

INFINITY IMAGINED

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Anyone who followed the “canon wars” of the late eighties knows that history departments and literature seminars have been experimenting with a new form of historiography in recent years: subaltern studies, people’s histories, “archaeologies” of the past—all told from the viewpoint of groups usually silenced in traditional accounts. The cast of characters is familiar by now: factory laborers, the mentally ill, Native Americans, working women, criminals, gays and lesbians—the whole parade of “otherness” championed by progressive thinkers and ridiculed by back-to-the-canon conservatives like William Bennett and Dinesh D’Souza. Maybe it’s time to add to that list the ever-growing dustheap of obsolete technologies—not only the machines that were outmoded by sleeker or better-marketed competitors, but also the machines that never found a market at all, despite possessing superior technology. If our social history now belongs to the outcasts and the oppressed, then perhaps our high-tech history is due for the same reversal of fortune.

What would this kind of history look like? For the most part, it would be dominated by cranks and tinkerers,

the sort who file for a hundred patents in a lifetime and never make a penny for their labors. The armchair inventor and the gadget freak didn’t preside over the lore of nineteenth-century capitalism the way the dashing young man about town did, but the figure of the neighborhood tinkerer certainly had its moments. Most of us remember the ending of *Madame Bovary* for the heroine’s suicide at the hands of pulp fiction, but the novel actually ends with the pharmacist Hommais—the amateur inventor and full-time crank—being awarded the Prix d’Honneur. You can see this denouement as an emblem of Flaubert’s dark irony, or his obsession with the pathologies of “modern stupidity.” (What better antihero for *Madame Bovary*, a book about the illusions of the mass-marketed romance, than the bothersome, know-it-all next-door neighbor?) But you can also see in that ending a remarkable prescience. If Emma Bovary is the great literary ancestor of the modern tabloid-addled suburban housewife, Hommais belongs uniquely to his own era—all those gentlemen of leisure concocting new mechanical plowshares, or those precocious twenty-somethings experimenting with metallurgy and magnetism in sooty, lamp-lit chambers.

Seen from the right angle, Hommais turns out to be nothing less than an incompetent, Gallic rendition of Edison—the definitive icon of late-nineteenth-century entrepreneurial capitalism. And even Thomas Alva himself would play a prominent role in our alternative history of obsolete machines. The man may have powered up the first electricity grid and sung “Mary Had a Little Lamb” into the first phonograph, but the labs at Menlo Park and West Orange also produced a steady stream of duds alongside the success stories. This is to be expected, of course: significant inventions are like omelettes—you have to

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break some eggs to make them happen. But we would do well to spend some time contemplating those broken shells, to learn more about the discards and miscarriages, the “creative destruction” that propels all high-tech advancement.

You could build an entire academic press around this line of inquiry, though the end result might look more like a machinic freak show than a serious body of research. In the end, I suspect, the most interesting studies would gravitate not toward the cranks and useless gadgetry, but rather toward the legitimate visionaries and their breakthrough inventions—If only to show how hard it is to project outward from a major technological advance, to see beyond the mechanical details to the machine’s broader social consequence. Remember Edison’s description of the phonograph and its future applications? How many of those had anything to do with what phonographic technology eventually became useful for? Only a small fraction, of course—because technohistory is littered with unintended consequences and limited fields of vision. According to Edison, the record player was an upgrade for the telephone medium, an enhancement. Perhaps people would occasionally listen to prerecorded music on the device, but for the most part, Edison thought, they’d be sending each other dictated letters through the postal system—like today’s voice mail without the immediacy.

As always, “the street finds new uses for things.”

What’s remarkable here is not that the street appropriates the technology but that we have such a hard time envisioning those appropriations before they happen. It’s as though the sharp, luminous shock of revelation—the eureka moment of all inventor mythology—carries with it a certain haziness, a glare that blocks out as much information as it reveals. You stumble across a way to record voices, but you can’t see what

it’s good for. You predict the rise of the desktop PC, but all you can imagine it doing is filing cooking recipes. This is the hard bargain of life on the cusp of high-tech paradigm shifts: you’re blessed with a certain technical enlightenment, but it’s difficult to see much beyond that bright knowingness. Blindness and insight—you can’t have one without a solid dose of the other.

Nothing illustrates this point more powerfully than Vannevar Bush’s wondrous Memex device, now widely considered one of the PC’s venerable ancestors. As we saw in chapter 4, Bush’s speculations on the associative powers of the Memex anticipated much of the modern PC’s storage-and-retrieval capabilities, as well as the hyperlinks of the World Wide Web. But this is a selective, hindsight-driven reading of “As We May Think,” one that emphasizes the passages where Bush gets the future right and ignores the many sections where his vision is decidedly less clairvoyant. You can describe the Memex as an information processor that enables you to store old documents, write notes to yourself, organize data, and perform calculations—all while sitting at your desktop. That sounds a great deal like your everyday PC circa 1997. But you can also describe the Memex in a different fashion, punching up other elements in the mix, elements that seem less consequential to us now because they didn’t come to pass. Consider just this short inventory:

1. The user captures information via a small camera lodged on her forehead or her glasses, snapping pictures of documents as she reads them.
2. The documents are transformed by “dry photography” into small microfilm-style images, which are stored in the body of the Memex device.

3. The storage mechanism is a linear roll moving from left to right, with each frame on the roll containing thousands of miniature documents.
4. When the user is away from her desktop, she enters text into the device using spoken words, transmitted via radio communication.

The list could go on. (Bush spends several pages at the essay's outset exploring the technical possibilities of dry photography, a reproduction method that has absolutely nothing to do with the modern computer.) In each instance, the machine described appears to be a completely different species from the modern desktop PC—more like a souped-up microfilm device that has been crossbred with a photocopier. Some might consider this a matter of quibbling over minor details. So what if Bush didn't anticipate the microprocessor or the video monitor? Surely it's enough that he came up with the basic vision of a desktop information processor. After all, no one else at the time had managed such a remarkable imaginative leap. Who cares if he happened to be distracted by the red herrings of dry photography?

