The final quarter of the twentieth century marks the beginning of the digital age. Starting in the 1970s, computers have become cheaper, faster, more capacious, and more connected to one another at exponential rates of improvement, merging previously disparate technologies of communication and representation into a single medium. The networked computer acts like a telephone in offering one-to-one real-time communication, like a television in broadcasting moving pictures, like an auditorium in bringing groups together for lectures and discussion, like a library in offering vast amounts of textual information for reference, like a museum in its ordered presentation of visual information, like a billboard, a radio, a gameboard, and even like a manuscript in its revival of scrolling text. All the major representational formats of the previous five thousand years of human history have now been translated into digital form. There is nothing that human beings have created that cannot be represented in this protean environment, from the cave paintings of Lascaux to real-time photographs of Jupiter, from the Dead Sea Scrolls to Shakespeare's First Folio, from walk-through models of Greek temples to Edison's first movies. And the digital domain is
assimilating greater powers of representation all the time, as researchers try to build within it a virtual reality that is as deep and rich as reality itself.

The technical and economic cultivation of this fertile new medium of communication has led to several new varieties of narrative entertainment. These new storytelling formats vary from the shoot-'em-up videogame and the virtual dungeons of Internet role-playing games to the postmodern literary hypertext. This wide range of narrative art holds the promise of a new medium of expression that is as varied as the printed book or the moving picture. Yet it would be a mistake to compare the first fruits of a new medium too directly with the accustomed yield of older media. We cannot use the English theater of the Renaissance or the novel of the nineteenth century or even the average Hollywood film or television drama of the 1990s as the standard by which to judge work in a medium that is going through such rapid technical change.

In 1455, Gutenberg invented the printing press—but not the book as we know it. Books printed before 1501 are called incunabula; the word is derived from the Latin for swaddling clothes and is used to indicate that these books are the work of a technology still in its infancy. It took fifty years of experimentation and more to establish such conventions as legible typefaces and proof sheet corrections; page numbering and paragraphing; and title pages, prefaces, and chapter divisions, which together made the published book a coherent means of communication. The garish videogames and tangled Web sites of the current digital environment are part of a similar period of technical evolution, part of a similar struggle for the conventions of coherent communication.¹

Similarly, new narrative traditions do not arise out of the blue. A particular technology of communication—the printing press, the movie camera, the radio—may startle us when it first arrives on the scene, but the traditions of storytelling are continuous and feed into one another both in content and in form. The first published books were taken from the manuscript tradition. Malory's Morte d'Arthur,
written in manuscript in 1470, drew on prose and poetry versions of the Camelot legend in both French and English, which in turn drew on centuries of oral storytelling. The elements of the story were all there already: the rise and fall of the hero Arthur, the gallantry of the knights, the love between Guinevere and Lancelot, and the destruction of the Round Table through civil war. But Malory's prose brought these elements together and introduced colloquial dialogue, more consistent plotting, and a pervasive tone of nostalgia. Fifteen years later, William Caxton took Malory's separate tales and bound them together into a single volume, with descriptive chapter headings that lured readers into the story. Only then, after such long episodic narratives were commonplace in publishing, could Cervantes write a contemporary tale like *Don Quixote* (1605), which marks the beginning of the European novel.

We can see the same continuities in the tradition that runs from nineteenth-century novels to contemporary movies. Decades before the invention of the motion picture camera, the prose fiction of the nineteenth century began to experiment with filmic techniques. We can catch glimpses of the coming cinema in Emily Brontë's complex use of flashback, in Dickens' crosscuts between intersecting stories, and in Tolstoy's battlefield panoramas that dissolve into close-up vignettes of a single soldier. Though still bound to the printed page, storytellers were already striving toward juxtapositions that were easier to manage with images than with words.

