> INSPIRATION FOR THE NEW COMPUTING
The old computing was about what computers could do; the new computing is about what users can do. Successful technologies are those that are in harmony with users’ needs. They must support relationships and activities that enrich the users’ experiences.

Information and communication technologies are most appreciated when users experience a sense of security, mastery, and accomplishment. Then these technologies enable users to relax, enjoy, and explore.

Imagine that after a sunrise climb, you reach the summit. You open up your phonecam and send a panoramic view to your grandparents, parents and friends. They hear the sound of birds, smell of mountain air, feel the coolness of wind, and experience your feeling of success. They can hear each other cheering, and point at the birds or click on other peaks to find out more. They remember how, on your last climb, a rockslide brought you to an emergency room unconscious. On that occasion, fortunately, your World Wide Med records guided the physician to care for you. She was able to review your medical history in her local language, helping her to prescribe the right treatment. Today’s climb has a happier outcome, which restores everyone’s confidence.

The challenge for technology developers is to more deeply understand what you, the user, want. Then they can respond to this challenge by creating products that are more useful and satisfying to more people.

The time is right for the high-tech world to attend more closely to the needs of humanity. Many people are not satisfied with current technologies that make them feel incompetent or unsuccessful. Others can’t benefit from technology because of high cost, unnecessary complexity, and lack of relevance to their needs. The new computing must be innovative, and it must focus on raising user satisfaction, broadening participation, and supporting meaningful accomplishment. All this is becoming possible today because the underlying technology is at hand and researchers are finding better techniques to discover what people want.

Computing technology is at a crossroads. The British scientist C. P. Snow wrote about the troubling split between science and art in his lecture on “Two Cultures.” He identified a modern dilemma that should be resolved with a second Renaissance, or maybe Renaissance 2.0. This modern Renaissance would unify thinking about technology by promoting multidisciplinary education and a sympathy for diversity. It would emphasize collaborations that enrich us with fresh perspectives and foster partnerships that enable us to create more freely.
However, linking the high-tech world more closely to the needs of people still requires some new forms of thinking. The Renaissance integration of disciplines that Leonardo da Vinci exemplified could guide us in repairing the split in our modern world. Leonardo integrated engineering with human values. He blended science and art to produce graceful drawings of human anatomy, flowing water, and innovative machines. Leonardo-like thinking could help users and technology developers to envision the next generation of information and communication technologies.

The creative genius of Leonardo da Vinci (1452–1519) has inspired technologists, scientists, and artists for more than half a millennium. His Renaissance integration of engineering with human values could be the path to appealing artifacts and provocative dreams.

What I like about Leonardo is that he was more than just a Renaissance geek. His playful side flourished in performing on the lyre and staging musical events. He even fabricated theatrical sets, complete with dancing lion puppets. This combination of skills delights us even today and can suggest future toys and entertainment.

Leonardo appreciated the importance of ambitious visions. His massive bronze horse to honor the father of Ludovico Sforza of Milan was intended to astound viewers with its size, its accurate anatomy, and a graceful ferocity that celebrated courage and strength. However, casting a 24-foot-high statue was beyond the capabilities of fifteenth-century metalworkers. Leonardo, undaunted, planned to make the casts in components. He built a plaster model to impress onlookers and promote the project, but politics interfered and in 1499 the invading French archers destroyed it—merely for target practice. What are the dreams we have for ambitious and inspirational technology projects?

We still admire his skill in producing treasured artworks. The dramatic fresco of the Last Supper pleases us with a composition of architectural space that uses perspective to frame the detailed portraits of four groups of three apostles, each with compelling emotional expressions. Leonardo mastered the artistic methods of light and shadow, the mathematical elements of symmetric alignments, and the iconic power of downturned hands and upraised arms. By comparison the iconic language of graphic user interfaces and the World Wide Web seems impoverished. Where are the graphics geniuses and the Web-designer Leonardos whose work stirs and thrills us?
During his lifetime, Leonardo was famous for his public art pieces and his portraits, although we know him also for his inventions of helicopters, submarines, and other mechanical devices. His engineering innovations were often a secret, locked in his notebooks with his medical drawings, insights about geology, optics, hydraulics, and much more. Over the centuries many people have been struck by Leonardo’s integration of art with science, and aesthetics with engineering (Kemp 2000).