These objections might be more persuasive if the Memex's dry-photography foundations didn't have such profound consequences for the device itself. The photographic medium is static, immutable—you take a snapshot of a page and it's frozen in that form forever. In Bush's system, even the notes entered directly by the user were captured on microfilm and remained crystallized in that original state for the rest of their existence. You could "interact" with documents by linking them to other documents using Bush's brilliant system of "trails"—but you couldn't actually *edit* them, change words around, add paragraphs, delete whole passages. You could orga-

nize documents using the powerful associative tools that Bush conjured up, but you couldn't manipulate their contents. This was no minor oversight. The ability to alter the content of a document—experimenting with different phrasings, rearranging things, cutting and pasting—this may be the defining characteristic of the digital computer, what separates it from its mechanical predecessors. Imagine a word processor or a spreadsheet that let you enter one draft of a document and then prohibited any subsequent alteration—it would be an appalling product, of course, but it would also suggest a fundamental misunderstanding of the digital medium, like an oven without a temperature knob or a radio tuned perpetually to one station. The power of manipulation is the sine qua non of the modern computer, its core competency. And Vannevar Bush missed it altogether.

I bring up this point not to take anything away from Bush's prophetic essay, but to introduce a larger argument about our own historical moment and this strange new medium of interface design. Bush, of course, described more of late-twentieth-century technology in that short essay than anyone before him—and for that he deserves pride of place in the annals of digital computing. (Indeed, as I tried to show in the "Links" chapter, today's interface designers would do well to be *more* faithful to certain elements of the Memex's architecture.) But for all his extraordinary insight, Bush couldn't see the PC's defining characteristic, the malleability of digital information. There is a lesson here for anyone who attempts to make sense of the high-tech world, a lesson that is close to the heart of this book's primary thesis. At the threshold points near the birth of new technology, all types of distortions and misunderstandings are bound to appear—misunderstandings not only of how the machines actually work but also of more

subtle matters: what realm of experience the new technologies belong to, what values they perpetuate, where their more indirect effects will take place.

Twenty years ago, the graphic interface seemed like a toy, virtual training wheels for computer novices. Now we readily accept it as a necessity for serious computing: functional and easy to use; an essential tool for power users and neophytes alike. But to go beyond that efficiency model and see the graphic interface as a medium as complex and vital as the novel or the cathedral or the cinema—that's an assumption that still requires some getting used to. The recent battles between techno-utopians and neo-Luddites have not helped matters much. One side announces that the Internet is the "greatest invention since the discovery of fire" while the other eulogizes the death of the slower, more introspective consciousness of print media. The cultural impact of new technology is hard enough to predict without the fury of manifestos obscuring our view. This, in fact, may be the most important lesson to draw from "As We May Think": not the dead-on predictions or the false leads, but instead the tone of the essay itself, which is sober, reflective, exploratory; intent neither on burying the past nor on renouncing the future. Vannevar Bush may have neglected a few critical elements of the modern PC, but the general sensibility of his prose should be a model for all techno-criticism to come.

What, then, are the blind spots of our own age? We have already encountered a few: the tyranny of image over text, the limitations of the desktop metaphor, the potential chaos of intelligent agents. But there is a more fundamental—and for that reason more difficult to perceive—blind spot in the high-tech imagination, and it has to do with the general region of experience that the interface is felt to occupy. Until very

recently, interface design belonged squarely to the geeks and computer hobbyists—a niche market at best. The rise of the Mac and Windows introduced a mass audience to desktops and icons, while the Web's popularity endowed browsers and hypertext with a certain subcultural sexiness. All these developments suggest a widening of the interface audience, but the medium itself still belongs to the world of functionality and increased convenience. We're subjected to endless advertisements promising us a miraculous digital future, and yet the scenarios they deliver tend to be remarkably mundane: ordering concert tickets, reviewing X rays from a remote location, sending photos to relatives by e-mail. There is a strange mix of narrowness and wild boosterism in this climate: we're reminded a dozen times each day that the digital revolution will change everything, and yet when we probe deeper to find out what exactly will change under this new regime, all we get are banal reveries of sending faxes from the beach.

The most profound change ushered in by the digital revolution will not involve bells and whistles or new programming tricks. It will not come in the form of a 3-D Web browser or voice recognition or artificial intelligence. The most profound change will lie with our *generic* expectations about the interface itself. We will come to think of interface design as a kind of art form—perhaps *the* art form of the next century. And with that broader shift will come hundreds of corollary effects, effects that trickle down into a broad cross section of everyday life, altering our storytelling appetites, our sense of physical space, our taste in music, the design of our cities. Many of these changes will be too subtle or gradual for most people to notice—or rather, we'll notice the changes but we won't perceive their relationship to the interface, because

the various elements will appear to belong to different categories, like so many aisles in a grocery store. But the history of technoculture is the history of such interminglings, the unlikely secondary effects of new machines rippling out to transform the society that surrounds them.

The most fertile historical analogy for this process is the invention of perspective in painting. When Brunelleschi and Alberti hit upon a way to create the illusion of depth on a two-dimensional surface in the early fifteenth century, you could see their techniques—the vanishing point, the picture plane—as just another clever *trompe de l'oeil*, a curiosity piece. Certainly, it was an improvement on the muddled visual space of medieval art, but artists were always coming up with new techniques to advance their craft: *chiaroscuro*, the camera obscura, pointillism. Perspective, however, turned out to be more than just a minor enhancement to the painter's repertoire. The mathematical studies of Alberti and Leonardo transformed not just the spatial language of European painting but also the role of the artist itself, elevating painting to a higher cognitive stature—closer to science or philosophy than to popular entertainment, and in doing so helped create the whole notion of the artist as intellectual. Perhaps more important, perspective centered the visual field on the human point of view, instead of a disembodied or divine locus, a shift that was limited in countless disciplines throughout the fourteenth and fifteenth centuries as scholars and artists and scientists grounded their work in the physical, lived reality of the human body. Perspective began as a technical innovation, but it eventually helped produce what we now call the Renaissance.

The discovery of information-space may engender a social transformation as broad and as variegated as the one

that followed Alberti's marvelous breakthrough. And that is why it is so essential that we acknowledge the medium's richness and complexity, its range of expression and its cultural import. Every major technological age attracts a certain dominant artistic form: the mathematical and optical innovations of the Renaissance were best realized in the geometry of perspective painting; the industrial age worked through its social crises in the triple-decker novel. This digital age belongs to the graphic interface, and it is time for us to recognize the imaginative work that went into that creation, and prepare ourselves for the imaginative breakthroughs to come. Information-space is the great symbolic accomplishment of our era. We will spend the next few decades coming to terms with it.