Now, in the incunabular days of the narrative computer, we can see how twentieth-century novels, films, and plays have been steadily pushing against the boundaries of linear storytelling. We therefore have to start our survey of the harbingers of the holodeck with a look at multiform stories, that is, linear narratives straining against the boundary of predigital media like a two-dimensional picture trying to burst out of its frame.
The Multiform Story

I am using the term *multiform story* to describe a written or dramatic narrative that presents a single situation or plotline in multiple versions, versions that would be mutually exclusive in our ordinary experience. Perhaps the best-known example of a multiform plot is Frank Capra's beloved Christmas story, *It's a Wonderful Life* (1946), in which hardworking, benevolent George Bailey, as played by Jimmy Stewart, is given a vision of what his town would have been like if he had never lived. The film juxtaposes two divergent pictures of George's hometown: the present-time Bedford Falls, in which George has saved his father's small savings and loan bank, married the town librarian, and been a benefit to his community, and a town originally called Bedford Falls but renamed Pottersville by the evil big banker Potter, a town in which there is no savings and loan to offer mortgages, the librarian is a bitter old maid, and everyone's life is poorer and meaner without George's compassionate guidance. The movie as a whole pivots around the moment when George, facing ruin and remembering all the disappointments of his life, is standing on a bridge contemplating suicide. The whimsical angel Clarence persuades him to live by running a kind of simulation experiment—a replay of the past thirty years in Bedford Falls as it would have turned out if George had never been born. In this film the multiform story format works as a kind of scientific proof of the meaning of one person's life.

But for many postmodern writers, the quintessential multiform narrative is the much darker story in Jorge Luis Borges's "The Garden of Forking Paths" (1941). Here the pivotal moment is a seemingly meaningless act of murder. The narrator, Dr. Yu Tsun, is a German spy during World War I who knows that he is on the verge of capture. He resolves to murder a man named Steven Albert, whose name he has selected from the phone book. Albert, by coincidence, has devoted his life to studying an incoherent novel (which is also called *The Garden of Forking Paths*) written by Ts'ui Pên, an an-
cestor of the narrator. As Albert explains to Yu Tsun, the story of the forking path is really a labyrinth because it is based on a radical reconception of time:

In all fiction, when a man is faced with alternatives he chooses one at the expense of the others. In the almost unfathomable Ts’ui Pên, he chooses—simultaneously—all of them. He thus creates various futures, various times which start others that will in their turn branch out and bifurcate in other times. (P. 98)

Time in Ts’ui Pên’s world is not an “absolute and uniform” line but an infinite “web” that “embraces every possibility.” Albert tells his future murderer that they are living in a world of similarly bifurcating time, full of many alternate realities:

We do not exist in most of them. In some you exist and not I, while in others I do, and you do not, and in yet others both of us exist. In this one, in which chance has favored me, you have come to my gate. In another, you, crossing the garden, have found me dead. In yet another, I say these very same words, but am an error, a phantom. (P. 100)

As Yu Tsun gets closer to committing the murder, he is aware of a “pullulation,” a splitting of reality. Like the characters in Ts’ui Pên’s story, he is choosing multiple alternatives, creating various futures simultaneously:

It seemed to me that the dew-damp garden surrounding the house was infinitely saturated with invisible people. All were Albert and myself, secretive, busy and multiform in other dimensions of time. (Pp. 100–101)

The notion of multiple possible worlds seems at first to absolve the narrator of moral responsibility and to make the deed much easier. He murders the unsuspecting Albert while his back is turned, choosing his moment in order to be as merciful as possible. It is a dispassionate crime, a triumph of cryptography. Yu Tsun has succeeded in
sending a message alerting the Germans to attack a city named Albert by causing his own name to appear linked with the name of his victim in newspapers. Since Yu Tsun does not believe in the German cause, the murder is a deeply meaningless act of pure communication. Yet the story ends with the narrator full of “infinite penitence and sickness of heart” (p. 101). The fact that Yu Tsun’s experience of life is only a slender thread in the infinite web of his possible lives does not change the fact that he is firmly embedded in his single lived reality.

