

Communication and Collaboration Support in An Age of Information Scarcity

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Abstract. A steady expansion in the use of the Web, the Internet, cell phones, and other technologies has driven considerable change over the past ten years. This chapter looks at some trends and emerging technologies and behaviors that suggest that the next ten years will not be more of the same. We appear to be entering an era of more rapid and more radical change.

“A machine with vast logic power, capable of storing enormous quantities of information... A much greater growth rate than an exponential increase... The dam is bursting... Mankind today faces an information deluge of unimaginable complexity... We must protect computer users from the vast and overwhelming mass of data...” – James Martin, 1973

Introduction

James Martin raised an alarm in the first widely-read book on human-computer interaction: A tidal wave of information—in 1973! Martin continued: “The computer files of current IBM customer orders contain more than 100 billion bits of information!” [1]

Today, my laptop contains 100 billion bits. 1973 now seems to belong to the era of information scarcity. Today, people complain of “information overload,” yet when viewed from 2035, our era, too, will seem to have been a time of relatively sparse information.

In other words, great change lies ahead. Over the past three decades, technology advances mostly affected engineers and entrepreneurs, numbering in the thousands. Today, technologies such as digital photography, DVDs and other storage media, and file-sharing are affecting major industries and millions of people. Thirty years ago, by investing a reasonable sum, Xerox PARC gave its researchers a 10-year technological lead on other laboratories. Fifteen years ago PARC shifted to high-end commercial systems and like other well-funded labs were about 5 years ahead of the pack. Today, an alert consumer can buy the latest technology and assemble a more powerful system environment than the average researcher.

Change is reflected in hardware, software, and behavior. As examples, consider the effects of USB memory sticks, free blog software that enables a person to do in minutes what previously required days and much effort and expense, and digital cameras employed as input devices.

We are at a discontinuity, an inflection point. From one perspective the past twenty years have seen dramatic change. The Internet expanded its reach, the World Wide Web appeared. But from another perspective, these decades have been a consolidation and maturation of trends apparent throughout the 1980s, following the introduction of personal computing, graphical user interfaces, email. The consolidation may be over, enabling new developments to emerge. The next section explores this second perspective, identifying forces that restrained change over the past two decades. The following section discusses changes underway now that those forces have been overcome.

1. Two decades of personal computing and the Internet

Moore's Law, broadly defined, has held with impressive consistency. Twenty-five years after commercial transistor-based computing appeared in 1958, its dramatic changes in technology appearance and use led to the spread of personal computing. Moore's Law held for the two decades that followed, supporting changes in personal computing, but its impact on communication and collaboration support was restrained by several factors. Two were primarily technical, two had behavioral as well as technical origins.

1.1 Architectures designed for individual productivity

The PC and Macintosh emerged in the early 1980s as individual productivity tools. They were not architected to support networking. Software developers focused on applications, and on features and interfaces for individual users: human-computer interaction. As attention turned to collaboration support, architectural obstacles had to be overcome. Some remain: a PC does not support multiple distinct keyboard input threads, for example.

1.2 Improving Internet reliability and reach

When the Web arrived a decade later, it was primarily used for personal information retrieval: a powerful online encyclopedia, yellow pages, newspaper, library, and so on. In the early years, sites could be inaccessible for days, and downloading was often very slow and all too often terminated before completion. It took years for access to become reliable and widespread enough to trust the Web to be as useful for communication and collaboration as email.

1.3 Conflict with the human perceptual-motor system

From 1965 to 1985 we went from the first IC-based mainframe through minicomputers to wide use of PCs, a series of miniaturization and cost cutting successes. From 1985 to 2005 Moore's Law continued, but not a single generation of smaller computer has had the success of those three. Handheld devices emerged on schedule in the mid-90s but have still not had the same impact. We spent 20 years consolidating because for the first time, fundamentally new user behaviors and visual organization of information were needed.

In the 1970s, as minicomputers shrank to the size of filing cabinets, the sheets of paper, displays, and keyboards that people used for reading, writing, and data entry were the same size as for mainframes that filled a room. In the 1980s, PCs fit under the desk, but the paper, display, and keyboard on the desk were largely unchanged. However, form factors smaller than laptops require different approaches to input and output. Design took time, behavioral adjustment even more time. The new designs and behaviors are only now starting to appear.