In the end, this book is only a preliminary survey of the field, a glimpse of the new medium in its formative years as it gropes uneasily for new ways to represent information. We can look forward to a great deal of maturation in our interfaces over the next few years. A decade from now the desktop metaphor may seem as quaint and bewildering to us as the command-line interface does now. On the other hand, certain interface elements may remain constant over time: the window, for instance, appears to have a certain durability—not unlike the Baroque frames that survived several generations of artistic fashion in the seventeenth and eighteenth centuries. Part of the point of this book, of course, is that we can't always predict what will change and what won't—that's one reason that the technology is so powerful. What is clear, however, is that the influence of this technology will extend well beyond the traditional scope of the computer interface, just as Renaissance perspective transformed more than the frescoes and basilicas of Florence and Rome. I have tried to

sketch some of those unlikely side effects and migrations in the preceding pages. The reader may judge whether they seem plausible, and history, of course, will grant us the final account.

While the details may change as the form evolves, I think it is possible to settle on a few broad themes or tensions in the interface medium—themes that will come to dominate both highbrow and lowbrow experiences of information-space over the next decade. I suspect some readers will already have detected other themes winding through the preceding pages; for clarity's sake, I have tried to deal only with the major threads here, the ones poised to dominate the field for some time. In other media, of course, such thematic oppositions are commonplace, and most of them end up outlasting the artistic movements that first brought them to the forefront of debate. The novel, for instance, has been wrestling with the demons of psychological depth ever since George Eliot and Henry James began to explore the full dimensions of late-Victorian mental life. (D. H. Lawrence once said that Eliot was the first to write novels where the most important events took place in the characters' heads.) The battle between introspection and social portraiture lies at the very heart of modernism, of course, and even extends to the vacant, brand-saturated wilderness of the K mart realists and other postmodern writers. At least a century of novel writing has agitated over that divide—so much so that the tension between inside and outside in modern fiction almost goes without saying now, a received idea last discussed in earnest during high-school American lit. But the theme itself still exerts an enormous influence over the way that we make sense of the novel as a form.

The problem with the interface medium at present—and this is one reason that we have trouble taking it seri-

ously as a medium—is that we don't have a language like this to describe it. For the most part, our evaluative criteria reduce to the bottom-dollar question: is it easy to use or not? There's invariably a bonus round for the cyber-slackers—is it cool?—but that's usually where the critique comes to a grinding halt. As I've tried to show in the preceding chapters, it's not that our interfaces are lacking in imaginative depth or complexity; it's just that we don't have the critical vocabulary to deal with them in anything but the most rudimentary terms. What follows is an attempt to sketch out a few major oppositions that will hold sway over the interface medium for at least the next ten years. Imagine these themes as templates of sorts, to be filled out by the detail work of countless interface artists to come. We need their labors and their insights to grasp the emerging stature of the interface medium, to see it in its full glory. As Eliot wrote in *The Mill on the Floss*, "The full sense of the present could only be imparted gradually by new experience—not by mere words which must remain weaker than the impressions left by the old experience."

Spatial Depth Versus Psychological Depth

In the spring of 1994, Broderbund Software released Robyn and Rand Miller's classic interactive adventure *Myst*, the gaming world's elegant and vaguely Borgesian ambassador to highbrow culture. Quickly dubbed the first "video game for adults" and the "*Ulysses* of CD-ROM," *Myst* attracted the kind of contemplative, sober analysis usually reserved for art films and literary biographies. The Miller brothers themselves seemed headed for certifiable cult status, auteurs for the digital age, a hybrid of David Lynch and J. R. R. Tolkien. But the hype led quickly to the inevitable backlash, and in November of that

year, the *Washington Post* ran a long story by its Pulitzer Prize-winning critic Michael Dirda that took issue with the game's inflated artistic reputation. As entertainment, Dirda argued, *Myst* offers a mixed bag: mediocre game play at a sedentary pace set against a lavish, fully-rendered backdrop. As a work of art, however, *Myst* didn't make the grade: "The characters are ciphers," Dirda wrote, "the language nearly nonexistent and the plot trite." In other words, gamers looking for stunning graphics will be well accommodated on *Myst*'s lavish isle, but aesthetes hankering for cutting-edge, digital art forms shouldn't purchase that CD-ROM drive just yet, given *Myst*'s limited offerings. If you're looking for psychological depth and literary complexity, Dirda suggested, you're still better off with the analog pleasures of Henry James and William Faulkner.

Dirda had a point, of course—the characters in *Myst* were as flimsy and low-resolution as the digitized clips they appeared in, and at the rare points where the writing was halfway decent, the lines were invariably mangled by the obligatory faux English accents of all CD-ROM acting. If this was supposed to be a *Ulysses* conjured up out of zeros and ones, then where was the cognitive depth of Joyce's novel, the ambulatory and absentminded central intelligence of Leopold Bloom or Stephen Dedalus? It was tempting to see in Dirda's critique an echo of Sven Birkerts's eulogy to the deep consciousness of the traditional novel:

As our culture is rapidly becoming electronic, we are less and less what we were, a society of isolated individuals. We are hurrying to get on-line, and the natural corollary to this is that the idea of individuality must come under siege.... In time

we will all live, at least partially, inside a kind of network consciousness.... Our spells of unbroken subjective immersion will become rarer and rarer, and may even vanish altogether

Reading Dirda's review alongside this passage, you wonder whether the flattening out of experience that Birkerts describes has met its symbolic match in the thin, undeveloped characters of *Myst*. We get the narratives we deserve, after all. If the hive consciousness of global networking has done away with "subjective immersion," then it's no wonder we're satisfied with the empty mental life of the Miller brothers' creation. We don't notice the limitations of the art because our own sense of self has been whittled away by the dark forces of perpetual connectedness.

This sounds like a compelling reading, but it is predicated on false assumptions. Like so much of contemporary interface design, *Myst* is primarily a spatial experience. If there is immersion, it is the immersion of locale, the strangely hypnotic feeling of exploring a terra incognita, of losing your bearings and then finding them again. The aesthetic pleasure of *Myst* is closer to the environmental jazz of certain architectural projects, where chance and disorientation are an explicit part of the package—environments like the Parc Villette installation outside Paris, or the eclectic sculptures scattered throughout Manhattan's Hudson River Park. (The lowbrow equivalent of all this, of course, is the densely imagineered rides of Disney World.) If there are no lifelike characters in *Myst*'s fictional world, that is because the world itself is more important than the characters that populate it. Denouncing *Myst* for its lack of character development is like finding fault

with an office building for its lack of emotional sophistication. We don't expect our architects to re-create the intensities of human consciousness—why should we expect anything more from our interface designers?

