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> UNDERSTANDING HUMAN ACTIVITIES AND RELATIONSHIPS

*These notes reveal the intimate tie in Leonardo's thinking between . . .
phenomena in general and the need to put such information to practical use.*
—A. Richard Turner, *Inventing Leonardo* (1994), 184

WHY DO WE USE COMPUTERS?

Human nature and needs were not changed by the invention of computers. Human values endured even during the dramatic growth of information and communication technologies. People have always needed food, shelter, and medical care, and they always will.

People also need, seek, and thrive on emotional relationships with family, friends, neighbors, and colleagues. A nurturing parent and a caring friend will always be valued. Similarly, a neighbor's cheerful assistance and a colleague's supportive suggestion will enrich interdependence and strengthen trust. These human relationships grow when there is a shared history of positive experiences. The atmosphere of generalized reciprocity, the willingness to help others so that they will someday help you, smoothes the way for more ambitious cooperation and increases feelings of security.

When basic physical and emotional security are achieved, people then seek to establish commercial, political, and legal structures, and they contribute to these structures by their work and voluntary efforts. As civic structures are realized, people have growing amounts of leisure time and the security to get beyond basic needs. They can become creative in science, literature, music, and art, and they enjoy participating in entertainment, games, hobbies, and sports.

When these needs and desires are fulfilled, most people are satisfied. Having a good meal with your family and friends at a restaurant near your vacation home at a ski resort would make most people happy. But utopian images are only one side of human nature. Every positive can be linked to a potential negative: food can contain carcinogens, houses consume energy, and resorts can destroy the environment. And every happy relationship can fail: families can be torn apart, friends can become unscrupulous, neighbors can be deceptive, and colleagues can be competitive. Commercial firms can take advantage of customers, politicians can be corrupt, and legal systems can be manipulated. It can be a cruel world, but diligent planning can reduce the risks.

If technology developers start from an understanding of human needs, they are more likely to accelerate evolutionary development of useful technology. The payoff from a technology innovation is that it supports some human needs while minimizing the downside risks. Therefore, responsible analyses of technology opportunities will consider

positive and negative outcomes, thus amplifying the potential benefits to society. These themes were inherent in the work of the social commentator and historian of technology Lewis Mumford (1895–1990), who characterized the goal of technology with quiet simplicity: “to serve human needs” (Mumford 1934). This straightforward phrase has been an inspiration for me, pushing me to construct principles to guide my own use of technology. Over the past year it has led me to a framework to help technology developers discover opportunities for innovation. Of course, the available technology greatly influences what one can build (Leonardo couldn’t forge his giant bronze horse or make an airplane), but the ideas can still be valid. The available technology also shapes what one may consider possible—Leonardo never thought of CD players or cell phones.

As I studied my own use of computers and information technologies, I found it easy to interpret my usage in terms of satisfying my needs. I use computers to support my relationships with family and friends, to teach my students, to organize conferences with other professionals, and to buy books from online stores. My activities include gathering information, collaborating with colleagues, designing interfaces, and distributing my ideas.

When I interviewed other people about their activities, they also reported that gathering information, communicating with acquaintances and colleagues, and instant messaging to close friends and family were central to their daily use. These patterns were confirmed by a variety of user surveys by the U.S. Census Bureau, the Pew Center, UCLA, and others.¹ More than 80 percent of Internet users emphasize information gathering (especially medical, travel, and entertainment) and e-mail plus instant messaging. Most users of computers are not interested in the technology; they are focused on their own information needs and relationships.

Leonardo’s thoughts about human needs are reflected in his list of four prime human activities: mirth, weeping, contention, and work. This was an appealing starting point, as he addressed emotional states that emerge in personal and business relationships. I also thought about Leonardo’s integration of art and science in the service of practical purposes. The take-away message reverberated in my head: technical excellence must be in harmony with user needs. But what potent statement of human needs could guide design of information and communication technologies?

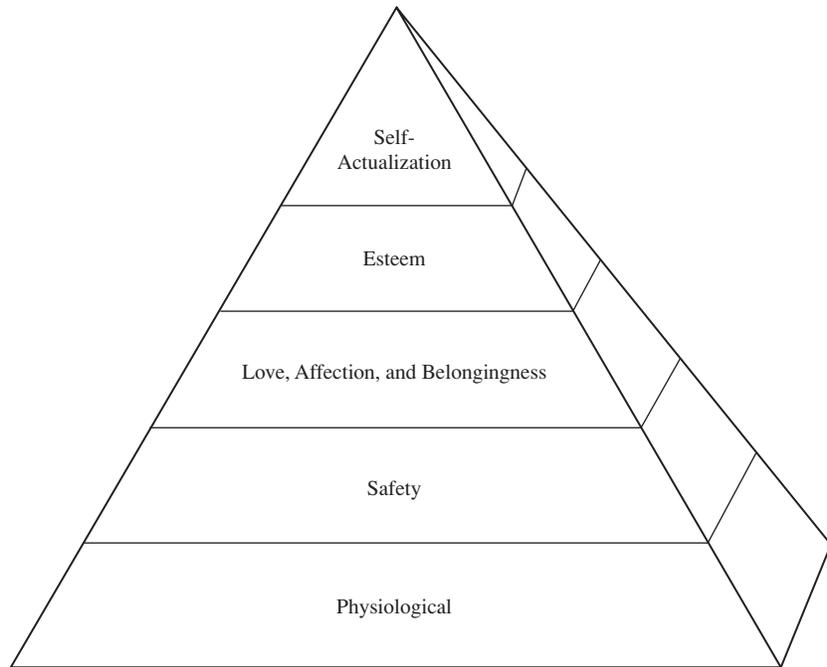
What better sources could there be than the Ten Commandments (“Thou shalt not kill, Thou shalt not steal, . . .”) and the Golden Rule (“Do unto others as you would have them do unto you”). These are inspiring principles that should be in the mind of every user and designer, but I wanted more refined guidance that was easily translatable into technology innovation.

Another source was Thomas Jefferson’s characterization of universal human needs in the U.S. Declaration of Independence, which proclaimed “life, liberty and the pursuit of happiness.” I agreed that these are admirable goals, but I was looking for something that I could easily tie to new technologies. I registered Jefferson’s goals in my mind and continued my search.

A later U.S. president, Franklin Delano Roosevelt, gave his Four Freedoms speech to the U.S. Congress (January 6, 1941) in which he looked “forward to a world founded upon four essential human freedoms.” Roosevelt sought freedom of speech and expression, freedom of religion, freedom from want (economics and health), and freedom from fear (especially reduction in armaments). These also laid out useful ideas that are important to keep in mind, but I was after a more detailed link to activities and relationships.