A similarly pullulating moment underlies Delmore Schwartz’s chilling story “In Dreams Begin Responsibilities,” first published in 1937. The story is told by a 21-year-old narrator who is dreaming that he is watching a silent movie of the day his father proposed to his mother on a date at Coney Island. His parents are engagingly vulnerable and hopeful, though it is achingly clear that they will make one another quite miserable. In the central scene of the story, the narrator watches as his father confidently orders an ocean-view table in the best restaurant on the boardwalk and awkwardly makes his proposal: his mother weeps with joy as she accepts. At this moment the narrator rises from his seat in the theater and begins to shout at the characters on the screen: “Don’t do it. It’s not too late to change your minds, both of you. Nothing good will come of it, only remorse, hatred, scandal, and two children whose characters are monstrous” (p. 9). But the usher forces him to sit down while the unchangeable past continues to unfold on the screen.

Near the end of the story, the narrator’s mother feels compelled to enter a palmistry booth. His father grudgingly waits around with her until the fortune-teller appears.

But suddenly my father feels that the whole thing is intolerable; he tugs at my mother’s arm, but my mother refuses to budge. And then, in terrible anger, my father lets go of my mother’s arm and strides out, leaving my mother stunned. She moves to go after my father, but the fortune-teller holds her arm tightly and begs her not to do so, and I
my seat am shocked more than can ever be said, for I feel as if I were walking a tight-rope a hundred feet over a circus-audience and suddenly the rope is showing signs of breaking, and I get up from my seat and begin to shout once more the first words I can think of to communicate my terrible fear... and I keep shouting: "What are they doing? Don't they know what they are doing? Why doesn't my mother go after my father? If she does not do that, what will she do? Doesn't my father know what he is doing?" (P 8)

As these alternate futures pullulate around his mother in the fortune-teller's booth, the dreamer is scolded by the usher in words that sum up his feelings of panic. "You can't carry on like this," he is told. "Everything you do matters too much" (pp. 8–9). The danger for the narrator is the same one George Bailey faces: the danger of wishing never to have been born and having your wish come true. The story ends here as he wakes up "into the bleak winter morning" of his twenty-first birthday, into the reality that is the result of his mother's moment of choice.

Schwartz's story was arresting when it came out, as Irving Howe remembers, in its depiction of the inexorability of the past as a movie reel that "must run its course; it cannot be cut; it cannot be edited." But from the perspective of the 1990s, we can see that the originality of the story also lies in its dramatization of the narrator's position in the audience as he attempts to turn a linear, passive medium into an interactive one. The question that is tormenting him is not whether he can bear to witness the past by watching the painful film unroll, but whether he would choose to change it if he could. Would the dreamer redream his parents' unhappy love story knowing that if he did so he might never wake up? The multiform story is an expression of the anxiety aroused by posing such choices to oneself.

To explore such questions concretely in linear media, we usually have to enter the realm of science fiction. In fact, Schwartz's narrator's disturbing fantasy of undoing his parents' marriage by interrupting their moment of betrothal is replayed as a farcical adventure in
the Robert Zemeckis hit film *Back to the Future* (1985). When the hero, teenager Marty McFly, time-travels back to the 1950s, his photograph of himself and his siblings starts to fade as his bumbling actions make his parents' marriage less and less likely. To survive his adventure, Marty must make sure his parents kiss at a particular moment of the upcoming high school dance, and he is appalled to realize just how unlikely their union seems to be. The moment of the kiss is so pivotal that it is repeated in the sequel movie, with a second time-traveling Marty seeing it (and risking its disruption) all over again. As George McFly stands on the dance floor in the school gym, unable to work up the courage to embrace his very willing partner, Marty No. 1, who has been playing guitar onstage to keep the mood going, starts to fade out of existence, a victim of his father's sexual cowardice. In the sequel version, Marty No. 2 is suspended on the catwalk over the stage, fleeing the villain and in danger of falling, much like Schwartz's narrator, who feels suspended on a mental "tightrope" as his mother stands between the fortune-teller and her fate.