You can see this distinction most clearly in the popular forms of recent video games, like Sega's Sonic the Hedgehog franchise. The visual iconography and storylines of these games are literally cartoons, pitched at a ten-year-old's level of sophistication. Widely hyped as the "fastest game on the planet" when it was released in the early nineties, Sonic wasted almost no time with complicated puzzles or thumb-straining feats of manual dexterity. For the most part, you blindly whizzed along, scrolling at high speeds past a luminous backdrop, bouncing and plummeting and catapulting along the way. For all the kinesis, the hapless Sonic addict had little control over the onscreen character's actions: there were really only two options—jump and go faster—and pretty much any combination of those two would produce something interesting on the screen. The lack of control wasn't perceived as a drawback because the whole point of the game—what made it such a phenomenal success—lay in the sheer exhilaration of moving, and moving *fast*. You didn't so much play Sonic as ride it. Its genetic code was closer to a roller coaster than to a board game. Sure, there were levels you could advance to, and the occasional trapdoor or secret passageway, but these were largely vestigial elements, left over from the conventions of the game's more sedentary predecessors. The game was finally all about the rush and the intensity of moving through digital space; you didn't need puzzles or plotlines for that. The game captivated its audience for environmental reasons, not narrative ones. Subsequent blockbuster games—like Nintendo's lush, 3-D-rendered Mario

64—were merely variations on Sonic's original theme, performed with more advanced instrumentation. The space was what mattered. Everything else was incidental.

For the neo-Luddites, of course, this hardly satisfies as a defense of the medium. Even if you give up on the idea of psychological depth, surely there's something oppressive in the mindless acceleration of Sonic the Hedgehog and his ilk. An art form predicated on speed alone is bound to remain at the aesthetic level of roller coasters and amphetamines. As with so much of today's techno-commentary, the critique is half-right. If we were doomed exclusively to a succession of Sonic imitators, our future would indeed look bleak. But the information-spaces of Sega and Nintendo are only leading indicators in this field, a glimpse of the future conveyed to us by the modest means of the present. The audiences that roared along with *A Trip to the Moon*—Georges Méliès's 1902 special-effects extravaganza—could sense that something potent was in the works, but the idea that those jittery, flickering images would somehow evolve into *Citizen Kane* and *Vertigo*—or even *Jurassic Park*—would have seemed preposterous. Sonic and Mario are the precocious infants lying at the base of what will become a formidable family line. We can't predict what their descendants will look like, but we can be sure that the exploratory, spatial quality of the medium—the *haptics* of information-space—will be of enormous importance to that tradition, whatever it turns out to be.

Society Versus the Individual

All great symbolic forms address the conflict between the private self and the larger community that frames that self,

whether this valuation lies at the surface of the work or is buried somewhere in its underlying assumptions. Most architecture gravitates naturally toward larger congregations of people, just as most abstract art centers itself on private, subjective contemplation. There are exceptions, of course—I think of certain International Style skyscrapers that deadened the lively, civic interaction that had once existed on the sidewalks beneath them—but the more interesting cases tend to be those where the form itself is not hardwired to accentuate one over the other. The cinema, for instance, has a dual tradition of psychological depth and social extroversion: the wintry mindscapes of Bergman's *Persona* next to the intertwined, communal narratives of Altman's *Nashville* or *Short Cuts*. Most enduring cinematic works have been a balancing act of the two: the broad social sweep of Charles Foster Kane's publishing empire measured against the lost childhood of Rosebud; the vast international conspiracies of *Kluge* countered by the stark, direct-address shots of Jane Fonda talking through her problems on the therapist's couch.

For a long time, the interface medium has concentrated most of its energies on the individual, for understandable reasons. The personal computer was just that, a *personal* computer, designed from the ground up to be used by a single individual, which is why most modern graphic interfaces draw so heavily on the imagery of desktops and closed-door offices. That symbolic sleight of hand is rightly celebrated, but who knows what imaginative avenues it closed down to us. The desktop metaphor is by definition a monadic system; it belongs to the individual psyche the way Freud's case studies do, and that inwardness can make it harder to think in more social, more communal terms. Longtime Netheads never tire of talking

about the way the Internet explosion blindsided many so-called silicon soothsayers. (The first issue of *Wired* barely mentioned the Net.) Perhaps the success of the virtual desktop contributed to this myopia, a zero-sum game of sorts, where the rise in one model's fortune presupposes an equivalent, and opposite, reaction in the other. Surely thinking in the language of solitary rooms must, on some basic level, make it more difficult to think in the language of public spaces.

Interestingly, it turns out to be harder to represent communities using the tools of the modern graphic interface. There have been a number of attempts at extended metaphors: Magic Cap's 3-D office space opened onto a virtual "downtown" that represented all the user's online activities; Apple's e-World service dabbled tantalizingly with a "town square" metaphor. Both designs were hyped heavily at their launch and then quickly fizzled. The irony is that to this day, some of the most engaged and elaborate virtual communities on the planet rely on text-driven interfaces that wouldn't have looked out of place in the seventies. (Most members of ECHO and the Well still rely on command-line interfaces for their digital socializing.) This can be taken as yet another sign that the power of text is underestimated by today's reigning design orthodoxy, but it should also be seen as a call to arms for the next generation of interface designers, a genuine problem in search of a solution.

Already the VRML worldsapes and the floating orbs of The Palace suggest that new metaphors are on the way, though most such virtual spaces have the air of a product demo about them, a proof-of-concept for a concept that still needs proving. Do people really want the environmental trappings of lived space—the lavish furniture, the gothic chambers, the glittering city lights—surrounding them as they type to each other,

or are these merely fringe benefits, distractions from the main event of live chat itself? The most promising recent designs have broken away from the more predictable models of town squares and watercoolers, abandoning fully realized environments for the two-dimensional, static frames of the funny pages. Microsoft has a wonderful product called ComixChat that dresses up participants with the onscreen visages of cartoon characters and scrolls through the conversation in thought balloons. There's something immediately appealing about the comic-strip metaphor: a sense of it working on the right *scale*. If the language of live chat is necessarily stripped down to the abbreviated essentials, then perhaps it's only fitting that the visual accompaniment be flattened as well. A chat-room pickup exchange that takes place in an ornate ballroom makes as much sense as spray-paint graffiti propped up against the wall of the Louvre (pace Jean-Michel Basquiat). Even if the visual metaphor is a compelling one, the context can overwhelm the conversation.