In the 1950s, the psychologist Abraham Maslow proposed a hierarchy of human needs (figure 5.1).² He was writing at a time when psychoanalytic theory suggested that people were governed by subconscious motivations. He was also battling behaviorists’ claims that people were merely stimulus-response machines and trying to shift researchers’ attention away from abnormal behavior. Maslow spoke the refreshing language of “human potential” and described people as seeking creative expressions that enabled self-actualization. His early writings presented five levels of a hierarchy of human needs, building them up from the lowest level of survival needs to the highest level of fulfillment, which he called self-actualization:

1. Physiological: biological survival, food, water, air
2. Safety: secure house, no physical threats
3. Love, affection and belongingness: giving and receiving
4. Esteem: self-respect and respect for others, generates self-confidence
5. Self-actualization: fulfillment of what a person was “born to do” . . . “A musician must make music, an artist must paint, and a poet must write.”



5.1 Maslow's hierarchy of human needs.

These are appealing because they deal with dangers to be avoided and goals to be sought. Levels 1 and 5 apply to individual needs, and levels 2, 3, and 4 describe relationships with others. This hierarchy appeals to me because it deals with an orderly spectrum of needs, is action-oriented, and focuses on relationships. I could begin to interpret how instant messaging or online communities support these needs. Maslow's hierarchy became an important guide to the new computing, but I was still eager to have a framework that made categories of relationships and precise activities more explicit.

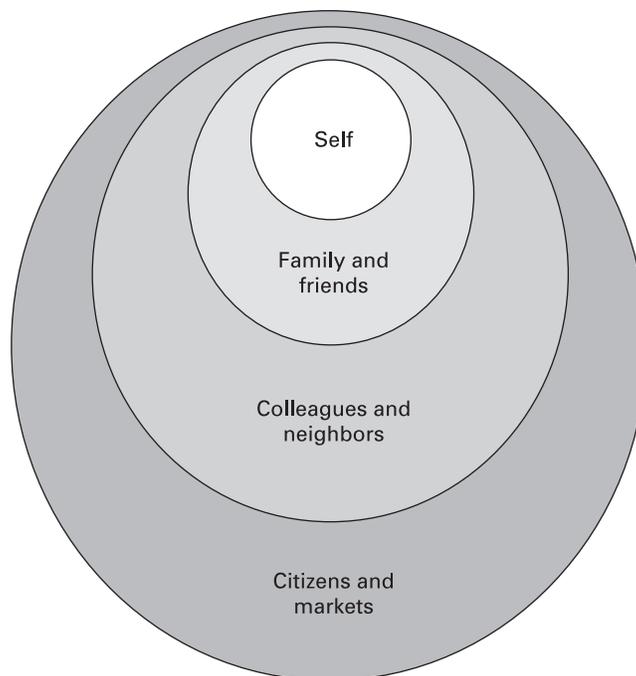
My quest for clearer statements of human needs led me to a simple formula for life: living, loving, learning, leaving a legacy (Covey, Merrill, and Merrill 1994). Living and loving reiterate Maslow's levels 1–4, and learning and leaving a legacy expand on Maslow's level 5. The formula is brief and punchy, yet thoughtful and compelling. Covey and his colleagues suggest setting goals by writing a personal vision statement (“begin with the end in mind”), then choosing directions carefully. They push down to specifics, such as time management, empathic communication, and measuring progress. I also found that their descriptions of independence, dependence, and interdependence were effective in making explicit the multiple aspects of human relationships.

These philosophical statements are all helpful in shifting attention to universal human needs. They do set out important goals, but coming up with a framework to help technology developers seems to require an integrated activity-oriented approach that also identifies relationships—who does what with whom.

FOUR CIRCLES OF RELATIONSHIPS

In my quest to develop a framework for technology innovation I focused directly on growing circles of human relationships. In the old computing, computer usage was usually defined as a solitary experience, a concept that was encouraged by the term *personal computer*. But turning outward to focus on relationships led me to a fresh place where *family computer*, *corporate community*, or *civic network* might be appropriate terms.

At the center is still your personal use of the computer (figure 5.2). You may just want to listen to music, read the news, or write in your



5.2 Circles of relationship.

diary. This is the private sphere, in which you are safe, secure, private, and free to create what you wish to satisfy your personal whims.

The second circle includes your enduring relationships with small numbers of trusted family or friends (2–50 people) with whom you have much shared knowledge and high expectations of meeting regularly. You've been cared for by your uncles and aunts, have played with your cousins and friends, and have gone to school with trusted classmates. They know a lot about you, and they would do a lot for you. You would trust them with your money, car, and emotions.

The third circle is much larger and includes the changing sets of professional colleagues or neighbors (50–5,000 people) who are moderately trusted, who share common interests, and who you expect to meet again. They might be members of your professional society or residents of your city, county, or state. You have a lower level of trust but share some common knowledge. You may not know other professionals or residents until introduced for a specific activity, but if they do the same work or live in the same neighborhood, you have lots to talk about.

Finally, the fourth and largest circle is defined by the citizens of a country or participants in a market (5,000 and more people). Your trust is low for them, your shared experiences may be few, and your economic situation may be different. Participants in a market such as eBay or MTV (music television) have some common ground, shared knowledge, and accepted social norms, but the risk of surprises is greater. People who regularly use eBay know about the latest policy changes and depend on the reputation manager to establish trust, but they are wary of each deal. Similarly, MTV fans share common knowledge of the latest music hits and fashion trends, but they don't leave their valuables in the open on the dance floor.

These four growing circles of relationships are characterized by size differences and the degree of interdependence, shared knowledge, and trust. It is an imperfect separation with fuzzy boundaries and boundary breakers, but it serves to identify current and potentially winning technology innovations. Buddy lists are for the intimate friends and family, whereas message boards and distribution lists work for colleagues and neighbors. Support for larger groups, such as novel Web strategies, are emerging to support relationships among millions of people who are citizens of a country or participants in a market. eBay, Nasdaq, and Amazon are examples of million-person online communities, although critics will argue about their boundedness and cohesion.³

Focusing on relationships is a new direction for many people in the computing field. After all, the basic notion of the personal computer was tied to the high degree of introversion among information-processing professionals. They usually prefer to be in their personal work space, and they believe that working alone is the fastest way to make progress, even if they could sometimes be more productive by cooperating with others.

It is not surprising that most software was designed for individual use, but as people with other personality types began using computers, their needs prompted the emergence of groupware and research on computer-supported collaborative work. As these new needs for cooperation appeared, new software and user interfaces were invented to provide appropriate communication. Of course, solitary work will always be necessary and group work has its problems. Many groups get into trouble, leading to spectacular controversies that trouble managers and participants. By contrast, individual failures tend to be more quietly covered over so that their damage is not noticed.

