also seen that major overhauls of the work environment, technologies, and processes are possible. A case in point was that of DanTech (chapter 2). But DanTech was special in that the company was at liberty to start from scratch. It was free to undertake extensive changes coinciding with a physical move to new premises. Most workplaces do not have that luxury. All the more reason, then, that they must proceed more incrementally and with caution.

Even so, we found that there were other lessons to be learned from DanTech's success that can be applied equally to organizations undergoing more gradual processes of change:

• *Focusing on the real underlying problems.* As we have said, visions of the future based on myths need to be set aside in favor of understanding the real underlying problems that an organization may have. Just as paper-based processes may not be the cause of problems for an organization, so, too, new tools and technologies may not provide the solutions. Organizations need to look at the combination of people, artifacts, and processes to assess where problems may lie and how solutions can be implemented. They need to look both broadly and deeply at what exists already.

• *Being willing to revise visions, reassess solutions.* Once the problems have been assessed, solutions can be ventured. However, solutions needed to be tested and changed if necessary. If they are rejected, there may be good reasons. So organizations need to give people time to adapt, but if they can't, they need to look at changing the solution. Consulting with end users at many points along the way will help with reassessing the solutions. As a result, an organization may have to change what its vision of the future looks like, but it is then likely to achieve a more collectively agreed-upon, realistic one.

• *Managing expectations.* Implementing successful change is often as much about managing the expectations that people have as it is about changing what they do. In other words, promise a paperless office, and you set yourself up for disappointment and failure. Promise incremental, realistic changes, and goals are more likely to be met, people more likely to be satisfied.

These are some important ways in which organizations can move more effectively and smoothly toward the office of the future, whether or not

that means an office with less paper. Key to all of this is that moving forward into the future must take account of the present. Predicting the future is not just about inventing or visualizing it. It is also about shepherding along a process of change and recognizing the importance of the transition.

So, what does this mean for the future of paper in offices? It means that the introduction of new technologies is unlikely, in most environments, to drastically reduce or eliminate paper as quickly or as radically as is often predicted or expected. Rather, in the short term, new technologies will usually *shift* the role of paper rather than *replace* it. Because change is an evolutionary process in complex environments, the new will not replace the old but will coexist with it. In doing so, both new and existing technologies will begin to interact with each other in different ways. These technologies will settle into different roles and niches over time as people make choices about what kinds of tools serve which purposes best. Paper will therefore be with us for some considerable time partly because of the slow pace of change but also because it will be assimilated into newly introduced structures and processes, including those that involve digital technologies.

Designing the Future

So, one main lesson is that there is a need to see the bigger picture. A second main reason why people are reluctant to give up paper is that the technological alternatives they have to hand are simply inferior for the tasks and goals they want to accomplish. Paper is often a fall-back when new technologies go wrong; paper can provide a quick fix; or paper can simply prove itself to be the better tool for the tasks people have before them. Here, then, is a challenge for designers to get new technologies right, to make them much better than they currently are. But we also know that the ways in which people want to accomplish activities are often a direct consequence of having used paper in those activities for so many years. New technologies may then be rejected because the processes they are trying to support have been optimized for use with paper. In a way, designers of new technology face the same conundrum as those who try to envision the office of the future. Does it make sense to invent the future by looking at the

present? Does this not anchor us to the old ways of working and steer us toward making only incremental changes? Does this not stifle true creativity?

Again, one of the messages of this book has been that, even with regard to design, we advocate looking at the future very much from consideration of the present. We have argued that treating the current use of paper as a design resource is in fact a radical approach, one that can lead to innovative new designs and even conceptual leaps over what already exists.

Let's look first at traditional approaches to the design of digital technologies. These have largely ignored what role paper may have in the workplace, have been indifferent to the interactional properties paper provides, and have been based on understanding of work activities curiously devoid of the paper-related elements of those activities. It is as if the underlying philosophy is to design away a technology (paper) without reference to what that technology is currently used for. While this is perhaps to exaggerate, it certainly is true to say that within the research and design community, paper has continued to be associated with inefficiency and old practices. One consequence of this is that designers have been somewhat fearful of having anything to do with paper in their work. Something about paper makes them worry that looking at it may result in their not achieving something "radical," something truly "innovative." As we noted in chapter 1, we were certainly subject to such prejudices, encountering surprisingly negative reactions from the technology research community when we started focusing on paper. Fortunately, attitudes within research are now changing, and we are beginning to see more studies that explore why paper is used.