Mainstream Versus the Avant-garde

Nothing will propel the interface toward the status of art more quickly than the development of a functional interface subculture—small pockets of designers working in opposition to the mainstream. Coherent, self-styled avant-gardes first appeared in the metropolitan cities of eighteenth- and nineteenth-century Europe, most notably in Paris. The two worlds of subculture and mainstream have existed ever since in an uneasy, but generative relationship: the avant-garde's flair for novelty prodding the dominant culture's more conservative inclinations, a system of checks and balances that is by now so commonplace that we can barely imagine an alternative. If it is sometimes dif-

ficult to accept the artistic aspirations of the interface medium, its lack of an intelligible subculture may be at least partly to blame. For it is the condition of any nascent medium that the innovators and the establishment be indistinguishable during its formative years. (It took television nearly thirty years to cultivate a genuine avant-garde of video activists and performance artists.) Interface design has had its fair share of wayward visionaries who never made a dime off their insights (Doug Engelbart and Ted Nelson come to mind), but for the most part its major breakthroughs have been targeted at mass audiences. The system still rewards commercial success over any other potential attribute. Art for art's sake doesn't exactly open doors for you among the venture capitalists of Silicon Valley.

But the very technological advances bankrolled by those VC funds are going to change all this, and nowhere more profoundly than on the Web, where the barriers to entry are so low as to be nonexistent. In the days of Xerox PARC, you needed an entire research department to dabble in interface design, and finding an audience for your new information-space required prodigious distribution resources. On the Web, the latest visual metaphors can find their way into circulation for a tiny fraction of the cost, which means that more experimental forms—forms more interested in pushing the envelope than pleasing the masses—will naturally prosper in this environment. Much has been said about the self-publishing revolution made possible by the Web, the egalitarian dream (or nightmare) of a nation populated by millions of living-room pundits. But the real revolution unleashed by HTML may well be the democratization of interface design. The task of imagining information will no longer belong exclusively to the high priests of programming; anyone moderately comfortable with a PC will be able to concoct his or

ber own infoscapes, and share them with friends or colleagues. Out of this more open-ended system, a legitimate interface avant-garde will emerge. You can already see its first stirrings in the infinite-loop hyperlinks of Suck, the eclectic multimedia "installations" of Jaime Levy's design for the Web 'zine Word, and the hallucinatory VRML worlds now appearing online inspired by rave culture and the novels of William Gibson.

The rise of an interface subculture will no doubt bring a new legitimacy to the medium, at least among the connoisseurs and the curators of High Culture. But beyond the external approbation, the digital avant-garde will also bring about an intriguing reversal in the basic rules of interface design. Put simply, an interface subculture opposed to the mainstream is bound to select for information-spaces that are deliberately confusing, environments designed to perplex more than to acclimate. Just as musical subcultures confound our melodic expectations with dissonance and unusual tuning schemes, the new interfaces will strive for disorientation—or if not that, then at least new ways of orienting, so new that they confuse on first encounter. Think of the contorted, postmodern built spaces of Rem Koolhaas and Frank Gehry, buildings that appear to have been turned inside out, like Richard Rogers's design for the Centre Pompidou. It is in the nature of any avant-garde to mess with our expectations, to keep us guessing, and for the most part, we've grown comfortable—even jaded—with this endless cycle of envelope pushing. No culture in history has so readily assimilated its avant-garde movements—just look at Disney's relationship to cutting-edge architecture, or MTV's usurpation of underground video-editing techniques.

All of this suggests a reasonable blueprint for the future of interface design: the subculture spins out the innova-

tions, and the dominant culture appropriates the forms it thinks it can market to a mass audience. But the transition is not likely to be a smooth one, if only because the field of interface design has been governed for so long by the cardinal rule of ease of use. An information-space that deliberately disorients its occupants is bound to be dismissed for its poor design, just as the critics of Stravinsky's day fulminated against the shapeless noise of *Le Sacre du Printemps*. As a product of engineering, interface design necessarily works in the interest of clarity and coherence, but once its practitioners begin to think of themselves as artists, those values grow more and more restrictive. The first generation of interface designers to break dramatically with the first principle of navigability will no doubt be pilloried by the digital establishment, but they will also open up a whole new possibility space for the designers that come after them. The DOS snobs that turned up their noses at the Mac's desktop metaphor did so because Apple's look-and-feel seemed too easy, more like a novice's training wheels than a legitimate software advance. The interface subcultures of the future will offend the traditionalists by being too *difficult*. "User-hostile" may sound like an odd goal for interface design, but the truth is the field could use a little tough love. No medium has managed to reach the status of genuine artistry without offending some of its audience some of the time. Even under the user-friendly dictates of interface design, you can't make art without a good measure of alienation.

One Interface or Many

Interface subcultures won't go very far, of course, if their more enigmatic spaces can't eventually be conquered, made sense of

Twelve-tone music and abstract expressionism struck many initial observers as noise and empty scribbling, but audiences eventually developed a taste for each. (Rothko derivatives now hang in the lobbies of sleek hotel chains, and Schoenberg-style scores pulsate behind most Hollywood thrillers.) Cutting-edge information-spaces will perplex their first occupants, but the most compelling designs will eventually grow more familiar; more intuitive. Users will learn over time to inhabit each new space, as though they were developing sea legs. After a few acclimations, the initial sense of disorientation will seem less intimidating, more like a challenge than an impediment. You can see this aptitude already in the generation of kids raised on video games. There's a certain fearlessness they exhibit upon entering into a new information-space. Instead of reading the manual, they'll learn the parameters in a more improvisational, hands-on fashion. (Sherry Turkle's book *Life on the Screen* has some wonderful studies of this activity.) These kids learn by doing, by experimenting, and that adventurousness comes from having cracked the code of other digital spaces in the past.

But this idea of multiple interfaces—each with its own logic, its own bylaws—also goes against the grain of interface design as we know it. Up to now, consistency has been a governing principle of the modern graphic interface. Apple gets a great deal of credit for translating the Xerox PARC desktop metaphor into a working product, but it probably deserves just as much praise for the sheer consistency of its information-spaces. For it is a basic rule of all interface design that predictability matters as much as clarity. You can have the most powerful visual metaphor in the world, but if it doesn't look the same from application to application, if the user must relearn the interface's language with each new project, then the

power of that original metaphor is greatly compromised. Apple alienated some developers with its insistence that the "File" and "Edit" menus remain consistent in all applications, but that doctrinaire stand had an enormous payoff. For longtime Mac users, reaching for the "save" command is as natural, as unthinking as dialing a telephone, and the same familiarity extends to copying a block of text or printing a document. We take these conventions for granted now, but they were hard-won. It took a rigid set of interface protocols to make them possible.