Of course, in the Hollywood version of the disrupted proposal story there is a much happier ending: not only do Marty's father and mother get together, but George McFly, who would otherwise remain an ineffectual and cowardly nerd, rewrites his life when he makes a fist and hits the evil bully, Biff. Marty returns to a world in which his father is a successful science fiction writer, his mother is thin and cheerful, his sister is popular, his brother has a good job, and he has unrestricted access to the family car. He has achieved a familiar twentieth-century adolescent fantasy: to totally remake his family according to his own desires.

Part of the impetus behind the growth of the multiform story is the dizzying physics of the twentieth century, which has told us that our common perceptions of time and space are not the absolute truths we had been assuming them to be. The emotional conundrums of the Einsteinian view have been most explicitly explored in Alan Lightman's *Einstein's Dreams* (1993), which offers poetic vignettes of human life as it might be under other systems of time. For instance, in
a world in which “time has three dimensions, like space,” a man stands on a balcony in Berne thinking about a woman in Fribourg. “His hands grip the metal balustrade, let go, grip again. Should he visit her. Should he visit her?” (pp. 18–19). In one world he decides not to go and instead “keeps to the company of men” until three years later he meets a nice woman in a clothing shop in Neuchâtel who eventually comes to live with him and with whom he contentedly grows old. In another he decides he “must see” the woman in Fribourg despite her volatility; he leaves his job and moves to Fribourg, where they live stormily together and “he is happy with his anguish.” In the third world he is also driven to see her but they merely talk for an hour and then she says she must leave; he returns to his balcony feeling empty. How do people live in a world where they are conscious of the world splitting in three at every decision point, a world in which there are infinite alternatives to every situation? Lightman imagines it this way:

Some make light of decisions, arguing that all possible decisions will occur. In such a world, how could one be responsible for his actions? Others hold that each decision must be considered and committed to, that without commitment there is chaos. Such people are content to live in contradictory worlds, so long as they know the reason for each. (p. 22)

Lightman’s story, like Borges’s, is a haunting evocation of the world of ordinary experience, of our own perception of moments of choice that teem with multiple possibilities, all of which seem authentic—if not in their “quantum signatures” (as science fiction writers would say), then in their emotional signatures. We know what it feels like to stand on that balcony and consider three possible lives that all feel real. We are outgrowing the traditional ways of formulating this experience because they are not detailed or comprehensive enough to express our sense of the pullulating possibilities of life.

The most successful attempt to portray multiple alternate realities within a coherent linear story is Harold Ramis’s farcical movie
Groundhog Day (1993), in which a selfish and bitter weatherman named Phil is forced to relive a single winter's day in a hick Pennsylvania town until he gets it right. The film works in part because it never attempts to explain why Phil keeps waking up on the same day. It just puts him in this absurd situation and watches what he does about it. The day is detailed as a series of witty variations on a set of comic motifs. Rushing to do a broadcast about the appearance of the groundhog, Phil is accosted by an overfriendly high school friend, Ned, who tries to sell him insurance. In his haste to get away from the irritating Ned, Phil steps off a curb and into a deep puddle of water. The scene is shown four times with interesting variations, including one in which Phil embraces Ned first and with so much intensity that Ned is the one to run away. The pleasure for the audience is in savoring the variations, wondering how Phil is going to play it this time. Phil's life is not an inexorable film reel, like the Coney Island date in Schwartz's dream-movie, but an endless series of retakes. When he sets out to seduce his producer, Rita, he repeats his date with her endlessly, revising every aspect of it to suit her tastes and fantasies, only to wind up slapped and rejected many times over. Eventually Phil learns to live his one day as a better person; he takes up the piano, prevents the accidents he knows are due to happen, and opens his heart to the people he formerly looked on with contempt. Once he gets the day right, he wins Rita's love and finally wakes up on February 3.