But these prejudices aside, there is a more fundamental reason that looking at paper use has not been a design resource until now: it goes against one of the core beliefs of design philosophy, which says that the future cannot be designed on the basis of the present. The argument goes that new technologies will allow wholly new activities and will transform what is currently done. Since current users may not understand what these changes may be, since they might be unwilling to countenance the full implications of any imposed change in their activities, there is simply no point analyzing their activities. Rather, designers of new technologies should seek to free themselves of conventional ways of thinking and to visualize what *might* be possible, not what is *currently* possible.

There is a lot to be said for this point of view. Visualizing the future through leaps of imagination to whole new environments, new ways of working, and new devices and services can be an inspiring and motivating way forward. But there are also several difficulties with it.

The first is that many designers and developers take no notice of current practices and don't have the foresight to look into entirely new ways of working. Rather, designs are often centered on conventions developed in the digital world, such as the desktop PCs, mouse, keyboard, and windows interfaces they provide. Proffered alternatives to paper may therefore lack imagination and not provide adequate alternative support for the tasks at hand.

A second difficulty is that without looking carefully at how people might make the transition from what they do to what they might do, or without looking at what value users might get from their new designs, designers and developers have to rely to some extent on a "Velcro" model of success. That is, they have to hope that whatever new technology they throw out there into the world will "stick" somewhere. This sometimes works very well, and it often doesn't matter that these new technologies get taken up and achieve success in unexpected ways. But, equally, the majority of these attempts fail, and huge amounts of time and money are often spent marketing the wrong product to the wrong market sector.

Of course, there are ways of relying less on trial and error. For example, new devices, services, or software can be tested against potential end users through iterative user testing either in laboratory settings or in real-world trials. Here, prototype models of new technologies are tried out with people to see how they react and behave in a variety of different tasks and activities. This is a more systematic way of allowing for the development of "far out" possibilities for new designs. This approach, as well as the Velcro approach, are sensible and often result in useful innovation.[6] Designers should, at certain times, concern themselves solely with the future and should disregard the present.

What we are proposing is a way of supplementing these approaches with the possibility of looking at the present as a way of better determining how the future ought to be. As it turns out, when we do this, when we focus on how people currently use paper, we have found time and again that the end result has been design that is *more* original and *less* like conven-

tional digital technology than had we started elsewhere. This is because looking at paper use can inspire new design concepts in a number of ways:

- By looking at *how* people accomplish things in the paper world, new techniques for interaction sometimes emerge that, when translated into the digital world, are in fact quite innovative and unique. For example, looking at how people navigate through paper using two hands and using multiple pieces of paper suggested how we might develop new techniques for two-handed interaction across multiple display screens. These are a far cry from keyboard and mouse input techniques and represent a conceptual leap forward even over pen-based interfaces.
- By looking at the *goals* people are trying to accomplish using paper, ways of accomplishing the same goals in different, non-paper-like ways are often suggested. For example, when we looked at why people hand-deliver paper documents, we found that it was because they often wanted the excuse for social interaction or discussion in the process of exchanging documents. This gave us a number of interesting ideas for building two-way audiovisual links into electronic document exchange services for people who are remote. It also suggested ideas for new kinds of digital devices supporting document exchange and discussion for people who are face-to-face.
- Finally, by studying the *range of activities* people carry out using today's tools and technologies (such as paper), we can begin to understand the great diversity of things that people do, which often get compressed and glossed over by simple terminology. Studying people's behavior often allows us to discern what people do and thus allows us more scope for new invention when we recognize the variety and richness of people's behavior in the real world. For example, studying how people read at work showed the many ways in which people read documents as well as the reasons they did so. This led us to think about different types of reading, which then served as useful leaping-off points for thinking about new design concepts. The result was a set of designs for new e-book devices that look radically different from any of the e-books currently on the market.