This predictability—the benign sameness of shared conventions—disappears once a vibrant subculture of interface designers comes into its own. Difference and novelty are prime movers in most digital-age concerns, but in the world of interface design they can be a genuine handicap. Information architects with an eye on mainstream success will be torn between two competing drives: the siren songs of intelligibility and innovation, the desire to conform to existing conventions battling it out with the desire to push the envelope. In this one respect, traditional programmers have it easy. New features are always welcome in software programs—even if they come at the cost of memory requirements or application speed. But new interface conventions sometimes face near-insurmountable odds in their bid for acceptance, for the very reason that they happen to be new. The field of interface design, in its present incarnation, naturally inclines toward repeated patterns, the deep allure of standards, conventions, predictability. If there is a gravitational force operating within this field—the one law that cannot be resisted—it is the force of habit. If the user has learned how to do something one way, then all subsequent iterations of the software must abide by those same conventions. Never make the user learn how to do the same thing twice.

That's a good rule of thumb if ease of use is your primary goal, but if you're reaching out for more challenging, expressive possibilities, then you're certainly going to want more variety in your design options. The conflict between these two impulses—"the force of habit" versus "the shock of the new"—has played itself out in a number of typically obscure, inside-baseball debates about more adventurous interface designs. For several years now, a company called MetaTools (founded by Photoshop guru Kai Krause) has been selling high-end graphics software that sports genuinely astonishing interface design: ordinary sliders are replaced by a succession of floating orbs, each covered with a shimmering, psychedelic surface; toolbars cycle through kaleidoscope displays of random textures; scroll bars and background colors give way to fractal landscapes and Mandelbrot sets. Krause's design sensibility has its partisans and its critics: if you're not a fan of vintage Grateful Dead posters or the recursive imagery of chaos math, then you're sure to be repelled by the MetaTools interface. But here, of course, it's not just the sensibility that's at stake. Krause could dress up his windows in the visual language of Vermeer or Le Corbusier and he'd still offend some of his audience, for the simple reason that he dresses up his windows at all.

The interface medium is still young enough for those criticisms to have real merit, particularly when they're focused on basic design elements like scroll bars and close boxes. But both Apple and Microsoft have promised plug-in interface modules in their upcoming operating systems, allowing users to alter significantly the look-and-feel of their computers with third-party products. When you add to this the anything-goes design philosophy of most Web sites, it seems clear that the next decade of interface design is bound

to be more diverse—and for that reason less predictable—than the preceding one. My hunch is that we should probably embrace this shift, given the aesthetic liberation it promises. A consistent look-and-feel may turn out to be one of those initial stages in the technology's development, a kind of crash course in navigating through information-space. As we slowly acclimate ourselves to the environment, too much regularity in the design may come to seem more oppressive than comforting, like a Hollywood thriller that leans too heavily on stock devices. Sure, the audience is bound to *understand* the film—it's just not clear if they'll want to sit through it. In these early days of the interface medium, consistency still reassures us. A decade from now that same consistency may feel like a shortcoming.

Metaphor Versus Simulation

One easy way to build a consistent user interface is to follow the codes and conventions of the real world. This, of course, was the fundamental logic behind Xerox PARC's desktop metaphor: if we think of the screen as a kind of mirror, reflecting the physical objects that surround us (trash cans, folders, windows), then we're already ahead of the game before we even reach for the mouse, since we can draw upon our preexisting expectations about how these objects work. In other words, the whole idea of a visual metaphor is really an extension of the more general principle of interface consistency, only this time projected out beyond the boundaries of the screen itself. The trash can works because it functions like a real-world trash can, just as a folder dutifully stores documents like a real-world folder. And yet, as we saw in chapter 2,

this deference to real-world conventions has its limits. More limber, loose-fitting metaphors seem to work better than meticulous simulations, if only because the world of atoms is subject to so many restrictions that have no purchase over the world of bits.

There is also the question of the literalness of the metaphor itself. Borrowing imagery from the real world can be enormously enlightening, but if the metaphors reside too close to home, the whole onscreen experience can seem deadening, listless—like the virtual living rooms of Microsoft Bob. The fact that most computer users happen to work in corporate-style offices shouldn't be license to fashion our interfaces after those same generic spaces—if anything, the modern interface should offer an escape route from that drudgery. We don't need virtual watercoolers; we need virtual worlds where watercoolers are meaningless, worlds that serve as an antidote to the numbed repetitiveness of most information-age labor. As the representational powers of the modern interface grow, designers will be tempted to simulate the flesh-and-blood realities of office life, but the temptation should probably be resisted.

The interface design for Corbis's *Leonardo da Vinci* CD-ROM illustrates this point perfectly. One of the most elegant and informative multimedia product ever made, *Leonardo* brought together a prodigious amount of information about the Renaissance master and his epoch and, in doing so, confronted two forbidding design problems: how to represent the work of Leonardo, and how to represent the overall shape of the CD-ROM itself, with its assorted exhibits, lectures, and time lines. For the first question, the answer was simple: build a virtual museum that the user can explore, with rooms

predictably divided up by genre: sketches, paintings, blueprints, and so on. It was a classic case of interface simulation: you've got an artist's work to represent onscreen, so you might as well deposit it in a sterile, austere art gallery, eight distinct rooms spun around a circular courtyard. Corbis did a wonderful job of realizing its fictional gallery-space onscreen, but the simulation seemed a little forced. Why cordon off the various strains of Leonardo's work into different rooms when the great promise of interactive media lies in the ability to make connections, to link from thought to thought and from image to image? You need separate rooms in a real-world museum, but in cyberspace they're an anomaly, a vestige held over from the world of atoms.

For the seemingly more vexing question of how to represent the entire CD-ROM, the Corbis designers opted for simplicity. Instead of erecting a fully rendered simulation, they drew upon a more poetic, if somewhat hackneyed, analogy—a tree. *Leonardo* opens out onto an oil painting of a massive oak, with two main branches trailing off from a single trunk. Waving the mouse over the image reveals a shimmering outline of the CD's contents, with the text sharpest at the cursor's tip and then fading out in all directions. The effect suggests a kind of radiance, more like shining a flashlight into a darkened room than riffling through a file cabinet. It centers the visual field masterfully, without dictating in advance where that center should be. The shape of the tree has a semantic value as well: the introductory "tours" of Leonardo and his epoch overlie the trunk, with the two branches representing the two main movements within the CD-ROM itself—the general collection of Leonardo's work, and the more detailed exhibition of the Leicester Codex (featuring the

magic lens discussed in chapter 3). Presented in all its verdant splendor in that initial vista, the tree then shrinks down to icon size as you explore the rest of the disk, neatly positioned in the upper-right-hand corner of each screen. Once again, waving the cursor over the image reveals the main compartments of the overall information-space, and a single click takes you to each of them.