1.4 Conflict with the human social-emotive system

By the early 1990s, PCs had been networked and large numbers of workstations were being sold. 'Groupware' surfaced as a popular buzzword. In August 1992, the welcome to the first in a series of Groupware conferences noted that when planning started in May, 1991, there were 150 commercial vendors in the space, and fifteen months later there were almost 400. For example, in 1990, IBM, Ventana, and Vision Quest began marketing meeting room support systems; by 1992, workflow management systems were appearing. But these products

did not do well. Ten years later, the Groupware conferences were long gone, only Ventana was still trying to market meeting room systems, successful workflow implementations were scarce despite scores of vendor efforts. Most other groupware of the 1990s fared no better.

The greatest challenges in successful innovation are often behavioral, not technical [2]. Our difficulty in anticipating problems, or even in identifying them when we encounter them, may originate in Toda's observation that human beings and their predecessors have interacted in groups for millions of years, and have an emotional and social composition selected to address real-time concerns face to face [3]. Many social behaviors are so much a part of our nature that they operate below the level of conscious or voluntary control. This would be less of a problem were it not for the fact that digitally mediated interaction is not real-time and is not face to face. It easily conflicts with our natural tendencies. Collaboration support tools often fail to take our nature into account.

One recurring example is a tendency to focus on the effects of tools on performance. This can overlook equally critical aspects of group interactions that address team health and individual member support. A recent study links this oversight to the poor reception given meeting room support systems [4].

2. Overcoming the obstacles

These four problems restrained progress in utilizing digital technology for individual productivity. They limited digitally mediated collaboration even more.

The technical problems—architectures and networking—are largely resolved. Operating systems support networking. The Internet matured into a reliable network. Through the 1990s people moved to platforms designed to exploit these capabilities.

The perceptual-motor issues were more difficult to address. Habits governing keyboard and display use are strong. Many people hoped that speech recognition and synthesis, language understanding, vision systems, and other forms of artificial intelligence would free us from relying on these input and output devices. They have not, nor are they likely to anytime soon.

Slow progress was made on improving keyboards and displays. One-handed keyboards, chord keyboards, and pen or stylus input did not become popular: People trained on keyboards rarely made the effort to learn them. Nevertheless, research improved these alternatives. The fact that growth in display size and resolution did not pace Moore's Law created tremendous pressure on interface design: We are forced to view and access ever more application features, documents, information and networked people through a small rectangle. It is not an exaggeration to say that for twenty-five years, human-computer interaction research has focused on organizing ever-greater quantities of information to be more easily accessible visually. This involved work on graphical interfaces, windows, icons, menus, tool bars, task bars, tool tips, toast, heads-up displays, immersive environments, ambient computing, ubiquitous appliances, awareness and notification mechanisms, larger monitors, multiple monitors, and so on. The considerable progress in design is easily overlooked, primarily because information demands outpaced the solutions. Visual presentation of information is also under pressure from the desire to exploit smaller form factors that have smaller displays.

How will habits that bind people to keyboards and larger displays be broken? Perhaps the way that paper and pen habits were overcome decades ago: By a new generation for whom the habits are not as strong. Children who grow up with text messaging and game consoles will enter the workforce ready to use smaller form factors, the first major generational shift in technology use in years. Ito noted the significance of PC peripherals based on cell phone handset designs that enable young Japanese to use phone input skills when working at a computer (Figure 1) [5].



Figure 1. The Mevael desktop computer keyboard for people used to text messaging.

In addition, architectures that are designed to present information efficiently around the edges of displays pave the way for routing information to smaller devices. Only after people grow accustomed to accessing awareness, notifications, and other communication and collaboration features on desktop systems will they expect to have them when mobile.

The final challenge is the most difficult: Designing technologies that accommodate inherently human forms of expression and interaction. This will be slow, due to our poor understanding of this aspect of human nature, and a never-ending challenge, because the world we function in is in fact different from the world we are designed to live in. Technology has for millennia distanced us from action in “the here and now.” Toda argued that the difficulties in forming effective large-scale organizations and societies stems from this. Digital technologies are accelerating the process: Once something is on a network we can never be sure where or when it will show up. Yet we will move forward. Progress in understanding requirements for social interaction on the web may be more by trial and error exploration than we would prefer, but today’s phenomenal level of experimentation in social computing all but guarantees that progress will come quickly. Here, too, the younger generation leads the way, experimenting with IM, blogs, networks of friends, and other technologies, because social interaction is of intense interest and importance to them. Older generations by and large have found their social networks and channels of interaction.