This shows that focusing on paper use or, more generally, focusing on the way people currently do things, does not necessarily mean that we need to be tied to the old ways of working. In fact, in our experience, taking

inspiration from the way people currently do things has typically allowed us (and the designers we work with) to find new inspiration and develop highly original concepts. This approach has the added advantage of helping to develop new technologies that allow people to leverage the skills they already possess and to draw on the everyday knowledge they already have. In the long run, this leads to interfaces and interaction techniques that are easier for people to understand and learn. It also leads to the provision of technologies that have clear value for people in the activities they already carry out. But more important, this approach can also result in technologies that support people in terms of the goals they need to achieve but that may do this in entirely different ways from how they were achieved with paper. To look at paper use as a design resource, therefore, clearly does not mean doing design through mimicking paper.

Using Paper as a Design Resource

Looking at paper use as a design resource does not necessarily mean that designers and development teams have to work with psychologists, sociologists, or anthropologists. It can be a matter of existing teams learning to take an interest in current practice and carrying out some simple observation of people in workplaces or doing work-related tasks. This has some immediate benefits. First, it forces design teams to ask, For whom are we designing? What environment are we designing for? What current tasks and activities are we hoping to replace or supplement? What goals will our technology help people to achieve? The whole process of design then becomes much more focused on what value designers expect that users will get from the new technology they are proposing.

To fully understand the issues, however, designers can greatly benefit from the insights and expertise that a multidisciplinary team can provide. We have seen that to understand office settings in all their complexity means looking at the cultural and social systems within which people act as well the technological and nontechnological tools that are used in those settings. Here, people with social science backgrounds can bring new perspectives to the design process in terms of understanding the goals that people have in the workplace and the social and cultural infrastructures already in place. By this we don't mean their personal goals as much as those

goals intrinsic to the work they are responsible for. These can be determined by the use of naturalistic methods, such as ethnography, as we reported in chapter 3. How people achieve goals can also be studied through more controlled techniques and experimental design, such as the reading studies described in chapter 4. This added knowledge can help make designers and developers more fully aware of the ways in which new technologies are instruments for the achievement of goals in a larger context (in a work situation or within a richer set of tasks) rather than being ends in themselves.

A further point to consider is that the help of multidisciplinary teams can also be very valuable for the purpose of improving the design of existing technologies. Here again, social scientists in field situations can help pinpoint how digital technologies are really used, including the possibility that new technologies are being avoided or that paper is being used as a workaround. From this, improvements to the design of tools (digital or paper) can be suggested. Similarly, laboratory studies may show how paper and online tools support the same task differently, suggest the benefits and drawbacks of different kinds of tools, and outline what design improvements may be made (as we did in chapter 4). Achieving even incremental improvements in much of the technology one finds in the office of today can make a substantial difference to the people who are required to use that technology.

So, what we are suggesting as a way forward for design is a focus on paper use and, more generally, a focus on current practice around paper, bringing to bear social science expertise and methods. This is not to discount the many other ways and means of doing design. But we do believe that design based on a sensitivity to what people do with paper will lead to better, more effective digital technologies in the workplace. We believe that this approach is more likely to lead to paper replacement technologies than a hit-or-miss approach. To be sure, people's needs and goals will evolve, and with the passing of time, the deployment of innovative technology will result in people's doing things differently than they do them now. But it is best not to lose sight of how to design in such a way as to allow a movement between present and future needs.

Where Paper Will Find Its Place

Finally, we turn to the third and final reason that people are reluctant to give up paper. Here it is not so much the case that digital alternatives are poorly designed but rather that paper itself works so well for some of the jobs it is called upon to do. Even as offices and organizations evolve, and even with the best possible design processes, we need to recognize that paper may remain the best tool for some kinds of activities well into the future.

From looking at many different kinds of workplace activities, we can begin to see where paper finds its natural place. We can begin to see where its affordances naturally lend themselves to certain classes of tasks and not to others. This, in turn, leads us to predict that paper will continue to find its place in support of some kinds of tasks but not others.