There is an interesting lesson here for anyone interested in the tension between metaphor and simulation in contemporary interface design. The *Leonardo* CD stores a prodigious amount of data on its laser-etched surface: four mInidocumentaries on the man's life and culture, ten slide show-style exhibits on Leonardo's scientific pursuits, the massive codex display, and the art gallery. But because that particular body of information maps so nicely onto the visual metaphor of the tree, and because the icon itself appears so consistently throughout the site, it's almost impossible to lose your bearings within the disk's information-space. Your mind naturally grounds itself in one region or another, and the connections—both physical and semantic—that exist between these regions are always clear. Ironically, the most difficult space to navigate turns out to be the art gallery, where the octagonal design, with a central perspective that pivots 360 degrees, makes it difficult to sense immediately which direction you're facing (and consequently which part of the museum you're about to visit). In other words, a detailed simulation of a physical locale does a worse job of representing less information than a visual metaphor based on an abstract associative link. An art gallery might seem like an ideal conceit for a multimedia tribute to Leonardo da Vinci, but a simple tree metaphor turns out to be much more effective. In interface

design, as in modern art and pulp fiction, being true to life can sometimes be a liability.

Fragmentation Versus Synthesis

One of the first Web sites I ever visited featured a giant roulette wheel on its only page; you clicked the wheel and it spun you out to a random link on the Web, sometimes buried levels deep in a site's architecture. (It usually took a few minutes of clicking around just to figure out where you were.) The Wheel struck me at the time as the perfect emblem for the Web's earliest incarnation: a page that offered nothing to its visitors but the privilege of being completely disoriented. There was no goal in this little game, no ultimate destination. You took your chances at the roulette wheel not because you were homing in on a target but because you wanted to get a little lost. Getting a little lost *was* the goal. Or at least it was more fun than knowing where you were going.

That digital roulette wheel has some formidable allies in the glittering casino of high-tech culture, though not all of them are playing at the same table. Some of them are boosters, some are neo-Luddites. Some of them claim to be innocent bystanders and nonpartisans, dragged onto the floor by a "friend with a problem." What they all share, though, is a belief—not always acknowledged, but present nonetheless—that the digital age is by definition an age of fragmentation.

This is how the story usually goes: we've begun to think in bits and packets, scattering our ideas out laterally through the infosphere, hoping for chance encounters and lucky streaks, improvising ourselves into existence along the way. Sherry Turkle embraces the "multiple selves" shuttling through

online communities and MUDs, while Sven Birkerts pines for the good old days of the novel's central intelligence. David Shenk bemoans the intrusions of "data smog" into our daily lives, all those e-mail spams and news bytes diverting our attention from the real issues. Camille Paglia churns out ode after ode to her multitasking skills, typing furiously at the word processor with *Exile on Main Street* on the headphones and *Hard Copy* on the tube. Even the reigning print-design philosophies reflect this schizophrenic condition: the murky, layered look of *Raygun*, or *Wired*'s sensory-overload, "Mind Grenade" introductory pages. Beneath all the browbeating and messianism, there is this one guiding principle: zeros and ones lead inexorably toward a more fragmented experience of the world, or at least the world that comes to us over the modem and the cathode-ray tube.

It's hard not to be sympathetic to this general consensus. No one doubts that our daily lives are saturated with more data streams than at any previous point in history, and all the evidence suggests that the tide is rising. The news does come in shorter and shorter blocks (though perhaps not so short as no news at all), and the ideal spectator of most visual entertainment undoubtedly suffers from a chronic case of attention deficit disorder. The sheer number of bits that the average office worker encounters in a day is positively unfathomable. And the lush anonymity of most online encounters certainly encourages "experimenting" with your digital persona, even if most of it comes in the form of adolescent chat-room intrigue.

And yet against all that dislocation and overload and multiplicity, there is the interface. Most of the time we talk about the graphic interface as though it were a logical culmination of the digital revolution, its crowning glory, but the truth is, the interface serves largely as a *corrective* to the forces

unleashed by the information age. Whenever I find myself being swayed by the fragmentation jeremiads, I like to sit down at my computer and go through the usual routines—check my e-mail, rearrange my desktop, log on to the Web—and concentrate all the while on what is *really* happening as I do these things. Because what is really happening, not on the screen but down in the innards of the machine itself, or out on the great expanses of the Internet, what is happening in that world is literally unimaginable. What is happening is that billions of tiny pulses of electricity are hurtling through silicon conduits, like an entire planet's worth of digital automobiles making their way across the grid of a single microchip. And all those pulses self-organize into larger shapes and patterns, into assembly codes, machine languages, instruction sets. Some of these ethereal languages then transform themselves into flashes of light, or audio waveforms, and depart en masse from my machine into the sprawling backbone of the Net, where they disperse into countless separate units, and then thread their way through thousands of other microchips, before reuniting at their destination.

But what happens on the screen is this: a window pops open, a dialog box appears, a bright, cheerful voice tells me that I have mail.

No news here, of course, but something profound nonetheless. The great surge of information that has swept across our society in recent years looks genuinely innocuous next to the meticulous anarchy of *real* bit-space, that nether-world that lurks in our microchips and our fiber-optic lines. But we see almost nothing of that universe because we have built such sturdy mediators to keep it separate from us, translators that make sense of what would otherwise be a blizzard of senselessness. It is undeniable that the world has never seen so

many zeros and ones, so many bits and bytes of information—but by the same token, it has never been so easy to ignore them altogether, to deal only with their enormously condensed representatives on the screen. Which is why we should think of the interface, finally, as a *synthetic* form, in both senses of the word. It is a forgery of sorts, a fake landscape that passes for the real thing, and—perhaps most important—it is a form that works in the interest of synthesis, bringing disparate elements together into a cohesive whole.