As a user, you might consider your balance of solitary and group work. Are there ways that you could use information and communication technologies to support your solitary work and to participate in the three larger circles of relationships? As a technology developer, could your innovation have multiple versions that are suited for solitary work or to support relationships in small, medium, and large groups?

As you shift your balance between solitary and group work, the benefits and dangers of each should be in your mind. Working alone frees you from interdependence but means you have only your own skills and knowledge to rely on. Working with others requires extra effort to build a trusting relationship, but you can share work and benefit from complementary skills and knowledge or simply split the effort to speed completion. Each approach has its satisfactions and frustrations, but drawing on both can provide the most productive and satisfying outcomes.

FOUR STAGES OF ACTIVITIES

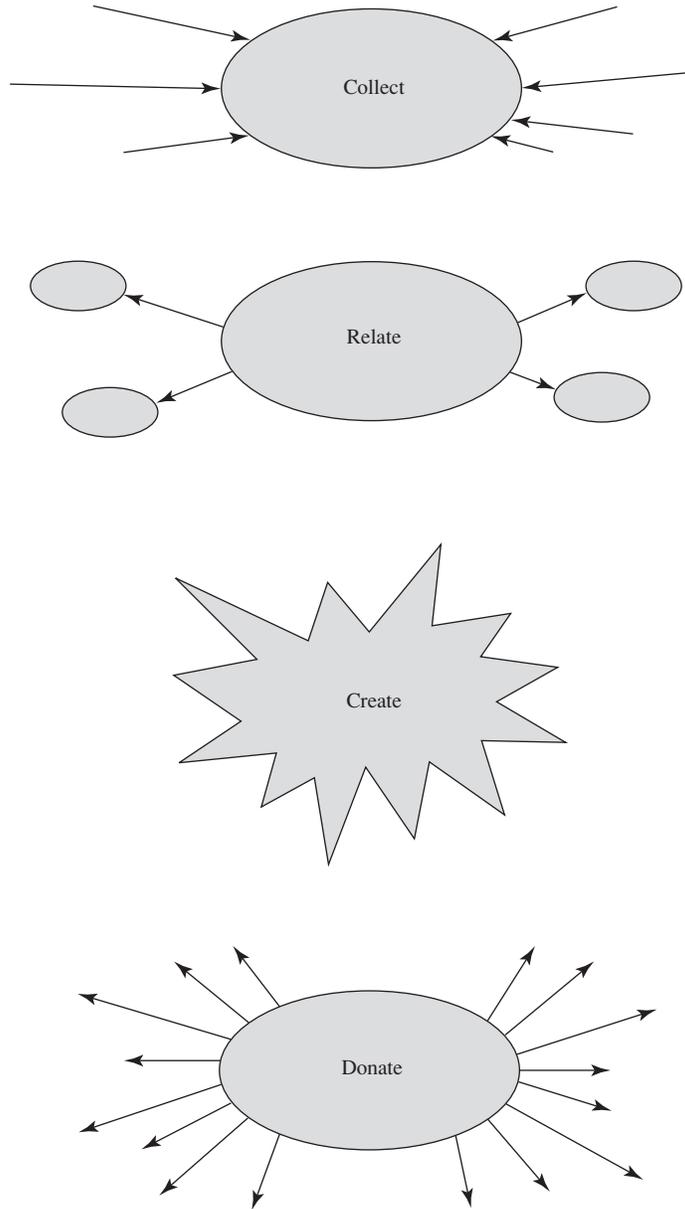
The four circles of relationships are one dimension of my framework to accelerate technology innovations. A second dimension is needed to separate out the stages of activities that users participate in. One approach would be life cycle events such as birth, adolescence, marriage, and

retirement. This generates new applications and Web sites, such as services to help new parents, teens in trouble, or wedding planners. A life cycle approach is helpful, but many important aspects of life happen between these memorable events. Another interesting approach is the rhythm of daily, weekly, or annual activities, so we'll save these for later refinements.

A better choice for an activity spectrum comes from studies of creativity (see chapter 10). The first step in a creative process, often called preparation, involves collecting information—just what today's Web supports quite well. In fact information technology has become the generic label for much of technology. But rather than focusing on how many gigabytes or pages of information are available (the old computing), we'll focus on the user's activity of collecting information (the new computing).

The responsibility for success in the information collection activity resides with the user. Users may *collect* information from family and friends, who are likely to offer what they know easily during a visit or phone call. The next circle of contacts includes colleagues and neighbors, who may be responsive to an e-mail message because of their expectation of reciprocity in their future information needs. Institutions such as professional societies, local government, corporations, universities, museums, and libraries offer informational Web sites that contain vast resources as part of their membership services, for a fee, or as a natural part of their institutional commitment. National resources such as the U.S. Library of Congress or the British Library, and marketplace databases such as eBay or Amazon serve broad audiences.⁴ Users often have serious intentions related to shopping, but there's great fun in checking eBay to see the price grandma's crystal glassware is getting, or reading nasty and nice reviews on Amazon. Similarly, financial markets such as Nasdaq or the New York Stock Exchange generate vigorous enterprises, such as Fidelity, Smartmoney, and Charles Schwab, which provide voluminous information ready for collecting by consumers and professionals.⁵

Collecting information is the usual first stage of activity, and users may return to this activity repeatedly (figure 5.3). A second vital stage of activity involves relationships with others. The *relate* activity, consultation with peers or mentors, may occur in the early, middle, or late phases of a project. Relationships are so powerful an attraction that telegraphs,



5.3 Four stages of human activities.

telephones, e-mail, and instant messaging grew rapidly and spread widely. Entrepreneurs quickly realized that the market was strong for communication technology. The thirst for relationships by phone and e-mail is so powerful that many people carry communication gadgets everywhere and spend large amounts of money for services.

By now, information (collect) and communication (relate) technologies are booming, so it is natural to ask what might be the next revolution? Leonardo now returns as the inspirational muse, because he reminds us of the strong urge to create. A broad interpretation of the *create* activity includes composing a song, planning a birthday party, launching a business, or organizing a social movement. So maybe the next revolution, following information technology and communication technology, is in innovation technology. This third revolution has already begun, and shrewd users and designers have already found the power inherent in creativity support tools. I'll have more to say later, in chapter 6, about the strong link between creativity and learning.

The fifth stage of human activity is what Maslow referred to as self-actualization and what Covey and colleagues called leaving a legacy. I'll use the term *donate* to complete the sequence with a rhyming scheme: collect-relate-create-donate. The *donate* activity covers giving to yourself, to your family, to your profession, to your community, or to your country. This is most visible in acts such as helping to care for friends and family, volunteering to help care for elders in a community center, or giving to national charities such as the Red Cross.