Why is this so? In chapter 2, we summarized the interactional limitations of paper. We noted that paper requires physical delivery, that it cannot easily be modified, and so on. But we also said that each of these limitations could also be viewed as an affordance. In other words, each property that appears to *detract* from paper's ability to support some kinds of tasks could in fact be seen as *shaping* and *providing support for* other kinds of tasks. An affordance is the obverse of a limitation.

Some key properties of paper are:

- A single sheet is light and physically flexible.
- It is porous, which means that it is markable (absorbs pigment) and that marks are fixed and spatially invariant with respect to the underlying medium.
- It is a tangible, physical object.
- Engagement with paper for the purpose of marking or reading is direct and local. In other words, the medium is immediately responsive to executed actions, and interaction depends on physical copresence.

All of these properties have implications for what actions paper does and does not make possible.

So, for example, the fact that paper is light and physically flexible means that it is ecologically flexible. In other words, it can be easily laid out in the environment, attached to walls and objects, stacked, and overlapped. One

could interpret this in the negative sense and point to the fact that paper creates clutter and takes up space. But these properties also mean that paper supports quick, flexible navigation and manipulation: riffling through, place holding with one hand while manipulating with the other, easily and dynamically moving pages in and out of the workspace, placing pages side by side on the desktop, and so on. One of the implications of this is that people who are working together around a desk, for example, can easily perceive what others are doing with documents. Their work activities are rendered visible to others through the physical manipulation of the documents they are working with.

The second property of paper, the fact that paper affords rich variegated marks that are persistent and static, also has a variety of different implications for perception and action in work situations. On the negative side, it means that marks on paper are difficult to modify, transform, or incorporate into other documents. On the positive side, however, we have seen that these properties have many other implications. For example, multiple co-authors on the same document can leave their own idiosyncratic and persistent marks. Thus, any changes made to a text leave a kind of audit trail of actions that contains information about the history of changes on a document, and who made which marks.

The third property of paper, its tangibility and the fact that it has a persistent physical presence, can also be viewed in two ways. On the one hand, as the amount of information within a document increases, so does its physical bulk and its weight. This means that storing paper becomes a problem and carrying and delivering documents requires physical effort. On the other hand, the persistence of paper documents means that leaving them on the desktop creates a physically embodied holding pattern that can reflect the ideas and activities in progress. If you get interrupted or go away, when you return to your office these bits of paper help remind you of where you were in a task. Physical delivery also has benefits in certain situations, for example, hand delivery of paper can be the excuse for social interaction and discussion over documents.

A final set of properties we have mentioned is the fact that paper requires direct physical contact for writing and manipulation of a document, and physical proximity for reading. There are obvious costs and benefits here when compared to digital media. The drawbacks of paper have to do with

the inability to remotely access or share documents, as one can do with digital networked document databases. On the other hand, clear benefits have to do with the immediacy and reliability of interaction with paper—a very short response time, no interoperability problems, and so on. More subtle perhaps is the way in which direct interaction with paper, and the ease with which it can be marked up during a conversation, affords effective interaction in the course of a delicate conversation (between doctor and patient, for example). Another implication is the way in which paper is often used as a private holding device for information until it is ready to be shared. The fact that information is on paper means that people can be more in control of who gets access to that document. Temporary documents, notes, work in progress are thus often paper-based until they are ready to be accessed by others in online form.

Digital Versus Paper-Based Tools in the Document Life Cycle

We can see, then, that the properties of paper are exploited in a variety of activities people do in the workplace. The affordances of paper show themselves in many different ways and in many different situations. Just as each limitation of paper can sometimes be seen as an affordance, each limitation of any digital technology can also be construed as an affordance. These, too, are coopted and used to best effect in a wide range of work activities.

This is not to say that people in workplaces ever think *consciously* about the relative merits of the different tools they have to hand for the tasks they have to do. Nonetheless, they do make choices, and they do combine their use of tools to best advantage. For example, people tend to turn to the computer when they need flexible tools for a writing task and turn to paper when they need flexible support for a reading task. Very often, they use both together when doing combined reading and writing tasks. People at some level recognize the affordances of the resources they have to hand and choose the best tools for the particular jobs they need to do. As a result, paper-based tools tend to find their place within some kinds of tasks and not within others. Similarly, certain kinds of digital tools find their own niche for certain kinds of tasks and not others.