His notebook pages demonstrate the benefits of integrating graphics and text, and his analyses testify to the power of combining visual and analytic thinking. And now again, five hundred and fifty years after his birth, this combination of skills inspires us—this time to envision information and communication technologies that are in harmony with human needs. In this book, I propose Leonardo as an inspirational muse for the new computing.

LEONARDO’S HUMBLE START

Uniquely, he was able to see science from the perspective of an artist, to visualize art with the mindset of a scientist; and architecture with the mindset of the artist-scientist. If there is one simple defining skill that distinguishes Leonardo, it is this most useful of talents.

—Michael White, Leonardo: The First Scientist (2000), 125

Leonardo began life humbly on April 15, 1452, as the illegitimate son of Ser Piero, a notary in the modest town of Vinci in Italy’s fertile Tuscany. Early on, Leonardo impressed his teachers with his rapid learning in math, music, singing, and drawing. When Ser Piero took some of Leonardo’s drawing to the great artist Andrea del Verrocchio, Leonardo was invited to apprentice in Verrocchio’s workshop.

Giorgio Vasari’s (1511–1574) flattering biography of Leonardo, first published around 1550, rhapsodizes about young Leonardo: “possessing so divine and wondrous an intelligence, and being a very fine geometri- cian, Leonardo not only worked in sculpture but in architecture. . . . He drew so carefully and so well on paper that no one has ever matched the delicacy of his style” (Vasari 1998). In a famous story, Verrocchio comments that Leonardo’s completion of an angelic figure was so masterful that Verrocchio considered giving up painting. But Leonardo responded
graciously that it was the greatest compliment to the master that the student should exceed the master’s ability. The model of teamwork in Verrocchio’s studio probably influenced Leonardo to build a community around him that later in life included the noted mathematician Luca Pacioli as well as devoted younger artists such as Andrea Salai and Francesco Melzi.

Leonardo’s remarkable capacity for observation was supported by a purposeful focus that led him to ask the right questions. His sharp eyes and mind enabled him to make discoveries and innovations in fields as diverse as medicine, aeronautical engineering, and geology. He was the first to accurately draw and recognize the role of curved spines in humans (figure 1.1), and shocked many with his drawing of a fetus inside a womb (figure 1.2). Leonardo’s keen observation of birds led him to make sketches of a parachute and a crude airplane that were four hundred years ahead of his time. His integrative spirit was not unusual in Renaissance Italy, where a conscious blend of scientific invention with aesthetics was common. Logic and art were partners; mathematics and music were collaborators.

But beyond integrating disciplines, Leonardo had a distinctly inquisitive mind and capacity for independent thinking that led him to go further than his contemporaries in many topics. For example, he considered why seashells were found in the Tuscan hills. Contemporary wisdom said that the seashells were washed up into the mountains during the Biblical flood. However, Leonardo noticed seashells at many sedimentary levels and correctly guessed that the Tuscan hills had once been under the ocean. This is accepted twentieth-century science, but it was heresy in the fifteenth century, when church doctrine was still founded on the unchanging nature of the earth. Challenging these deep beliefs took an independent mind and a courageous spirit. Galileo (1564–1642) suffered terribly for merely raising the possibility that the earth might revolve around the sun, a possibility first raised seriously by Copernicus (1473–1543).

The same skills of observation and systematic inquiry empowered Leonardo to draw and paint remarkable images (Clark 1939). He would walk the streets of Florence and return at night to sketch twenty accurate and sympathetic portraits of the peasants and elderly citizens he had seen. His paintings depicting *Mona Lisa* (figure 1.3) and *Ginevra de’ Benci* (figure 1.4) fascinate viewers because the compelling faces reveal subtle emotions that invite lengthy contemplation. Leonardo’s portraits can be


1.4 Leonardo’s portrait *Ginevra de’ Benci*. Ailsa Mellon Bruce Fund, Photograph © 2001 Board of Trustees, National Gallery of Art, Washington, D.C.
interpreted as smiling or smirking, contented or contemptuous. The precise facial details are complemented by the careful choices of background plants, such as the juniper tree, which is *ginevra* in Italian. The orderly compositions in his paintings and frescoes guide the viewer’s eyes, demonstrating Leonardo’s mastery of architecture and detail. If you visit the Louvre in Paris, you can see the elaborate installation honoring *Mona Lisa*, or if you travel to the National Gallery of Art in Washington, D.C., you can join the crowds in front of Leonardo’s portrait *Ginevra de’ Benci*.²

I would have loved to have seen Leonardo at work. He was an endless doodler, sketcher, and dreamer who tucked several notebooks of varying sizes into his waist belt to record his thoughts. He had small notepads, assorted notebooks, and large folders with fine parchment folios. Scholars estimate that he filled 13,500 pages, of which less than 5,000 survive. His sketches for a submarine and for a helicopter reinforce the characterization of Leonardo as an innovator who was far ahead of the available technology (Wallace 1968).