Groundhogs Day is, in its way, an updating of the familiar marriage plot, like the ones in Jane Austen's novels, in which courtship is depicted as a process of moral education. Because Phil is a man of the 1980s, his learning is conducted in the form of an educational simulation—the opposite of the one the angel Clarence runs for George Bailey—in which the town is held constant and only the protagonist changes. Because of his simulation structure, Groundhog Day, though it has none of the shoot-'em-up content of videogames, is as much like a videogame as a linear film can be.

Multiform stories often reflect different points of view of the same
event. The classic example of this genre is Rashomon (1950), the Kurosawa film in which the same crime is narrated by four different people: a rape victim; her husband, who is murdered; the bandit who attacks them; and a bystander. The increasing moral confusion of their accounts in part reflects the postwar cultural crisis in Japan. Similarly, in Milorad Pavić's Dictionary of the Khazars (1988) the impending dissolution of Yugoslavia is prefigured by the fragmentary account of a mythical lost tribe whose history is known through conflicting Christian, Jewish, and Moslem versions. The book is designed as three incomplete "dictionaries" (really more like encyclopedias), which represent the three religious traditions and have conflicting entries for the same events. Although published in a bound volume, the book is not meant to be read in consecutive order, as the author tells the reader:

The three books of this dictionary... can be read in any order the reader desires; he may start with the book that falls open as he picks up the dictionary... The Khazar Dictionary can also be read diagonally, to get a cross-section of all three registers—the Islamic, the Christian, and the Hebrew... He may move through the book as through a forest from one marker to the next... He can rearrange it in an infinite number of ways, like a Rubik cube... Each reader will put together the book for himself, as in a game of dominoes or cards, and as with a mirror, he will get out of this dictionary as much as he puts into it. (Pp. 12–13)

The fragmentation of the story structure represents patterns of historical fragmentation, and the patterns of readings echo the characters' efforts to reconstruct the past in order to restore a lost coherence.

As this wide variety of multiform stories makes clear, print and motion picture stories are pushing past linear formats not out of mere playfulness but in an effort to give expression to the characteristically twentieth-century perception of life as composed of parallel possibilities. Multiform narrative attempts to give a simultaneous form to
these possibilities, to allow us to hold in our minds at the same time multiple contradictory alternatives. Whether multiform narrative is a reflection of post-Einsteinian physics or of a secular society haunted by the chances of life or of a new sophistication in narrative thinking, its alternate versions of reality are now part of the way we think, part of the way we experience the world. To be alive in the twentieth century is to be aware of the alternative possible selves, of alternative possible worlds, and of the limitless intersecting stories of the actual world. To capture such a constantly bifurcating plotline, however, one would need more than a thick labyrinthine novel or a sequence of films. To truly capture such cascading permutations, one would need a computer.

The Active Audience

When the writer expands the story to include multiple possibilities, the reader assumes a more active role. Contemporary stories, in high and low culture, keep reminding us of the storyteller and inviting us to second-guess the choices he or she has made. This can be unsettling to the reader, but it can also be experienced as an invitation to join in the creative process.

Italo Calvino’s If on a Winter’s Night a Traveler (1979) is a novel in the form of a long meditation on fiction making, a story that keeps unraveling and restarting itself. In a world that is perceived as a vast interconnected web, how is the author to know which thread to pull on first? How can he hope “to establish the exact moment in which a story begins”?