This is an important point because it suggests that paper may be ideally suited to certain kinds of tasks and digital technologies to others. This is

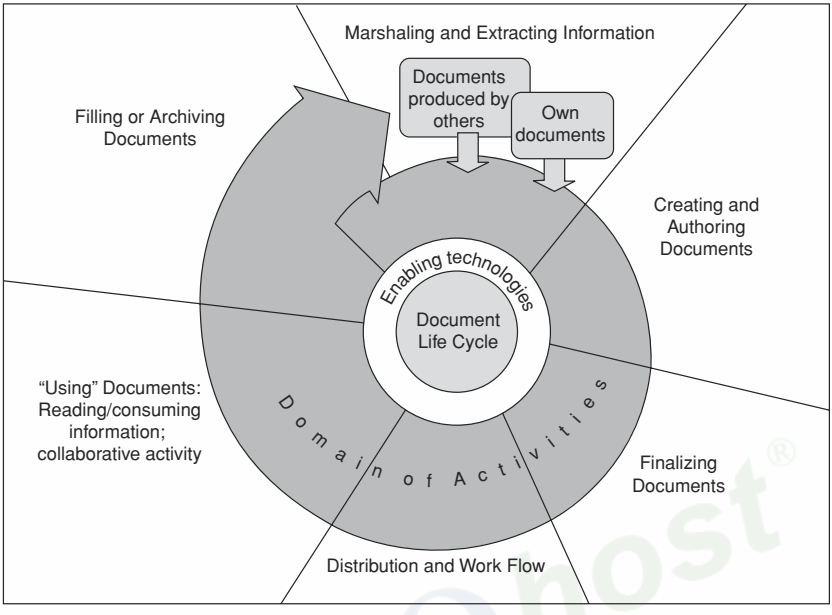

Figure 7.1
(The document life cycle).

not to discount the fact that changes in digital technologies will change their role and will affect how paper and new technologies are combined. But given that we have seen many commonalities about the kinds of tasks and activities that paper and digital tools support across a very diverse set of workplaces, and given that these can be linked to some of the underlying properties or affordances of one kind of technology versus another, these are fundamental findings. In particular, it suggests that there might be something fundamental about the kinds of activities that paper supports. If so, then we might expect paper to continue to play a crucial role in these same activities for a long time to come.

So, let's summarize some of the findings with respect to the tasks that digital versus paper technologies seem to support best across different workplaces, looking at it from different aspects of the document life cycle. Figure 7.1 shows some of the major activities that people carry out with documents and information: marshaling and extracting information,

creating documents, finalizing and distributing them, and using and archiving them.

While this vastly oversimplifies what people really do with documents, it helps us summarize what we know about how people tend to use paper versus digital tools in each of these phases of document use.

Marshaling and Extracting Information Digital tools provide powerful tools for quickly searching through vast information repositories and bringing candidate information to the desktop. Other useful affordances include the ability to quickly link to related materials and the ability to view and sort data in various structured ways. As such, digital tools are good at bringing large amounts of information to the attention of the user from what may be unfamiliar repositories of information to allow it to be filtered and extracted.

Paper documents best support browsing through familiar materials. For example, flicking through paper files helps remind owners of their contents. Familiar documents also support thinking and planning activities when users physically lay them out and arrange them in space. This usually involves flexible, unsystematic document organization and reorganization as well as note taking.

Creating and Authoring Documents Digital tools support the drafting and editing of documents, including the updating, modification, recalculation, and reformatting of text and data. They also support the integration and analysis of data from diverse sources, and the reuse and repurposing of well-defined pieces of documents for new documents.

Paper supports some of the processes prior to writing, such as note taking and making plans for writing. It also supports the cross-referencing of documents during online authoring as an important supporting set of activities. For example, this may mean checking for the consistency of a story across documents or creating a coherent mental picture of what to write by reading across multiple documents.

Finalizing Documents Digital tools provide the means of formatting, finalizing, and producing professional-looking documents once their con-

tents are determined. Tools such as spelling and grammar checkers also help to automatically check and polish documents.