The concept of donation is also tied to dissemination of creative products. Composers of songs want to do more than write a great song, they often want distribution to and appreciation by others. Business leaders often talk about the desire to create value and develop successful businesses that change people's lives. Inventors want patents and royalties, while scientists want publications and citations. The desire for broad recognition and one's fifteen minutes of fame is widespread.

These four stages of human activity are not a complete representation of life, but they may help you by suggesting new ideas for accomplishing your goals. For example, you may think of shopping as merely finding the best price for your next car. But you could decompose shopping into collecting information about products, their features, and uses; forming a relationship with the seller; putting some thought into creating the deal; and then offering to be a positive reference for the seller.

This could make you a more effective shopper, and it might be more satisfying to you and the seller.

Similarly, you might rethink how you participate in sports or plan your next vacation in terms of learning more about the game or destination, building relationships along the way, creating something novel, and spreading the word about what you have done. The collect-relate-create-donate rhythm of activities may suggest new ways of thinking about old problems.

AN ACTIVITIES AND RELATIONSHIPS TABLE

You've probably guessed where this discussion is leading. The four circles of relationships combine neatly with the four stages of activities to make a two-dimensional grid: an activities and relationships table (ART) (table 5.1). This 4×4 table shows what activities you can accomplish with members of each circle of relationship using one of the technologies: information, communication, innovation, and dissemination. It's not perfect, but it may help you, as a computer user, to solve some of your problems in fresh ways. It may help technology developers in spotting new opportunities.

For example, if you are moving into a new neighborhood and need to find a doctor, your first step might be to collect information (first column of ART). Recommendations from family and friends would be a great starting point because you trust their comments. They know that you need a physician to take care of your two young children and a physician who is good in dealing with your asthma and your spouse's high blood pressure. You could ask your new neighbors, but you might be cautious since they may not know enough about your preferences or needs in medical care. You could try to track down listings of local physicians or local agencies that make recommendations, but you are likely to assume that these recommendations are biased or insufficiently tuned to your needs. Finally, you could consult national medical directories that list physicians by region and specialty, but this is generic information that is only a starting point for further inquiries.

Your second step would be to contact local doctors or healthcare organizations, describe your needs, and ask for references so you could

A R T	COLLECT Information >Read documents >Listen to stories >Explore libraries >Learn customs	RELATE Communication >Ask questions >Join meetings >Participate in dialogue and reciprocity >Develop trust and unity	CREATE Innovation >Compose, write, sketch, build, make >Brainstorm, visualize >Make plans and policies >Explore alternatives >Simulate outcomes	DONATE Dissemination >Write reports >Record history >Tell stories >Publish insights >Organize events >Advise, lead, care, train, mentor
Self				
Family and friends (2–50 intimates)				
Colleagues and neighbors (50–5,000 regular encounters)				
Citizens and markets (5,000+)				

TABLE 5.1 Activities and Relationships Table

communicate with current patients (second column of ART). References and testimonials can be an important part in building trust in new relationships. You might even contact medical review boards or state agencies to get details on performance of specialists or healthcare organizations.

If you've been especially diligent, you might organize all your information, ranking candidates by key attributes such as quality of care, cost, and convenience. If you were a truly devoted community activist, you could apply your creative energy to constructing a small handbook for newcomers to your neighborhood that records your information (third column of ART). Then you could help others by disseminating (donating) your information through a posting to a community Web site (fourth column of ART). The "donate" activity leads to creation of ever larger libraries of information that are the sources from which others can begin their collection process.

The new computing as mapped by an activities and relationship table could also be an opportunity for technology developers to invent software tools or services to organize and speed the process of choosing a physician. Spin-off ideas such as discussion groups among patients of specific doctors or among patients with specific diseases expand the possibilities. More ambitious opportunities to compare physician performance within regions or nationally become possible, as well as research to improve the quality of patient care.

This scenario portrays a diligent, motivated, and resourceful person who has the knowledge and time to find the right physician for his or her family. You might not be so dedicated, but you may find other ways to create a satisfying social community or to create something for your family or colleagues. Most people want to have friends invite them to go jogging and to live in a community where neighbors happily care for their children. Unfortunately, increased time pressures, longer commutes, higher expectations, and even growing use of the Internet can undermine your ability and willingness to give generously. But you can just as easily put greater emphasis on human needs and your community. You can use the new computing to restore the lost social capital.⁶

Many other everyday challenges that you face, such as finding a home to live in, starting a business, or getting a new job, could be facilitated by thinking about the circles of relationships and following the collect-relate-create-donate stages of activities.

For technology developers, the activities and relationships table might suggest new tools and services. The remainder of this chapter offers two case studies of interface innovations that were fostered by thinking of the activities and relationships table. The rows and columns are not sharply defined, and many activities will fit in several cells of this table. Imperfections and omissions are easy to find, but the goal of this table is provocative inspiration.

The first case study would have delighted Leonardo because it focuses on human needs in dealing with visual information, especially photos. The second case study covers desires for mobile and ubiquitous access, and suggests some novel ways and places in which to provide information, expand relationships, inspire creativity, and disseminate ideas.

THE EYES HAVE IT! VISUAL INFORMATION

It's a visual world! Images capture the thrills, emotions, and concerns of many people. Art can shock or inspire, concerned photography is a tradition, and family photos are some of our greatest treasures. Leonardo would have agreed. He wrote, "The eye . . . the window of the soul, is the principal means by which the central sense can most completely and abundantly appreciate the infinite works of nature." He believed that visual senses were the most important way to learn about our world.

It is not surprising that visual information is a vital component of the new computing. Most people depend on visual input for much of their understanding of the world around them and as a basis for further creative activities. Information visualization is becoming the next big success story as designers are succeeding in showing hundreds of times more information than tabular displays. These novel approaches show stock market trends, reveal disease patterns, or uncover flaws in manufacturing processes.

Mainstream success stories are inherent in the popularity of visual media such as photos, short videos, and clever animations. Digital photos and image-laden Web pages are already major computing applications, but users want still higher resolutions and faster downloads.