Leonardo was also a fine self-promoter, exemplified in his consultant’s pitch to Ludovico Sforza in Milan, offering to help design war machines, defensive walls, and the massive bronze horse. Leonardo’s letter to Sforza shows his capacity to make a convincing business presentation, but in the main Leonardo was devoted to his scientific pursuits, filling his notebooks with observations and speculations. In Sforza’s court and later as he traveled, Leonardo kept a household entourage of varied characters. Vasari, always ready to make a compliment, wrote, “His generosity was so great that he sheltered and fed all his friends, rich and poor alike, provided they possessed talent and ability.” His late delivery of projects was legendary and his unfulfilled promises made him an easy target for critics. Still, Leonardo was revered in his day and remains a muse who can inspire creative endeavors (Gelb 1998).

During his last years, Leonardo was the honored guest of the French King Francois I, at Amboise. Although he lived in royal surroundings, when Leonardo died at the advanced age of 67, his will contained an unusual request. He wanted to express his lifelong sympathy for the poor and be honored by a funeral procession that included sixty peasants carrying torches.

Leonardo would have been amused that in 1994, Bill and Melinda Gates bought 72 pages of Leonardo’s writings, the Codex Leicester, for $30.8 million, and arranged for a well-financed exhibition tour to leading museums and an informative CD-ROM (Corbis 1997).
ENVISIONING THE NEW COMPUTING

The models of Leonardo’s inventions in Milan’s science museum provoke me to wonder, if Leonardo were alive today, how he would use a laptop and what kind of novel computers he would design. Would Leonardo be employed by Apple to “Think Different” or by Intel and Microsoft to give Windows a Renaissance 2.0 look and feel? Certainly, Leonardo’s visual thinking would be important in shaping modern computing environments.

Inspired by Leonardo’s penchant for portable notebooks, and larger sketchbooks, and by his frescoes, we as users and technology developers might imagine the need for a comprehensive line of computers from small but elegant wearable devices to ornate desktop machines and impressive wall-sized models. Keeping in the spirit of Leonardo, each new computing model would be delightfully entertaining and compellingly useful. A modern Leonardo of software might be inspired to pursue projects such as a precise 3D medical simulations with tactile feedback that lets you crawl through the human body, a complete environmental model of the world to study global change, and a building-sized FrescoMaker drawing package.

The medical simulation would show precise details and allow you to explore down to the level of each muscle cell and nerve synapse (Nuland 2000). You would be able to see each cell functioning, watch genetic processes, and find new relationships. The environmental model would allow you to try a thousand alternative management policies in an hour and communicate them easily to colleagues and decision-makers. The modern FrescoMaker would allow easy reworking of images until every dangling curl of hair was just right, even on a thousand-foot high building facade.

The new computing technologies would include wall-sized displays, palmtop appliances, and tiny jewel-like medical sensors and fingertip computers that change your sensory experiences and ways of thinking. Your understanding of the world would change when you watch an HIV virus invading a healthy cell or a genetic drug stopping a breast cancer. Your health would improve when tiny sensors assure you that the tasty bite of raspberry ice cream has low enough cholesterol to suit your diet.

New computing will immerse you in dramatic projected experiences or it will become invisible, as the technology is embedded in common devices or inserted under your skin. Mobility and ubiquity will become
accepted and expected. New computing will enable you to gather the names and e-mail addresses of everyone in a room who gives their permission and to send them all copies of your slides or home page. The movement from independent work to collaboration with distant colleagues will be seamless.

When you plan a trip, you can select itineraries based on your complete travel history with records of your preferences for cities and natural locations balanced with profiles of new museums, scenic parks, or tranquil beach resorts. You can choose historic or natural sites based on comments from people you trust and interview local guides whom you hire for their colorful personality or botanical knowledge. Your planning will create travel experiences that are more emotionally intense and memorable.