3. The next decade: colonization of the web

Even if hardware innovation ceased, rapid progress would result from overcoming software and behavioral challenges. Despite some signs of stress, hardware innovation continues, operating at a scale that affects major industries.

Technology advocates have long expressed overly optimistic predictions of change. Language understanding and other panaceas did not materialize on schedule. But changes are coming, perhaps from an unexpected direction. People are colonizing the web.

A decade ago “virtual worlds” attracted attention and pulled some people online, but never grew beyond a niche activity. There was little to do in a virtual world other than text chat with strangers. The Internet population was scattered, so online relationships rarely led to physical world meetings (exceptions made news, as when online acquaintances met and married). Virtual world activity was also walled off from other *digital* activity: Documents and other online objects could not be shared in a virtual world.

A successful variation emerged, massively multiplayer online role-playing games (MMORPGs) such as Final Fantasy XI, Ultima Online, Everquest, and Asheron's Call that grew from MUD games. They provide a rich set of activities, digital materials, and chat-based communication. In some, players engage in almost literal colonization. Game objects and activities remain walled off from other digital objects and activities, and largely separated from physical world activity. But the online world—real world separation began to shift. Players sell objects and personas on eBay, and schedule regional physical world meetings.

Napster took another step in merging physical and online worlds. The density of people swapping music was so great that real-world discussions about online activity were widespread. Napster also showed that digital technology was powerful enough to support multimedia on a wide scale, and powerful enough to threaten major industries.

3.1 Quantitative change leading to qualitative change

Population growth takes two forms: geographic expansion and increased density. For example, as the United States was colonized, for almost four centuries it expanded as a frontier was pushed back. When the frontier disappeared around 1890, population growth became solely a matter of increasing population density.

Similarly, early Internet growth involved a high degree of expansion, as use spread to more regions of the world. This may continue, but in many places Internet use is now established. We primarily see increasing density of use in specific geographic regions.

Visualize a network covering a geographic region that over time becomes increasingly reticulated, with more and more endpoints representing users. At each of these endpoints, the density of information—digital documents, photographs of ever-increasing resolution, and so—is also increasing.

Detail, density, thickness, richness—what are the right words for this profusion and growth? Ethnographers speak of “thick description,” the accumulation of detail from which insight arises, a qualitative change produced by a sufficient quantity of interwoven observations. It is easy to describe quantitative changes—the number of people in a city who use the Internet, the number of photos on an average computer, the amount of time and money spent online communicating, collaborating, or purchasing. It is more difficult to grasp the consequences when these numbers become sufficiently high.

3.2 Qualitative change (1): Virtual merges with physical

When more people in a geographic region are online, it becomes more practical for them to organize real-world activities. Geographically based computer clubs and online bulletin boards hosted by a server owned by someone in a community have long existed, each serving a limited number of people in one area. In 1989, the Santa Monica Pen project was begun as a community-wide online effort. Subsequent efforts include the Blacksburg Electronic Village and Canadian Netville projects. These were top-down technology experiments based on donated hardware and support. As computer use spread, email lists for housing associations and high school graduating classes emerged. These communication channels for pre-existing groups typically require complementary paper coverage to reach people not online.

As density increases, the region needed to support a physical meeting shrinks. In the case of EverQuest, a single annual event in Las Vegas became separate events on the U.S. east and west coasts, then spawned regional meetings.

Meetups.com enables online organization of “IRL” (in real life) meetings on diverse topics. Meetings are organized in Tokyo for expatriate Americans, Germans, Australians, and others. Scores of cities around the world will hold Beagle Lovers meetings on the same day, three weeks from when I am writing. Tokyo Beagle Lovers can vote on whether to meet in the Animal Plaza at Gohongi or at the Yoyogi Koen at Yoyogi Kamizoncho. Meetings are face to face but may share pictures online. Popular topics include Anime, which has about 5000 meetups members in over 300 cities from Tokyo to Texarkana, and Kerry for President, with more than 100,000 members across 500 cities including Tokyo.