The possibilities for photo databases can be understood by using an activities and relationships table filled in with photo applications (table 5.2). The oldest applications are traditional database searches, such as

A R T	COLLECT Information	RELATE Communication	CREATE Innovation	DONATE Dissemination
Self	Digital photo import		Photo diary PhotoShop	
Family and friends	PhotoFinder PhotoMesa Family albums	Photo-sharing Web sites	StoryStarter Export to Web	Family photo histories
Colleagues and neighbors	PhotoFinder kiosk Corporate photo histories	Neighborhood photo sharings		
Citizens and markets	Library of Congress PictureQuest Corbis		PhotoQuilt	Web sites for photo exchanges

TABLE 5.2 Photo Applications in an Activities and Relationships Table

those presented by the Library of Congress. The Librarian of Congress James Billington has courageously promoted his vision through the National Digital Library Program to produce American Memory.⁷ This system is making seven million objects available on the Web, organized into two hundred collections, many of which are already available, such as 1,100 Mathew Brady daguerrotypes of the Civil War, 25,000 architectural photos of Washington, D.C., from the 1940s and 1950s, George Washington's handwritten letters, Thomas Edison's films, and Walt Whitman's manuscripts. This is a national treasure accessible to all citizens and is structured as an information resource for teachers, students, journalists, researchers, history buffs, and others. As in a traditional and diligently catalogued library, images are annotated with information about the photographer, date, location, and a caption, all of which are searchable. You can search for "Missouri buffalo" or "Civil War general" to find photos with captions. It supports the "collect" activity in the broadest circle, citizens and markets. Other stock photo services such as PictureQuest or Corbis provide similar search services to broad markets.⁸

However, this is only one of sixteen cells in the activities and relationships table. Our research group took on the problem of organizing personal and family photo libraries, which addresses people's desire to collect and find photos of their families and friends (first and second rows, in the table). Personal photos deal with images of friends and family, typically at life cycle events (births, weddings, graduations) and on trips (whitewater rafting down the Colorado River, family visit to Disneyworld, summer trip to London). The distinctive nature of personal photos is that the same small circle of friends and family appear in most of the photos.

Personal photo images come from scanning services and digital cameras, which merely provide a sequencing number and then store the photos in directories. Few users are sufficiently motivated to give meaningful file names to each photo and organize them into named folders. But even those who invest the effort are limited by the crude file name searching that is available.

The challenge for users and designers is to overcome the paradox that family photos are among our most valued possessions but are rarely viewed. The value is exemplified by the story of a wedding that was restaged because film processors ruined the negatives. The entire wedding party and guests reassembled two weeks later, dressed in their fancy

clothes to reenact the wedding for the cameras. Similarly, homeowners have run into burning or flooded homes to retrieve their photos. However, the paradox stems from the fact that most people cannot find their digital photos easily when they want them, and rapid browsing is not always possible. As users amass thousands of photos on their hard disks, they are stymied in trying to find that picture of grandma at Susie's first birthday party.

The personal photo paradox grows stronger over time because older photos are valued even more but viewed even less. It is just too hard to find that picture of grandpa in the navy during World War II. Therefore if search capabilities could be made effective, personal photo users might adopt them and be able to spend more time with their personal photos.

The main impediment to searching for photos is the complexity of specifying what you want and the difficulty of annotating the photos appropriately. If photos are annotated by date and place, as the Library of Congress does, then you can search for river photos of St. Louis, Missouri, or Cairo, Egypt. Places, dates, names, and nouns are relatively easy to search for, but images of concepts such as parenthood or themes such as mourning are more difficult to retrieve. Many thematic taxonomies or thesauruses have been built, but accepted standards are not in place.

Natural language techniques for expanding keyword searches can be helpful. For example, programs can use synonyms (*child, youngster, youth, kid, infant*) or hierarchical terms ("New England" is the more general term for "Maine, Massachusetts, New Hampshire, Vermont, Rhode Island, and Connecticut"). Some institutions, such as the anthropologically oriented Musée de l'Homme (Museum of Man) in Paris, organize photos by topics such as agriculture, housing, and religion, and the Detroit Institute of the Arts, for example, separates out still life, portrait, and abstract images.

Since annotation is so time-consuming, many researchers have attempted to use computer vision techniques to automatically analyze photos to recognize features, textures, faces, and colors. Color matching may help in finding sunset images, and feature detection can help find corners, lines, or circles, which do work in locating some images such as eyes or corporate logos. Photos of a person can be matched and located when good lighting conditions and face-forward poses are possible, but a general solution to the annotation and search problem is far into the future. Still, progress in automatic techniques may soon allow for counts

of the number of faces in a photo or the recognition of indoor vs. outdoor photos. Other near-term possibilities are to distinguish buildings from trees, and male from female faces, which would be useful even if the results were not completely accurate.

An alternative to automatic analysis and annotation is to facilitate human annotation. While the Library of Congress and other institutions are willing to spend their resources to support detailed data entry, most users are not ready to spend hours typing in names of friends or family, locations, and contents. Even when they do, their inconsistent approach (Bill, Billy, William, Willy, or New York, NYC, New York City, NY) undermines successful searching.

Our approach to this problem with personal photo libraries is to enable you to drag names from a list of your family members onto the photos (Shneiderman and Kang 2000). This direct annotation interface, implemented in the PhotoFinder, records the names in a database that is easily searchable (figure 5.4). To make finding photos of grandma easy, for instance, we added drag-and-drop searching, so that you merely drag a name onto the search area and thumbnail photos of grandma will appear immediately. Our solution works well for personal photo libraries because even if there are thousands of photos, there will only be twenty to fifty people who reappear frequently.

Even before we finished the PhotoFinder, it was clear that finding photos (“collect” activity) was only part of personal photo library usage. Users wanted to send photos by e-mail to the people in the photos to confirm, capture, and relive their experiences. As we scanned older photos, users wanted to send photos to reminisce with participants about the event and tell stories to others who weren’t there. The appeal of photos is that they are proof that something happened, the testimony that you did whitewater rafting through the Grand Canyon, caught the big fish in the South Pacific, or shook the President’s hand in the Green Room at the White House. In terms of the activities and relationships table, PhotoFinder users were interested in more than just viewing the photos on their own; they wanted to use the photos to relate to other people.

And soon enough the retrieval of the photos became only the starting point for another creative activity. Users wanted to be able to export selected photos to a Web site and add commentaries to tell a story (“create” activity), such as the growth of a daughter from age one to age two. Users also wanted to print artistic compositions of multiple photos with



5.4 PhotoFinder software tool lets users organize, annotate, find, and share personal photos; <<http://www.cs.umd.edu/hcil/photolib/>>.

textual captions. This led us to add the StoryStarter component to PhotoFinder. It allows you to export a set of photos with annotations and captions to a Web site in a convenient way and allows additional editing using commonly available editors.

Of course, the goal for most users was more than to make these creative products; they also wanted to disseminate them (“donate” activity) to family and friends. Each of these user needs led to expansions of the PhotoFinder beyond its original conception. These experiences helped confirm the utility of the activities and relationships table, but the next steps were to use the table to invent new applications.

In seeking photo applications for colleagues and neighbors, we came up with business uses, such as real estate agents’ taking photos of houses for sale, insurance agents’ photographing automobile damage, or surgeons’ recording injuries and treatment outcomes. Such activities ranged from retrieving the photos (collect) to sharing them with colleagues for a consultation (relate), to making a report with recommendations (create), and publishing them on the Web for others to use (donate). Specialized applications to support creative effort become possible, such as retrospective searches by insurance agents to find all cases of failed bumpers or roll-over survival. Similarly, surgeons could annotate surgical procedures and then search for patterns over thousands of cases.