When you travel—even while en route supersonically at 40,000 feet or at your remote destination—the new computing will enable you to record and share your experiences with family or colleagues. They’ll be able to see what you see, hear what you hear, smell what you smell, and experience your excitement. When you point your palmtop digital guides at the Alamo Monument or the Suez Canal, you’ll get a historical, political, or geological summary. Then you can read comments from previous visitors, look at nineteenth century photos, or leave a record or your impressions for others.

When you point your IdentiCam at a bright yellow flower, its name and description will appear. When you point at a red, white, and black striped snake you’ll get a warning that “coral snakes are poisonous.” The record of your journeys will be preserved using automatic TravelTemplates that combine your photos with professional ones. When you get home, you’ll be able to reexamine your climb up Mt. Kilimanjaro or reminisce about your working side-by-side with a Japanese pottery master.

You will have greater choices when you follow sports teams, take up hobbies, and indulge in Web-based entertainment. You won’t have to limit yourself to local teams but could follow playoffs anywhere in the world, replay historic tournaments, and simulate games with players selected from any time in history. Families will create detailed multimedia histories, vividly relive weddings, and reenact key events in their ancestors’ lives. You won’t be able to go back in time, but you will have an intense appreciation of who your ancestors were and how they lived their lives. You’ll share these multimedia histories with family
and friends using open directories that only your family members can access.

And beyond information and communication, the new computing will emphasize innovation, or maybe e-novation. Computers are tools for doing and making. They fit comfortably with the Renaissance definition of *homo faber*, man the maker. The new computing software that supports innovation will provide exemplars of excellence for you to build on, templates for getting started, and processes for guiding your creative experiences. Even as a novice you’ll be able to perform better than today’s experts.

**THE OLD COMPUTING GIVES BIRTH TO THE NEW COMPUTING**

Looking to the past is often a good way to see to the future. During the early development of computers, technology promoters were in the driver’s seat. Their destinations were large-scale engineering projects for military or industrial purposes. These founders of the old computing overcame technological limitations to build impressive projects and then turned to producing tools for themselves, giving little thought to the needs of other users.

By the 1980s, with the advent of the personal computer, the steering wheel of innovation was taken over by those who recognized the importance of considering diverse user needs. These spirited innovators came up with the hot products that opened the doors to a wide range of users: graphical user interfaces (GUIs), the World Wide Web, online communities, instant messaging, information visualization, and e-commerce. This shift has accelerated in recent years, and future breakthroughs are likely to come more often from those who put users first.

Of course, we still need good work from professionals of the old computing to create faster processors, larger databases, and more reliable networks, but I believe that the significant future advances will emanate more frequently from thinkers who are in tune with the new computing. They are more likely to recognize and respond to broad markets in which tools to empower users include collaborative experiences, entertainment, and aesthetics.
Progress is already being made in improving users’ experience of computing, but too many people still find computers to be frustrating. This book is designed to raise your expectations of what you get from information and communication technologies. It presents a vision of truly helpful technologies in harmony with human needs. You have needs to communicate with friends, organize family vacations, or find information about your health problems. You want to collaborate with professional colleagues, participate in your local, national, or international communities, and find the best deal for your next car. You should be able to do all these things and much more in a hassle-free and confident way. Your attention should be on your goal, not on the technology you are using to accomplish it.

But too often, the old computing designs produce confusion and frustration. Too often they have incomprehensible terminology, poor online assistance, and nasty failures. Too often the complexity of networks, the layers of applications, and the fragility of software result in untimely crashes and unhappy users. These experiences generate anxiety about computers, resistance to using technology, and fear of losing control.

The challenge for new computing developers is to understand what you, the user, want and to help you get it. Developers can then design information and communication technologies that enable you to achieve your goals rapidly and gracefully in an atmosphere of trust and responsibility. You should be able to trust the information sources that you consult, the deals you are offered, and the privacy you are promised. You should be able to take responsibility for your decisions and for your communications to others. The underlying systems should provide an infrastructure that generates a user experience of reliability and security so that you can concentrate on your work and relationships. This transformation is proceeding in leading research centers and progressive companies, but it does meet resistance. In order to encourage the spread of new computing ideas, it will be helpful to understand and make explicit the underlying changes of attitudes.