Printing on paper supports proofreading and getting the sense of the flow of the text. Paper is also the main medium for the reviewing and mark-up of documents by people other than the authors. Here, reviewers may look at documents at various levels, including reviewing contents, syntax and grammar.

Distribution and Work flow Digital tools support automated work flow for well-structured, routine processes and transactions. This is turn helps in the standardization of processes. Digital tools also support the fast replication and distribution of information to different people and sites.

Paper also provides a method of achieving effective work flow, but usually it is best when routine processes break down and people need to find a workaround solution. Paper supports delivery of information when social processes are important. For example, hand delivery supports discussion at the point of document delivery.

Reading/Consuming Information Online tools support the reading of small, well-defined, self-contained pieces of text. They also support viewing and use of multimedia and interactive materials, such as videos, music, and interactive software.

Paper supports reading of longer documents for deep understanding, reading while writing or note taking, reading across multiple documents, and flexible browsing and navigation through documents.

Collaborative Activity Digital tools (such as groupware and audio-video links) support real-time collaboration for remote conversations and meetings as well as various kinds of asynchronous collaboration (chat rooms, e-mail, document exchange, and so on). They also support the sharing of the same information by more than one person.

Paper tools provide an effective medium for various forms of face-to-face interaction. For example, they provide a flexible mechanism for team coordination in physically shared environments. Paper-based note taking provides support for delicate face-to-face interaction, and paper documents help coordinate and focus discussion in face-to-face meetings.

Filing and Archiving Digital tools support widespread, remote access to large, shared information repositories. They also support the sharing of the same information by more than one person. These repositories are best for polished, published information (documents that stand alone or are self-explanatory). Digital tools are best for high capacity storage of cold files or information that is not currently in use.

Paper provides a good temporary holding mechanism for knowledge until it is ready to be shared. Paper allows owners to control access to knowledge and to be present when there is a need to explain the relevance or importance of that knowledge. Paper provides good temporary storage for documents with short-term value, for files that have had recent value (warm files), or for files that are currently in use (hot files).

What we can see from all this is that paper tends to find its natural place in workplace activities that are point-of-use activities or that are the kinds of activities we normally think of as key to knowledge work.[7] These are the activities that involve making judgments, solving problems, making sense of information, making plans, or forming mental pictures of information. In other words, these are the activities we have come to think of as getting to grips with information. Paper also finds its place naturally in social processes (especially face-to-face situations), such as those processes that involve discussion, collaborative writing or viewing, and coordinated teamwork. The particular affordances of paper naturally lend themselves to human interaction, either by providing external support for complex internal mental processes or as a tool in support of managing complexities in a collaborative environment.

Digital tools *by contrast* tend to find their natural place for many of the activities *supporting* these point-of-use or knowledge work activities.[8] For example, digital tools offer good support for the accessing and organizing of information prior to its use or prior to the thinking or collaborative processes that need to take place. Digital tools are very well suited to the polishing, finalization, and storage of information after its use. They are also good for managing work flow, distribution, and transactional processes when these are well structured and when these processes go according to plan.

The Role of Paper in the Future

The design of digital tools may eventually be capable of supporting these knowledge work activities much better than they currently do (and especially, as we have argued earlier, if designers look to paper use for guidance). Until such time, paper will maintain its importance in the kinds of roles we have outlined. In other words, it will continue to predominate in activities that involve knowledge work, including browsing through information; reading to make sense of information; organizing, structuring, and reminding of ideas; information integration in support of authoring; and activities that involve showing and demonstrating ideas and actions to others (mark-up of documents, hand delivery, collaborative authoring, and discussion in face-to-face meetings).

Digital technologies, on the other hand, will increasingly take over more of the activities for which electronic media are better suited—those activities in a supporting role for knowledge work: large-scale search and retrieval of information and documents; short messaging for internal/external communications; analysis of data; document production and finalization; processing of business and transactional data; large-scale dissemination and transmission of documents; and long-term, high-capacity storage of cold data and documents. Digital media technologies will also predominate in production and distribution of new kinds of media, such as non linear, searchable documents (dictionaries, reference manuals, encyclopedias), and multimedia genres (videos, music, and interactive multimedia content). We would expect to see, then, that paper is gradually replaced in all these kinds of roles, that it becomes less and less the medium of importance for such things as routine business transactions, intra- and interorganizational communications, large-scale distribution and delivery of documents, and the bulk of storage and archiving of documents in offices.