Our research plan expanded to include group processes for annotation. We scanned more than four thousand photos from twenty years of conferences in human-computer interaction and invited our colleagues to participate (relate) in providing annotations and captions. We installed seven PhotoFinder kiosks at the April 2001 ACM Conference on Computer-Human Interaction in Seattle. During three busy conference days, hundreds of visitors found their way to our booth in the back of the exhibition hall to browse photos and reminisce with friends. They added more than one thousand name annotations plus four hundred captions, and contributed twelve hundred new photos.

This process among colleagues contributed to a history (create) of this community of researchers and developers. By the end of 2001 we established a Web site with all the images, annotations, and captions to provide a public archive for this emerging discipline (donate). Of course, respecting the desires of individuals for privacy is a central concern in moving from private collections to public archives. Photographs of par-

ticipants at a public conference are relatively uncontroversial, but personal photos that become public could produce sensitive issues and require model releases, especially if commercial gain is part of the goal. Responsiveness to requests for withdrawal of photos must be part of any public display.

One appealing application for families and friends is to build a personal history database of photos and stories that allows rapid finding of joyous events such as births and weddings or somber occasions such as illnesses and deaths. It seems likely that many people will keep more detailed electronic diaries with pictures, audio recordings, and videos. Software for indexing, organizing, and exploring these complex personal information forms are likely to be a large opportunity in coming years. Thousands of scanned or digital photos can be included and indexed by person name, date, location, and event. Software tools with user interfaces to allow viewing thousands of photos and zooming in on ones to be examined carefully are becoming possible on ordinary laptops.⁹

Since browsing has become so pleasant, you can imagine sitting with your grandparents, looking over old family photos while you capture their stories in audio format. Then you could tie in to one of the genealogical databases that allows easy creation of family histories. The graphic display of family trees and temporal presentation give you an overview of family evolution and the social context of the time. Along the way you might get distracted by the story of an aging relative whom your grandparents mention. The photos and captions describe his colorful life history of ambitious business ventures and dramatic travel adventures. You recognize one of his children as a distant cousin who once visited from Caracas, and make a note to contact him during your next business trip to Venezuela.

Neighborhoods and companies have histories, too. The ease of capturing events and stories, coupled with improved tools for organizing and presenting them, encourages some users to construct histories and mini-museums of their neighbors and colleagues. If Brooklyn is your home, you can find out about it, its neighborhoods like Prospect Park or its history, just by clicking to their Web sites.¹⁰

Similarly, IBM's ambitious archives are online and Intel's physical museum has a rich Web version.¹¹ Smaller companies can also have their history on the Web with photos of the founders and stories of how the

company grew. The aging storytellers and devoted archivists of many minicultures become empowered and celebrated by their use of technology tools to capture experiences and encourage community.

Still more ambitious efforts are coming from Corbis, a for-profit company set up by Bill Gates. Corbis has been scanning photos and paintings from the world's great museums and archives with the intention of selling rights. But the image scans are only the starting point. Annotation, indexing, and search services are needed to make such collections accessible. It will be interesting to see how Corbis compares to the biggest library of them all—the U.S. Library of Congress.

Royalty and presidents have libraries of their archives with photos of their accomplishments, but in the future more people will create museums on the Web and slide shows about their lives and ancestors. Similarly, today only a few diligent specialists amass photo collections, such as the architectural historian, the birdwatcher, or the plant collector. But future experts and enthusiasts of many sorts will be able to develop and distribute their photo collections. They could do this as a hobby or a business, as an avocation or as a serious research effort. The communal aspects of group annotation, e-mail distribution of photos, and countless Web-based photo libraries are likely to stimulate a still higher degree of visual literacy in a wider range of people.

One of Kodak's efforts, PhotoQuilt, enabled thousands of people to create a joint photo archive.¹² Consumers sent in photos with captions that were assembled into a huge quilt-like image. Users could zoom in on a section and then click to get larger images with captions. This collaborative creation involved thousands of contributors and millions of viewers, but it is only the beginning. A natural next step would be to take the wildly successful concept of peer-to-peer sharing of music files and allow sharing of photos. Photo-sharing participants could easily access family photos or form collections from databases of historic photos locked away in the personal archives of cousins, uncles, aunts, and grandparents. Such photos could be tied to each family's genealogical database, allowing relatives to view each other's family photos.

Photos are a popular form of visual information, but there are other forms, such as trademarks, logos, cartoons, advertisements, paintings, and maps. In the early days of the World Wide Web, a University of Maryland computer science graduate student, who was

an enthusiastic skier, approached me about his Web-based library of ski maps. He had diligently downloaded and scanned hundreds of ski area maps and arranged simple indexes to find resorts geographically, alphabetically, by difficulty, and so on. With some help from the university's Office of Technology Liaison, he managed to pay for his studies and support his young family when he sold the rights to an Internet service provider.

You may have your own examples of how you, your family, your company, your neighbors, or your college alumni created photo albums, stories, and archives. Photos are a fundamental technology, and they become compelling when they are used to support human needs for self-expression, collaboration, and creative endeavors.