The first transformation from the old to the new computing is the shift in what users value. Users of the old computing proudly talked about their gigabytes and megahertz, but users of the new computing brag about how many e-mails they sent, how many bids they made in online auctions, and how many discussion groups they posted to. The old computing was about mastering technology; the new computing is about
supporting human relationships. The old computing was about formulating query commands for databases; the new computing is about participating in knowledge communities. Teachers no longer cover the subject; they guide learners to discover it. Salespeople no longer sell products; they form customer relationships.

The second transformation to the new computing is the shift from machine-centered automation to user-centered services and tools. Instead of the machine doing the job, the goal is to enable you to do a better job. Automated medical diagnosis programs that do what doctors do have faded as a strong research topic; however, rapid access to extensive medical lab tests plus patient records for physicians are expected, and online medical support groups for patients are thriving. Robots to clean your home are still a playful fantasy, but music downloads and Web-based family photo albums are booming. Natural language dialogues with computerized therapists have nearly vanished, but search engines that enable users to specify their information needs are flourishing. The next generation of computers will bring even more powerful tools to enable you to be more creative and then disseminate your work online. This Copernican shift is bringing concerns about users from the periphery to the center. The emerging focus is on what users want to do in their lives.

As technology developers acknowledge these two transformations, they will more easily understand the new goals. Short-term benefits will emerge in already ascendant applications such as e-learning, e-business, e-healthcare, and e-government services. Longer-term innovations will appear in new forms of employment, interactive entertainment, decentralized political organizations, and empathic online communities.

To spark our imagination about the new computing, let’s go further and explore how an extraordinarily creative historical figure, like Leonardo, might reflect on computers. Wouldn’t he put people at the center and think about how to apply technology for their benefit? Leonardo wrote boldly, “Work must commence with the conception of man” (White 2000, 166), and he characterized the “four universal states of man” as “mirth, weeping, contention, and work.” His attention to emotional states and activities would make him a good user experience designer.

So, taking Leonardo as our inspirational muse, we can wonder how his thinking would influence our use of technology. How might Leonardo’s integrative approach that blends science and art lead us to new technologies, applications, and designs?
These questions might guide you in thinking about how a truly beneficial technology might reshape your life. They steered me to examine how I could apply a user-centered view to accelerate technology evolution. Such questions could propel developers to get past old ways of thinking that are stuck on the old theme of making impressive computers. They would do better by considering new ways of thinking about facilitating and empowering users. The key questions are not whether broadband wireless networks will be ubiquitous, but how your life will change as a result of them. Life choices come first, technology second. Enduring values should govern technology evolution.

ABOUT THIS BOOK

To reach the goal of promoting human values, we need to build a solid foundation that supports human needs and aspirations. The supporting technology foundation begins with better designs that generate better user experiences with common tools such as word processors, e-mail, and Web pages. Current designs are often too difficult to use. Too many users experience anxiety and frustration when their computers crash, when they can’t open e-mail attachments, and when they inadvertently lose their last hour of work. Faster processors and higher bandwidth networks will not save the day—too many designs are unusable at any bandwidth (see chapter 2). So the first step toward the new computing will be to promote good design by getting angry about the quality of user interfaces and the underlying infrastructure. This public outcry can pressure industry leaders and designers to improve their software designs in applications such as word processors and the reliability of support environments provided by operating systems and networks. These changes will accelerate learning and performance while reducing confusing dialog boxes, frustrating crashes, and incompatible data formats.

The second step toward the new computing is inclusiveness, what I call universal usability, enabling all citizens to succeed in using information and communication technologies to support their tasks (see chapter 3). This goal leads to designs that support users with new or old computers, fast or slow network connections, and small or large screens. It should make possible participation not only by young and old, novice and expert, able and disabled, but also those yearning for literacy, over-
coming insecurities, and coping with varied limitations. Responding to these digital divide challenges will take hard work, but we have come to learn that diversity promotes quality. Accommodating diversity pushes designers to produce higher quality for all users.

If universal usability were achieved, more people could benefit from technology more often. But universal usability is still a dream, a wish, and a hope. The three challenges to designers, managers, and teachers are to support a wide range of technologies, to accommodate diverse users, and to help users bridge the gap between what they know and what they need to know.