Note that there are economic, technological, and demographic trends that will reinforce the continuing emergence of paper and digital technologies in these different kinds of roles. For example, in terms of reinforcing paper in its support of knowledge work, consider the following:

• *More and more knowledge workers.* Estimates are that over 30 percent of the U.S. workforce now consists of knowledge workers and that

this proportion will continue to grow. More knowledge work means more paper consumed.

• *Mobile working and working from home.* As people do more work from home and while mobile, the same document is often printed more than once so it can be dealt with in more than one place. Paper now populates not only the workplace but also the home office and the mobile worker's briefcase.

• *Increase in home computer and printer penetration.* More and more households now own computers and printers as these come down in price. More people also have access to high-quality software to produce their own documents. These trends are now allowing people to easily print at home for many of the same reasons they print in the workplace.

• *Increasing interconnectivity and increases in Web content.* The power of the Internet and the amount of information available through the Web is transforming the economy. At the same time, it is also allowing an ever-increasing percentage of the population to access vast quantities information from their electronic desktops. More information means increased demand for the means of sorting it out and making sense of it. This is often done through printing on paper.

At the same time, many of these economic, technological, and demographic trends are facilitating the use of electronic tools in the supporting roles for knowledge work we have pointed to:

• *Mobile working and working from home.* As the number of mobile and homeworkers increases, so too will the need for the infrastructures to support them, such as the need for more reliable networking facilities, better document archiving systems, and better distribution and work flow tools.

• *Increasing interconnectivity and networked computing.* Advances in networking capabilities, bandwidth, and wireless networking will spur on these changes in infrastructure. At the same time, we will see more demand for tools that can fully make use of these networks.

• *Electronic commerce.* Data transactions have been handled electronically since the 1960s, but technological trends such as networking, home computer penetration, and the Internet revolution mean a phenomenal

surge in business-to-business and business-to-consumer transactional processes.

• *Emerging document exchange standards and interoperable computing.* These changes will help overcome compatibility problems in platforms and applications, facilitating the ease with which workers can access, search, repurpose, and archive information.

• *Better scanning and digital archiving tools.* Cheaper, better scanning technologies mean that we will in the future be better equipped to deal with the legacy of paper documents we already possess. This means they can be more easily archived in digital form.

All these changes mean not the disappearance of paper in the workplace, but some fundamental changes in its role. We can also see that as digital technologies begin to increasingly inhabit our homes, so too will printing in the home be on the increase.

The Office of the Future

What does this all mean for the future, then? On the one hand, it means that paper manufacturers can take heart: paper consumption will not wane any time soon. On the other hand, it doesn't mean we are looking at a future in which our offices are stuffed with more paper than ever before. In fact, we argue that we are not headed toward offices that *use* less paper but rather toward offices that *keep* less paper. This is because we will continue to need paper for some of the critical work activities we do, but in these roles it will be very much a temporary medium.

So the office worker of the future may well access her information from an electronic database, and she may do this wirelessly from home or from the road. But at the point she needs to deal with it, at the point she needs to read it, reflect on it, and use it in the core of her work, she may well print it. Having done that, she might then turn to digital tools and refer to her paper to create something new in the digital world, or to perform some necessary transactions. Or she might be just as likely to scan what she has been working on to send it electronically elsewhere. Similarly, when a project is finished, she will most likely perform any archiving activities in the digital realm. The paper produced and used in the process may be kept for the

duration of the project, but when the project is over and done with, so too will be the paper.

All of this means big changes to offices as we now know them. Look around most offices, and the place where paper affects the office environment most is in the space needed for the filing and archiving of paperwork for past projects, or for the paper forms and stationary needed to carry out routine business processes. Added to this, consider the warehouses full of paper archives that many organizations need to maintain. When offices begin to keep less paper, their landscapes, costs, and work processes will also be significantly altered.