As with online games, online social activity is a byproduct of functional goals. For gamers, the functional activity, playing games, was also online; real-life meetings were an afterthought. With meetups, the functional activity is IRL. In both cases, when enough people participate in a live meeting, it can be split into two or more gatherings, reducing the required travel. More people then attend, enabling further division. There is a natural potential for growth. This can be amplified by complementing the bottom-up aspect of meetup organization with top-down structure or communication across meetings, establishing a larger group identity.

3.3 Qualitative change (2): Engagement

As the quantity of digital information available to a person increases, their experience changes. Quantitative increases take many forms. I can access a huge amount of information on the web, and more colleagues, friends, and family members. I have an ever greater number of documents in digital form. The number of photographs I keep online grows, and tools for handling them get simpler. Picture resolution increases. I store more audio and even video.

Creating content has become inexpensive and far simpler. I recently used freely available software to create a hosted blog. It was fewer than 5 minutes from my first action to a nice-looking, easily accessed web page visible to the world. I can add entries more easily than sending email. The software automatically notifies search engines of a new entry.

The greater detail, finer texture, increased richness, and easier handling of more channels, objects and people online has given rise to a growing focus on design, with aesthetic and emotional as well as functional components.

Increased detail and resolution can be described objectively from an information-theoretic perspective. A chart shows a smooth curve. But from a human perspective, there can be points at which increased detail or richness suddenly changes everything. Section 4 identifies four non-digital examples of qualitative change based on an accumulation of detail. In each case, detail triggers a greater degree of *engagement*, which has cognitive and emotional components. Section 5 sketches examples of markedly enhanced engagement triggered by digital information.

4. Engagement through immersion

4.1 *When an author's fictional character 'comes alive'*

"This thing happens where the characters take over and you almost want to look behind you to see who's writing your story." – Joseph Wambaugh, author of best-selling novels

Many fiction writers describe a shift from when they are inventing their characters to when the fictional characters seem to take over. The characters become real to an author. Authors bring this about in different ways: some invest effort in obtaining detail about places, historical times, or characters similar to those portrayed. Others develop a detailed back-story about each character. In such cases, an immersion in detail can lead to this psychological shift to total engagement with the characters. And of course, authors try to provide enough detail to engage readers.

4.2 *When an actor prepares for a part*

"The actor's awareness of what is needed for the creation of Inner Character can be greatly stimulated by asking himself honestly, as the character, a series of questions pertinent to the life of the character... For example, Who am I? What are my particular likes and dislikes? Do I have a hobby? Am I religious? Which religion do I believe in? What is my background? What did my father do for a living? What was my day like? On what street do I live? (Be able to describe the street.) What does my apartment look like? How many rooms do I have? (Give a full description of the type of living quarters that you as the character might inhabit. Give particular detail to the furnishings.) What did I do today? Who did I talk to? What is my basic relationship to the other characters in the play? What is my political outlook or my views on the world situation at the time of this play?... The actor can ask himself what kind of music a character such as this would enjoy. He can then listen at length to pieces of this music, deciding which passages the character would like best and, more important, why..." – Edward Dwight Easty, *On Method Acting*

Many actors preparing to play a role also research their role in detail. Some embrace method acting, which employs exercises such as those described above. As with writers, the goal is to use an accumulation of detail to trigger a psychological change, a shift in the engagement with the character that enables natural reactions without fully conscious thought.

4.3 *Creativity*

Different approaches to and theories about creativity abound. One axiom is that it is "99% perspiration and 1% inspiration." In a 1977 interview on creativity, James Watson argued that creativity was above all else an immersion in facts, an accumulation of detailed knowledge that can be brought into new patterns.

4.4 *The 'thick description' of ethnographic accounts*

Ethnographers have two tasks: obtaining an understanding, and communicating what they've understood. Both of these involve a psychological change that results from immersion in detail. Typically a relatively long time is spent observing daily life to obtain the understanding. IN communicating to others, 'thick description' is considered a praiseworthy approach. An ethnographer can't recount everything. Selectivity of example is necessary. But an effective approach is to use extensive detail, examples and illustrations drawn from experience, rich enough for the reader to immerse in and engage as the ethnographer has. This is considered more effective than relying solely on a direct summarization.