Getting adequate public pressure for good design and universal usability during the product development process is the third step. Too often, well-intentioned product managers or software engineers ignore recommendations from human factors and usability professionals. These managers bypass appropriate evaluation processes and choose easier-to-implement design choices. The evaluation processes involve usability testing with real tasks and real users followed by continual monitoring to refine products. The design choices emphasize comprehensible, predictable, and controllable interfaces (see chapter 4).

With these fundamentals in place we can turn to thinking about the future and what we want from the next generation of technology products. Leonardo’s inspiration might promote the new computing by encouraging deeper understanding of human activities and relationships. Chapter 5 offers just such a fresh framework for thinking about innovation. It offers an activities and relationships table that could be helpful to users in thinking how to use existing information and communication technology, and to designers who are inventing novel products and services. The columns of the table cover activities such as collecting information, communicating with other people, creating something novel, and sharing it with others. The rows of the table suggest the range of relationships, from intimate friends and family, to colleagues and neighbors, and to broader communities of citizens and markets.

Applying Leonardo’s phrase that “work must commence with the conception of man” will push us toward a user-centered design process, with technology on the periphery. Encouraged by Leonardo’s interests in learning, his engagement in commerce, his obsession with medicine, and his concern for socially beneficial outcomes, I choose four likely directions for near-term innovations. For each hopeful vision there are many challenges embodied in my provocative rhetorical questions:
Collaborative education and online courses will be disseminated widely, as universities and companies make face-to-face classroom experiences more intense and expand their audiences with distance and online education (see chapter 6). How can students take greater responsibility for their own education? Why shouldn’t teachers have higher expectations for student accomplishment and creativity? Why can’t every student earn an A?

Dramatic shifts in business have already occurred with the emergence of e-business (see chapter 7). Customer relationship management and personalized marketing are indicators of the new opportunities for merchants and customers. Online catalogs, customer service, and purchasing interfaces for e-business, e-services, and e-entertainment will expand rapidly, as will e-complaints. Why shouldn’t you get the deal you want?

The increased responsibility of students is matched by the increased responsibility of patients in the new medicine, sometimes called e-healthcare (see chapter 8). Well-informed patients who seek specialized treatments or participation in clinical trials are challenging the dominant position of physicians and healthcare providers. Two-way telemedicine and healthcare information resources will grow dramatically as patients, nurses, doctors, and health management organizations all go electronic. Why shouldn’t advanced networks with adequate privacy protection enable your medical records to be available in every emergency room? Why shouldn’t your physician create a special treatment plan for you? Why should you ever be sick?

The new politics are apparent in more potent public interest groups, livelier political discussion groups, and greater access to government officials. The rapid push toward e-government services will make it easier for people to search vast government digital libraries, influence legislation, and apply for disaster relief funds (see chapter 9). Political deliberation will promote advanced designs that could support rational discourse among millions of citizens while minimizing disruptions. How can citizens make governments even more responsive to their needs while preventing government bloat and unnecessary regulation? How can citizens be heard? Why shouldn’t you get what you want from government?
These four applications—e-learning, e-business, e-healthcare, and e-government—take care of basics, but many other applications are also important. We could go further with e-entertainment, e-travel, e-justice, and e-everything, but I hope readers will be able to extrapolate.

An ambitious goal for the new computing is to support your creativity in many domains: sciences and the arts, composing and performing, and work and entertainment. Computers won’t ever have Aha! moments; only people are capable of experiencing that joy. However, computers will support your access to previous work, consultation with peers and mentors, rapid generation and exploration of proposed solutions, and dissemination within the field (see chapter 10). They can help make more people more creative more of the time.

The pull of creativity is strong because the satisfactions and rewards can be large. The struggle to solve a problem can be frustrating, but the thrill of success is often proportional to the intensity of the struggle. For some people, the urge to create is so strong that life is unfulfilling if they cannot create. An old Greek aphorism captures this strong connection in a positive way: “Art is life; Life is art.”

The University of Chicago psychologist Mihaly Csikszentmihalyi (1996) uses the term flow to describe the engaging experience of responding to appropriate challenges: Your absorption is total, the world disappears, time is irrelevant, and your skill is applied entirely to writing a song, making pottery, or playing basketball. It is a thrill!