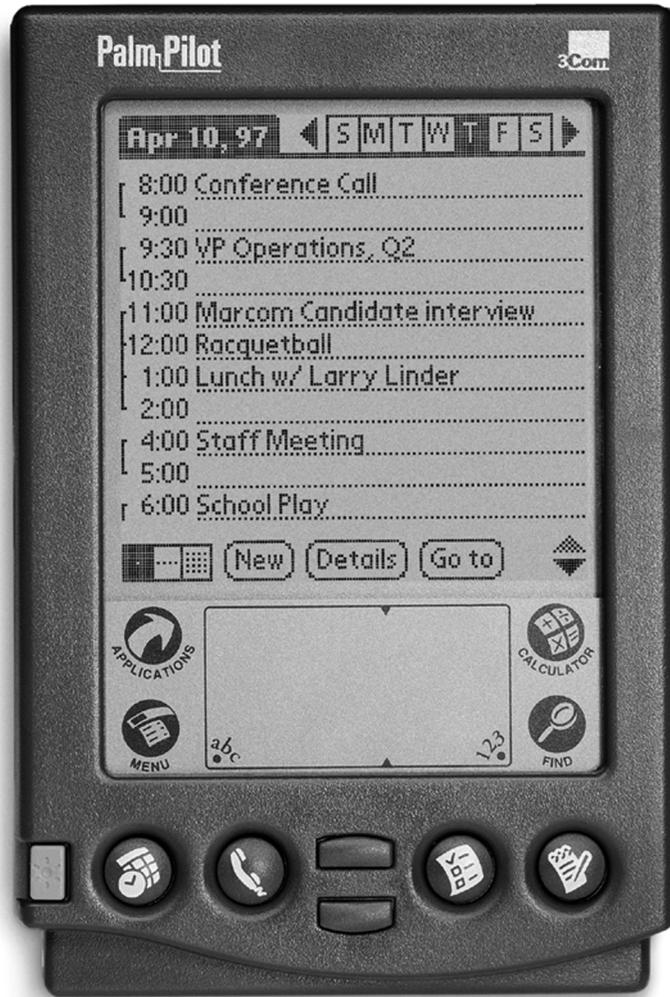
MOBILITY AND UBIQUITY: PALMTOPS, FINGERTIPS, INFODOORS, WEBBUSHES

An activities and relationships table can be applied to the needs of users anywhere and anytime (table 5.3). The success of portable devices from the venerable transistor radio to the cherished Walkman cassette tape player to the amazing MP3 digital music players demonstrate the strong desire consumers have for music on the go. The same users who want big screens and impressive desktop machines in their offices and homes, also want small portable devices to carry with them everywhere. They want big screens for viewing maps and designing houses, and small screens for stock prices, weather reports, and flight information anywhere, anytime. Leonardo was just the same, sometimes working with wall-sized frescoes and large portraits but also using many small notepads. He was a scribbler, a doodler, who took his notepads everywhere.

Recognizing the desire for mobility, the designers of the 1990s started to produce small devices. The Palm (figure 5.5) and the Psion demonstrated that technophiles would use well-designed portable information tools—truly information at their fingertips. (Bergmann 2000). At the same time, exploding growth of cell phones exposed the intense desire for communications. By the early 2000s the combinations became irresistible: wireless communications for palm-sized devices and bigger displays for cell phones.

A R T	COLLECT Information	RELATE Communication	CREATE Innovation	DONATE Dissemination
Self	Flight info Weather		Diary	
Family and friends	Address lists	Find-a-Friend E-postcards	Music play lists	Family vacation histories
Colleagues and neighbors	InfoDoors Gather e-mail	Send-a-Link InfoDoors	E-guestbooks	
Citizens and markets	Stock quotes WebBushes	Click-n-pay	E-guidebooks	Web sites for exchanging tourist info

TABLE 5.3 Mobile and Ubiquitous Applications in an Activities and Relationships Table



5.5 Palm™ hand-held computer. Palm™ is a trademark of Palm, Inc.

The Palm designers brilliantly focused on a few portable information needs: calendar, address book, to-do list, and notepad. The surprise was that users were willing to learn a variant of the English alphabet, called Graffiti (figure 5.6) so that they could enter data with a few quick strokes for each character. The surprise is even greater in light of the failure of the Apple Newton, which offered recognition for handwritten words. Apparently most users get greater satisfaction and utility from entering many easily recognized small strokes than a few often misrecognized handwritten words. Many users are willing to learn a new alphabet to obtain reliable data entry. Most users feel responsible for Graffiti stroke recognition errors, whereas they tended to blame the Newton for word recognition failures. This may be because the locality and cause of errors is clearer in Graffiti, making it easier to go back and get them right.

Palm add-ons, such as games and restaurant guides, appeared quickly, and now e-books and news headlines are growing applications as screen sizes grow and readability improves. In parallel, cell phone designers found a surprising willingness for users to enter short e-mails on the telephone keypad. Soon enough millions of young users shifted from talking to texting. Here again, mastering a new skill seems to have engaged many young users. The motto for the Yellow Pages directories was to “let your fingers do the walking,” but with cell phone data entry, you let your fingers do the talking.

The Palm wins on screen readability, making it likely to grow as an information resource beyond news, calendars, or navigation. The cell phone wins on commercial viability because it is already tied to a pay-for-service mentality, making it natural to spend money by phone. Not only will one be able to buy stocks or airline tickets by cell phone but many little simplicities seem likely to appear. Why not pay for parking or a can of Coke by cell phone. As you park your car, just key in the code number pasted on the meter and a dollar gets charged to your phone bill. As you stand in front of a soda machine, just scan the code number pasted on the soda machine, and “You are on your way with Click-n-pay!”

But these devices are just the beginning of the miniaturization and pervasive implementation process. Wristwatch devices can already contain cameras or calendars, and other technologies will be embedded in



5.6 Graffiti® alphabet. Graffiti® is a registered trademark of Palm, Inc.

shoes, bracelets, necklaces, rings, and clothing. Some will facilitate information gathering such as exchanging contact information, or be part of commercial activities such as payment processes, or collect medical information. Here again, visionary insights come from thinking more about human needs than technology possibilities.

The exchange of business cards is a delightful tradition that has acquired some appealing rituals, such as the formal Japanese offering process or the playful style of tossing them across a conference table. Palm users make a game out of their infrared beaming to send contact information. But imagine I want to gather the e-mail addresses of the fifty people at a meeting in order to send them a message. The Palm solution of beaming one contact at a time is much too slow and still makes it tedious to collect all the e-mail addresses into the header of a message. Recognizing the need for a GatherEmail tool is the first step, and then a dozen different technologies could be applied to solve the problem.

Other devices are likely to become fads. Lapel pins or earrings might become information exchange devices, with ten thousand names stored in shoulder pads or belt buckles. Other FingerTip applications would be to have rings, bracelets, or batons to operate devices around you. Imagine a ring that could be rotated to dim the lights of any room you were in, lower the air conditioning, or turn the sound volume up on the TV or radio. Maybe a bracelet that detected gestures would do the job, such as making a fist to turn the lights off or raising your finger from the stereo to the ceiling to raise the sound.

I've often wanted information services when traveling. Imagine that as you board an airplane you could check out if any people from your company or any alumni of your college were on board, or more practically, if anyone else was going to the Hilton Hotel so you could share the long taxi ride. These possibilities become viable as information access becomes widespread, but user control over privacy will become a growing concern. As I visit a new city, especially if I am wandering around on my own, I wish for a radar-like device—Find-a-Friend—that would let me identify friends who might be nearby to recommend a restaurant or show me around.

An extension of these ideas is that when attending a business presentation, you would automatically get the copies of the speaker's slides on

your laptop—Slides-to-Go. This can be done by a wireless transmission (radio waves or infrared signal) of the file or simply its Web address—Send-a-Link. You could walk out of the meeting with the slides, the minutes, and the list of action items on your laptop or easily accessible from the Web.

But portable devices are only one manifestation of the intense desire for personal information and communication services. On the activities and relationships table, information tools that reach friends, neighbors, and colleagues might present opportunities for developers. Let's follow one more idea in depth.