Figure 2. General posters: comparing persona characteristics and presenting real quotations from users fitting one profile



Figure 3. Targeted posters with specific new information



5. Engagement through immersion in the digital world

Computer games increase engagement by providing more detail than is required for the task faced by the player. Memory and processing power have now become so inexpensive that in a wide range of situations we can routinely assemble a degree of detail that will carry computer users across a threshold to higher levels of engagement. When that happens, they psychologically begin to live online. We are starting to colonize the web in a real sense. It can be a new experience for non-gamers, with lasting effects. It creates expansive opportunities for design.

Below, three examples are described, identifying the nature of the detail involved and the power it delivers. They have strong devotees but are not now widely adopted among computer designers and users, and they are not unique—you may think of others. In each case, effectiveness is based on enhanced engagement.

5.1 Personas

Personas is a technique gaining currency in designing, developing, and testing software [6]. Personas are fictional people with names, faces, clothes, jobs, families, friends, pets, and possessions. They have age, gender, ethnicity, educational achievement, and socioeconomic status. They have life stories. Scenarios can be constructed around personas, but persona design comes first.

Persona use supplements other techniques for user research and testing. A set of personas comprises the target audience for a product. They are a mechanism for delivering knowledge about users, gathered from all possible sources, to development team members. Once team members engage with a persona the way people engage with characters in movies or books, personas become a powerful conduit for delivering data from ethnographic studies, quantitative analyses, usability tests, or other sources. As a hypothetical example, team members who have learned a lot about ‘Melissa the middle manager’ can be told “studies show that Melissas are adopting IM.” They can put this in perspective and figure out how it could affect her behavior. Testers who spend a day “testing the product like a Melissa” will know to include IM distractions as part of the context. And so on.

An ongoing campaign to keep information about personas in front of the team is a key to success. Documents on web sites, email (perhaps including occasional email 'from' a persona), posters around the workplace (see Figures 2 and 3), and other means are used.

Why have Personas arrived as a technique now? One reason is that digital technology enables us to collect data from multiple sources, deliver it to team members in diverse ways, and present it in engaging formats. The heavy use of digital technologies provides the means to produce the necessary level of engagement in a timely fashion. Early efforts with more impoverished materials did not succeed. Considerable effort is required now; it would be prohibitive without these tools.

5.2 Digital Photos

Digital photos have spread remarkably quickly, with digital cameras replacing film and cell phone camera attachments. The day before a recent meeting, the organizer sent a request for photos; almost everyone sent one. Shortly before a workshop I was able to find online photos of all but one participant on the web. Seeing how people dressed and presented themselves contributed to my feeling for how the workshop would progress as much as reading their position papers did.

A tool for rapid creation of employee intranet home pages was prototyped (Figure 4). During its design, it was decided that the tool should not encourage the inclusion of photos that could reveal age, race, and other characteristics that could inappropriately influence others or attract unwanted attention. But once the tool was deployed, people wanted pictures. A page with a picture feels more direct and engaging, as though the person is speaking to readers. The same text without a picture can feel ghost-written, or pulled together by software (as it actually was!). Attitudes may vary across individuals and cultures, but photos were popular in this case.

5.3 Weblogs

Blogging is a communication medium that incorporates several features that make it ideal for fostering discussion and social networking. These include comments, trackbacks, blogrolls, syndicators, aggregators, and referrer logs.

Uses of blogs are emerging in several contexts. Best known are personal on-line diaries, written for a circle of friends, and widely-read journals by real or aspiring pundits on technical, political and other topics. Blogs are also finding uses in enterprises. A blog can be a channel for communicating to customers and other outside parties. It has more immediacy and genuineness than public relations press releases, it gives a human voice to an enterprise. Since being seen as open and balanced is key to credibility, this can be risky, but the benefits of attaching a human face and voice to a company are powerful.

Blogs present a person with whom others can engage, in the way that a newspaper columnist, television commentator, or movie reviewer becomes a known, reliable source to whom we return, whose viewpoint we come to understand and use to interpret the information they deliver.