Seen in this light, all that ranting about the fragmented consciousness of the digital age sounds a great deal less convincing. After all, critics have bemoaned—or championed—the accelerated pace of the present, its dislocations and divided selves, ever since the industrial age powered up in the early nineteenth century. Think of Baudelaire losing himself in the shimmering, half-lit streets of Paris, becoming a “kaleidoscope gifted with consciousness.” Think of Joyce’s characters bouncing back and forth between biblical references and advertising jingles. Think of Marinetti’s poetry, renouncing “the ‘I’ in all literature” for the speed of the race car and the destructiveness of the machine gun. Conceptual turbulence—the sense of the world accelerating around you, pulling you in a thousand directions at once—is a deeply Modern tradition, with roots that go back hundreds of years. What differentiates our own historical moment is that a symbolic form has arisen designed precisely to counteract that tendency, to battle fragmentation and overload with synthesis and sense-making. The interface is a way of seeing the whole. Or, at the very least, a way of seeing its shadow, illuminated by the bright phosphor of the screen.

When I think about the gap between raw information and its numinous life on the screen—something I try to

avoid doing, because it is a dark and difficult thought, more than a little like contemplating the age of the universe—the whole sensation has a strangely religious feel to it, that sense of the mind trying to reach around a vibrant (and convenient) metaphor to the wider truth that lies beyond. Cathedrals, remember, were “infinity imagined,” the heavens brought down to earthly scale. The medieval mind couldn’t take in the full infinity of godliness, but it could subjugate itself before the majestic spires of Chartres or Saint-Sulpice. The interface offers a comparable sidelong view onto the infosphere, half unveiling and half disappearing act. It makes information sensible to you by keeping most of it from view—for the simple reason that “most of it” is far too multitudinous to imagine in a single thought.

The spiritual resonance of interface design is not as unusual an idea as it might sound at first. Umberto Eco’s compare-and-contrast exercise between operating systems and world religions circulated widely among the digital citizenry when it first appeared in 1994. Less playful critics have talked about the “technological sublime”—the Wordsworth-style reveries that come from confronting the epic expanses of information-space, the InterNIC backbone doing for a new generation of aesthetes what the Matterhorn did for the Romantics nearly two centuries before. As I write, the Silicon Valley start-ups are devising new types of onscreen “avatars”—digital creatures that represent you in your virtual habitats—borrowing the Buddhist term for angels. For me, the most moving rendition of this theme comes almost as an aside in Thomas Pynchon’s 1990 novel, *Vineland*:

If patterns of ones and zeroes were “like” patterns of human lives and deaths, if everything

about an individual could be represented in a computer record by a long string of ones and zeroes, then what kind of creature would be represented by a long string of lives and deaths? It would have to be up one level at least—an angel, a minor god, something in a UFO. It would take eight human lives and deaths just to form one character in this being's name—its complete dossier might take up a considerable piece of the history of the world...

None of this is to suggest that there are genuine religious values to be found on the Net or in our microprocessors. While certain strains of New Age mysticism seem to have embraced digital technology, for the most part the modern computer is a deeply secular invention. Still, the act of comprehending an infinite universe of data through the figureheads and symbolic gestures of the interface, the whole project of "infinity imagined"—this experience runs parallel to the metaphors and sense-making narratives of most organized religions. They share a similar "structure of feeling," in Raymond Williams's term, the sense of a disordered universe made orderly again by the power of metaphor. And in a world that increasingly lays its tributes at the great altar of information, where the "symbolic analysts" and digital visionaries sometimes seem like a new caste of priests and prophets, then perhaps the visual metaphors of interface design will eventually acquire a richness and profundity that rival those of Hinduism or Christianity, without crossing over into genuine theology. The empire of Byzantium ruled much of southern Europe and eastern Asia for nearly a thousand years, but during the eighth and ninth centuries, the

regime was locked in a vicious internecine war over the role of icons in orthodox worship. (The modern word *iconoclasm* derives from this debate.) Was the icon a suitable stand-in for the sacred—or was it a perversion, a false idol? Did it bring us closer to the heavens, or condemn us to hell? You can hear the same melody today in the great symphony of high-tech culture—fluttering softly in the background, of course, and transposed into a secular key, but it is the same melody nonetheless. Whatever else may befall the digital world in the coming years, that spiritual refrain is bound to grow louder.

I wrote in the Preface that I saw this as a "secular" book, a middle ground between the dual religions of techno-boosterism and the Luddite reaction, and for the most part, I have tried to stay true to that original vision. If there is a spiritual dimension to the interface medium, it has nothing to do with dogma or unapologetic mysticism. It has nothing to do with believing—or not believing—in God. It has to do more with the general structure of trying to think about something that is too big to think, and the devices we build for ourselves to help us complete the thought. Other forms in history have taken on similar quandaries: Dickens and Balzac condensed down the teeming masses of the modern metropolis into five hundred pages; a radio station here in New York City regularly announces: "Give us twenty-two minutes and we'll give you the world." But these forms at least have the luxury of representing a world that can be experienced through other means. You could stroll along the Seine or take a gander at Chancery to experience the worlds of Balzac and Dickens more viscerally. The novel made sense of social movements that transcended the scale of individual lives—industrialization, urban population explosions, epidemics—but you could still venture out

into the city streets to encounter those trends in their day-by-day manifestations.

With a few momentous exceptions, the sense-making apparatus of religious belief has not had it so easy. Experiencing godhead usually involves some kind of mediation, if only because most humans accept the idea that a direct encounter might blow a few fuses in the act. (There's a limited-load-capacity clause written into most sacred texts for good reason.) This is where the modern interface resonates so powerfully with the customs and pageantry of organized faith. Both are imaginative systems predicated on a world ruled by invisible forces, forces made sensuous only through the luminous icons and rituals of faith. Interface designers talk about the "user illusion," but there is also a strong measure of "suspended disbelief" in the modern desktop—which, if you cancel out the negatives, leaves you with old-fashioned belief. This is probably how it should be.

The interface came into the world under the cloak of efficiency, and it is now emerging—chrysalis-style—as a genuine art form. All this in less than half a century of innovation. Who can tell what awaits us in the next fifty years? The religious analogy seems less rhetorical when measured against that scale. Even today, there's an undeniably enchanted quality to the icons on our screens, like a crucifix or the lives of the saints. We can't predict how far that enchantment will extend itself in the next century, but its potential scope should not be underestimated. Our interfaces are stories we tell ourselves to ward off the senselessness, memory palaces built out of silicon and light. They will continue to change the way we imagine information, and in doing so they are bound to change us as well—for the better and for the worse. How could it be otherwise?

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