What this also means is that the place of technology in the office of the future will evolve and develop in certain ways. There will not be fewer printers, for example, but more of them. In the future they will sit on everyone's desktop. They will be the personal device for transforming information into the only form usable to carry out some key activities. In many ways, this is trend that is already observable, though the reasons for it have not been properly understood. There will be some changes, also, in the design of printers, particularly in the methods used to deliver print jobs given the ongoing emergence of air-based networks and protocols, for example. But essentially printers will remain a fairly stable technology subject to incremental improvements.

The scanner will be a second key tool, becoming a vital part of the personal technology of the office, being the route into the digital archives for preserving and making accessible those bits of paper that have been read and marked up in the process of knowledge work. Scanners, like printers, are becoming increasingly ubiquitous, although unlike printers their design is likely to change substantially. Innovations will allow richer ways of capturing documents, for instance, and this will include over-the-desk scanning. Here the user will be able to select specific elements of paper-based materials to scan, as well as using scanning as a way of interacting with digital documents in real time. Such applications are already in the marketplace, though they have yet to reach a mass market.

Both scanning and printing technologies are, of course, familiar technologies, while some of the other technologies we have described, such as multiscreen reading devices, have yet to reach beyond the prototype stage. Once technologies become familiar, they become subject to the symbolic

world of offices. It was with this topic that we commenced our empirical discussions. We saw in chapter 2, for example, that many organizations think of scanners as a technology that can help do away with paper and printers, especially desktop printers, as technologies that are encouraging people to print too much. According to this view, printers and scanners are battling over paperlessness. But we saw that such symbolic meanings are profoundly wrong. Printers, scanners, and paper are not competitors; they are part of the required tool set of any office, supporting each other in performing distinct roles within the document life cycle.

And yet symbols—whether they are right or wrong—are important. It is symbols that motivate people; it is symbols that are used to measure change, success, and failure. The lab we discussed in chapter 2 hid paper documents from the eyes of visitors so as to be seen to be reaching into the future; it was having paper documents at hand that enabled police officers to appear competent when meeting with the public. Thus, symbols are complex and often full of paradox. Even the most mundane artifacts get laden with meaning.

Consider the lowly wastebasket. In the past, a wastebasket stuffed to the brim with paper could symbolize inefficiency and an organization looking to the past rather than the future. One of the by-products of paperlessness would have been the disappearance of wastebaskets and hence the loss of that symbolic meaning. But now it should be clear that wastebaskets will have an even more important role in the future. According to the vision we have outlined, a full bin will reflect the fact people are working effectively because they are using paper at various stages in the document life cycle, particularly in the knowledge-intensive stages. As they move on to other stages later in the life cycle, the role of paper diminishes. At this point they will no longer need it, and it will become the detritus of their work.

This has some delightful paradoxes for the symbolic meaning of full wastebaskets. It means that if wastebaskets never get filled up with paper, then the kinds of temporary uses that we have identified as essential to various kinds of knowledge-based activities are not being done. Or, if such activities are being undertaken, then the staff in question is not using the best medium for the job at hand. In this situation, office managers need to worry about how to get their staff to use more paper. Hence the symbolic meaning of the wastebasket could be reversed. If in the past a full bin was

an indication of waste and inefficiency, in the future it will be the empty one that makes people worry.

Of course, full bins and empty bins are at opposite ends of a continuum, and it will almost certainly be the case that the norm will be somewhere in between. But what is important to recognize is that the role of paper as a temporary medium will be a vital part of offices. The symbolic meaning of wastebaskets is merely a playful example illustrative of the reasons that this will be so. Needless to say, our intentions in this book have been altogether more serious. We have wanted to explain, through empirical evidence and research, why this vision of the future should not dismay technologists and organizational managers or the people who actually work in offices. The paperless office is a myth not because people fail to achieve their goals, but because they know too well that their goals cannot be achieved without paper. This held true over thirty years ago when the idea of the paperless office first gained some prominence, and it holds true today at the start of the twenty-first century. We hope to have shown that it will hold true for many years to come.