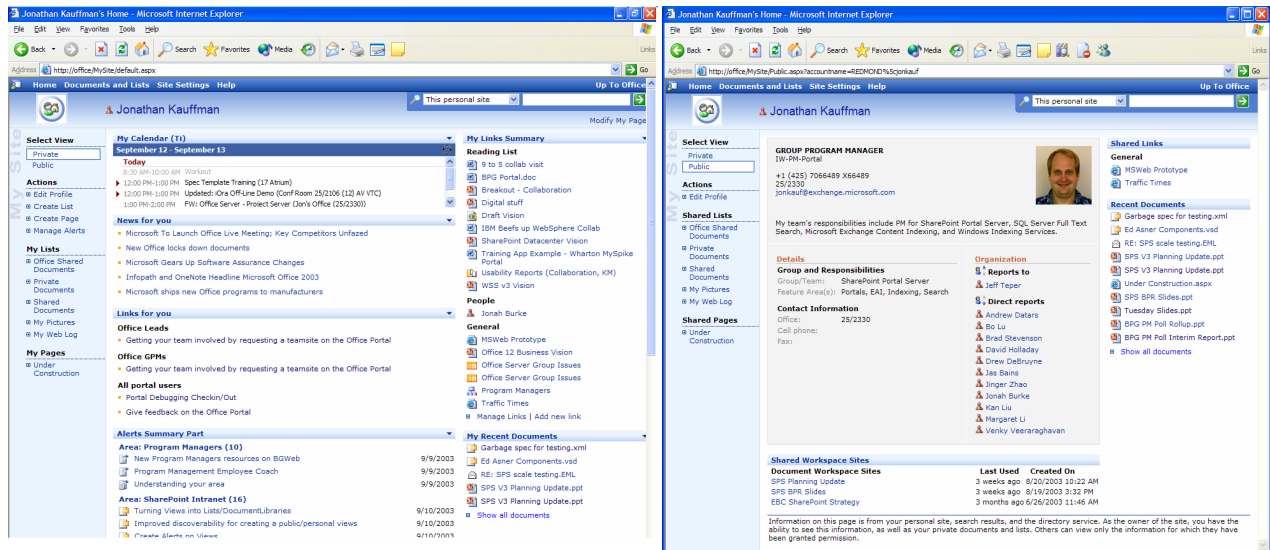


Figure 4. Individual page with and without photo.

Another use of blogs is a co-authored or project blog. Although the authorship is shared, the intent can still be to deliver a chronological record that presents a single view to outside parties. Rather than a discussion among the authors, it is a collective presentation of their activities. A political campaign might enlist multiple authors in putting forward a candidate's positions; a development project can communicate their current state to other groups in a company.

Figure 5 is a facsimile of a blog used by two Microsoft ethnographers in the Windows group to report on a two-week overseas study of technology use. Every day they posted a new text entry and composed a multimedia snapshot (on the left): clicking launches an audio account of the day's events, accompanied by still photos illustrating them. Visitors can also scan previous entries.

The conceptual simplicity of blogs does not diminish their ability to engage viewers. The inexpensive, lightweight, easy-to use tools are helpful, but a blog needs an audience. Tools help attract readers, but why do people return? Richness is a factor, detail about the thoughts or life of an author; outgoing and incoming links that turn exploring a blog into navigating through a network of interlinked people and places; multimedia—snapshots of homes, friends, randomly encountered places and objects.

The strict chronological sequencing limits blogs in one respect but enhances the ability to engage. Human beings are good at reasoning about information when they know how old it is and can quickly see what came before and after. It allows us to rapidly understand how the focus of a person or project has shifted over time, where activity bursts occurred, and what they were about



Figure 5. Project blog by two ethnographers to report from field to their team (adapted).

6. Concluding Remarks

This essay began with the observation that future generations will look back at the early 21st century as a time of information scarcity. It ended with the observation that the increased quantity and richness of information that is available now is leading to a dramatic transformation in our stance toward the web and digital technologies through higher levels of deep engagement on many fronts, a few of which were illustrated. This is not a contradiction, it suggests even more dramatic change ahead. We are on the threshold of a broad expansion of sensor technologies, mobility, notification capabilities, and other advances that will produce a future of more plentiful information.

The link between today and tomorrow is apparent in a younger generation's adoption of text messaging, blogging, and other technologies. They are developing the skills to process and create multimedia information without effort, often multitasking, often mobile. James Martin wrote of a dam bursting in 1973. That wave swept away many habits and structures. In any era, the younger generation learns to ride any wave that comes along.

Acknowledgments

I would like to thank Mizuko Ito, John Pruitt, Jonathan Kauffman, Nelle Steele, and Tracey Lovejoy for the examples and figures, Ed Cutrell for help with graphics management, and Tomoo Inoue for comments.

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