Look at your office door at work. It probably has a nameplate in a wooden or metal frame, giving the room number plus your name and title. If you move, your nameplate gets replaced. Often your door acquires additional notes with schedule information, referrals for assistance, or a photo. Office doors often become a resting place for Post-it notes with messages such as "Out to lunch, be back at 2 p.m." or "Look for me in the kitchen." Travel plans such as "I'm in New York till Thursday" or "Vacationing in Paris till Labor Day" also wind up on many office doors.

Imagine mounting a Palm display on your office door with an Internet connection (wired or wireless). Voilà—the InfoDoor! The InfoDoor is an information appliance located at your doorway providing practical services such as personal scheduling, weather reports, or organizational announcements. It would have an Internet connection and a touch-screen surface mounted at eye level on or near the doorway to your office, linked to a server in the building. The InfoDoor would have an important role in emergencies, when it could steer you to safe exits in case of fires, toxic gases, or earthquakes. The lifesaving aspect of InfoDoors may justify their installation, but clever users will undoubtedly find other applications that are compelling or just plain fun, such as posting cartoons or personal photos.

A typical office building might have hundreds or thousands of InfoDoors. If bought in bulk and installed during construction, they would soon cost less than one hundred dollars per unit. The flexibility and openness for future growth should be appealing for "smart building" promoters. Normal operation would be quiet mode, in which the InfoDoor

displays your name, title, or other standard information, but it could be changed to include a quote or joke of the day.

You could send a message to the InfoDoor to indicate that you are late for a meeting and you could provide information or instructions, for example, "I'll be in by 10:30 a.m., meanwhile please see Judy at the front desk." If you posted a schedule, then a visitor could select free times for a visit. If you were in a meeting, you could post a note saying, "Please do not disturb till noon" and encourage visitors to select a later time for a visit.

If you were not in your office or you were busy, the InfoDoor could provide referral information to appropriate providers, for instance, "For assistance till noon, see my secretary in room 472. To pick up a job application go to room 532. For information on available jobs, touch here."

You or the management could post announcements of time-sensitive events in the building, such as lectures, meetings, visitors, blood donation drives, charity programs, flu injections, and holiday gift sales. Other announcements could include weather reports, such as snow emergencies, hot weather warnings, and air-conditioning or heating changes. Traffic accidents, crime alerts, or early office closings could also be posted. Some of these can be sent by e-mail, but sending them to the InfoDoor would get them off e-mail and make them publicly available in familiar places.

Fire alarms or emergency messages could be sent with a warning tone. The messages could be more specific than current fire alarm systems and could direct people to the nearest safe exit while guiding fire fighters to the fire sources. InfoDoor alarms might satisfy emergency needs for rapid information during earthquakes, floods, toxic releases in industrial sites, explosions, or hostage situations in banks.

InfoDoors in office buildings, hotels, or homes are only one manifestation of ubiquity. Even in natural surroundings there are interesting opportunities to sprout new information, communication, innovation, and dissemination portals. I'll call these WebBushes. While every rock and tree might become the site for a new display device, let's explore a simpler approach of merely labeling distinctive objects with a barcode or small responder. This would make it possible to point your PalmPilot at a palm tree and find out what kind of palm tree it is, what its medicinal properties are, how it is used, and other bits of environmental, cultural, scientific, or historical information.

As you are rafting down the Colorado River, you pass some striking sedimentary rock face and click to find out what kind of geologic formation you are seeing, who first charted the upcoming rapids, and when the river crests in the spring. In-depth information about the location, its cultural importance, and tribal histories could all be available for the interested reader. Since each palm tree and river rapid would also have an associated Web site, as you travel your portable device would accumulate the sequence of URLs that defines your journey. Then when you return home, you could always retrace your steps because you would have a permanent record of where you were.

Text information is only a starting point for WebBushes. Each palm tree or river rapid could also be the basis for a photo database of professional photos in every season and through history. Visitors could leave their written experiences or photos for future reference or for others to see, possibly for a fee. They could dispatch e-postcards from memorable places and include photos from the here-and-now to connect with those who are far away.

Museum or hotel guest books are other applications that could be expanded in many tourist and natural locations. E-guestbooks could elicit user stories and encourage creative reporting that could enhance the experience for the teller and the recipient.

E-guidebooks are other opportunities for information collection and innovation. Think about riding along the Lewis & Clark trail from Missouri to Washington State, biking the 184-mile Chesapeake & Ohio Canal, or walking the Appalachian Trail from Georgia to Maine. At each rest area you could follow your interests and download onto your portable device the information about the next section of the trail. You could upload your sunset photos or add your observations of a rare heron. Some might argue that such media would distract from the natural experience, but they can intensify it as well by making visitors more aware of local birds, plants, or history. Not everyone wants to read the experiences of earlier visitors or leave their own comments, but many people seem to enjoy such exchanges.

Specialized information also spawns niche audiences. Guides for parents with kids, disabled tourists, amateur archaeologists, and so on extrapolate existing trends in guidebooks and other information sources. Following the footsteps of frontiersman Davy Crockett or the residences of Leonardo may be specialized desires, but such individualized experiences

give many people great satisfaction and a good story to tell when they get home. Registering at each destination and then having access to photos may be as much fun as visitors get at Disney's EPCOT when they stamp their passports at each country's pavilion.

The activities and relationships table (table 5.3) can now be partially filled in with these ideas. But these are just the beginning. By now you may have your own inventions and ideas for new products or services that could benefit yourself, your family, your colleagues, or wider circles of users. You may find new ways to contribute to the new computing, serving human needs for information, communication, innovation, or dissemination.

THE SKEPTIC'S CORNER

The activities and relationships table is not as neat as Mendeleev's periodic table of chemical elements. Human activities and relationships are more fluid than puddles of mercury and harder to contain than clouds of hydrogen. The activities and relationships table is easy to complain about, incomplete, and too vague. But it does help shift the discussion from technology to human needs. It helps me think of whom I interact with and what I want to do in my life. It's not easy to make this shift in thinking, especially for those with technology-centered backgrounds, but putting user needs first is the key to the new computing.

You may be skeptical about some of my proposed photographic applications and even more doubtful about the InfoDoors or WebBushes. These are exploratory fantasies that may seem far-fetched, or they may send you to work writing a business plan to seek venture capital funding. If I've provoked you to do better, that will be an even happier outcome.

You may also challenge the fundamental idea that human needs should guide technology development. I've put this forward as a central thesis, even while I am aware of the enormous temptation, great power, and fun of thinking about technology first. Maybe I haven't won you

over completely, but I hope that you will think about your and others' needs more often as you apply and design new technologies.

The next four chapters apply the activities and relationships table to e-learning, e-business, e-healthcare, and e-government. Those chapters explore these expanding applications from the perspective of the new computing. You will see opportunities for changing your family life and ways of working. You will see some of the dangers that lie ahead, but a cautionary approach might yield the most successful outcomes.