Creativity support tools can help novices perform at the level of experts, and enable experts to innovate more ambitiously. They expand the possibilities for artists, musicians, poets, playwrights, and journalists to sketch bold ideas, compose fresh symphonies, and write compelling poems. Creativity tools enable scientists, engineers, architects, physicians, and lawyers to analyze more deeply, design more thoroughly, and disseminate more widely. They allow you to do your job as a teacher, student, manager, and salesperson in ways that give you greater freedom to reflect, integrate, and produce. Creativity tools support exploration, discovery, innovation, invention, and more. In the words of Star Trek, the goal for many people is “to boldly go where no person has gone before.”

Such bold and broad expectations are difficult to satisfy, so the vision I offer in this book will be an enduring challenge. The good news is that existing software provides a good foundation to build on. Of course, there are many problems with contemporary software that need to be overcome, and change is difficult. I try to lay out the possibilities and
provide a framework for the next generation of user experiences. The same framework gives you the concepts by which you can organize your work with existing tools. I hope to convince you to join in pushing developers to provide needed improvements.

The book closes with questions and proposals to help us reach still grander goals. Can technology be designed to support peaceful outcomes, conflict resolution, or violence reduction? Can computers support reflection as well as action? self-awareness as well as compassion?

THE SKEPTIC’S CORNER

Advanced technologies have the potential to promote positive contributions, but they also can support the dark side of human nature. Information and communication technologies have been used to disseminate hateful and racist messages. They enable users to spread lies and encourage prejudice. They can alienate children from families, violate privacy, and spread pornography.

Poorly designed information and communication technologies cause frustration, confusion, and anger, as well as contribute to social exchanges marked by hostile comments. Technology flaws have caused deadly errors in medical care, troubling delays in air traffic, or disruptive losses of data and services. Networking has benefits but also allows computer viruses to spread across our vulnerable networks and error messages that warn of a failed hard drive that has entombed all our data.

These unhappy realities do not have to remain forever a part of our technology experience. User groups can pressure manufacturers, developers, and suppliers of information and communication technology to build better environments, just as they have pressured industry to build safer automobiles and more environmentally friendly factories. Skeptics do not believe that the course of technology can be changed. They see competitive market forces and malevolent corporate power to be unstoppable. Dystopian critics fear that things will get worse. They fear that society will fragment along ethnic lines, digital divides will grow across economic gaps, and freedom of choice will recede.

Without a fundamental change in values inspired by a Leonardo-like blend of human-centered design, aesthetics, and engineering, there is a danger that future information and communication technologies could
further raise barriers between disciplines and widen the gulf between diverse communities. Without an inspirational muse like Leonardo, poor designs could increase user frustration, erode emotional contacts and undermine empathetic encounters. Without Leonardo’s “spiritual kinship for the underprivileged” (Frere 1995, 9) computers could become tools restricted to highly trained specialists and small elite groups. Without Leonardo’s clarity of thinking, computers could become complex machines with unpredictable agents launched by confused users. Some users would benefit by being able to master the complexity and overcome the barriers, but most users would have little control and flexibility to explore alternatives or pursue their dreams. As the perceived complexity of technology grows, user empowerment fades. As unpredictability proliferates, user responsibility deteriorates. Users could become victims of the machine.

These dark scenarios could be avoided by giving more attention to the muse of the new computing. The Leonardo muse would be on the side of clarity, simplicity, and beauty. Leonardo’s Renaissance spirit, one that combined science and art, could influence the evolution of the new computing in a way that blends advanced technologies with human concerns. The new computing could support creative endeavors while accommodating varied working styles. It could promote participation by culturally diverse users whose complementary knowledge and skills contribute to more creative solutions. I will not promise that every user will become a Leonardo, but for those of you who seek to be more creative and want to build a better world, technology can be a remarkably helpful tool.

Skeptics may also argue that changing the dominant values among technology developers from the old to the new computing is impossible. It is not easy, but the evidence of recent years is that user-centered designs can be the winning strategy.3 Another challenge is that proposing high-minded concepts about improving quality and labeling them the new computing is the simple part, but the realities of software implementation are much more difficult. This is true. I do not underestimate the challenge nor the good intentions of software professionals, but too often the goals of improved quality are given too little attention.

Finally, even if these tools are wonderful and helpful, low or no technology may be the wiser choice in many cases. The therapeutic benefits of walking in the woods, holding a baby, and talking to your friends should always be respected. Natural surroundings, solitary reflection, and intimate caresses are also important human needs.