Everything has already begun before, the first line of the first page of every novel refers to something that has already happened outside the book. . . . The lives of individuals of the human race form a constant plot, in which every attempt to isolate one piece of living that has a meaning separate from the rest—for example, the meeting of two people, which will become decisive for both—must bear in mind that
each of the two brings with himself a texture of event, environments, other people, and that from the meeting, in turn, other stories will be derived which will break off from their common story. (P. 153)

The beginning of any story is fraught with possibilities:

On the wall facing my desk hangs a poster somebody gave me. The dog Snoopy is sitting at a typewriter, and in the cartoon you read the sentence, "It was a dark and stormy night. . . ." Every time I sit down here I read, "It was a dark and stormy night. . . ." and the impersonality of that *incipit* seems to open the passage from one world to the other, from the time and space of here and now to the time and space of the written word; I feel the thrill of a beginning that can be followed by multiple developments, inexhaustibly. (Pp. 176-77)

The commitment to any particular story is a painful diminution of the intoxicating possibilities of the blank page. Calvino’s fiction is offering a new kind of story pleasure, a delight not in the tale but in the fertile mind of the writer.

It is not just intellectual fiction that has become so self-aware. Evidence of the same tendency in popular fiction is as close at hand as two of my son’s recent Christmas presents. Popular comic book writer Mike Baron introduces a collection of the first five *Nexus* issues with a chatty description of his collaboration with his graphic artist partner, Steve Rude. He shares with the readers his perspective on one of the main villains of the ongoing story: "I think Nexus' universe would be a duller place without Ursula, but the Dude is constantly howling for her blood. I've saved her life several times in impassioned late-night phone calls." When the writer talks about her in this way, Ursula loses credibility as a fictional character but she becomes more interesting as an aspect of her creators’ imagination. The important contest for the reader, the focus of dramatic suspense, is not the one between Nexus and Ursula but between Baron and Rude.

Giving the audience access to the raw materials of creation runs the risk of undermining the narrative experience. I lose patience with
Calvino when he repeatedly dissolves the illusion. When in *Groundhog Day* the conversation at a bar between Phil and Rita is repeated over and over again to show how Phil changes his pickup routine over several days, the sequence looks confusingly like a series of re-takes of a single movie scene; I am reminded that I am watching Bill Murray and Andie MacDowell repeating lines for the camera. Nevertheless, calling attention to the process of creation in this way can also enhance the narrative involvement by inviting readers/viewers to imagine themselves in the place of the creator.

Murder mysteries, for example, count on the reader to be aware of the conventions of the form and to anticipate multiple arrangements of the elements provided by the author. Is that odd-looking woman outside the murder scene an important witness? A murderer? The next victim? Is she perhaps not a woman at all but a man in disguise? Serial narratives like Victorian novels or contemporary television shows also sustain audience involvement between installments by skillfully setting up plot patterns that encourage speculation on which possibilities will be developed. Comic book franchises acknowledge and encourage the audience's free-form fantasies by publishing special series devoted to events that are contrary to the official history of the characters but full of interesting narrative possibilities. Marvel Comics uses its "What If...?" monthly series to explore such questions as "What if Spiderman's uncle had not died?" and "What if Spiderman had never gotten superpowers?"; and DC Comics uses its forty-eight-page Elseworlds issues (twice the size of the usual monthly) to imagine Superman transported to the Metropolis of Fritz Lang's 1926 film or Batman born into Victorian England and fighting Jack the Ripper. These efforts assume a sophistication on the part of the audience, an eagerness to transpose and reassemble the separate elements of a story and an ability to keep in mind multiple alternate versions of the same fictional world.

Although television viewers have long been accused of being less actively engaged than readers or theatergoers, research on fan culture
provides considerable evidence that viewers actively appropriate the stories of their favorites series. Fan culture has grown over the past decades through conventions, underground magazines, and the trading of home videos. The Internet has accelerated this growth by providing a medium in which fans can carry on (typed) conversations with one another and often with the producers, writers, and stars of ongoing series. Much of this discourse is focused on the consistency of the shows, with careful debate on such issues as whether a supporting character on a sitcom is a widower or a divorcé or which fictional New York City cop most deserves a promotion.

In addition to sharing critical commentary and gossip, fans create their own stories by taking characters and situations from the series and developing them in ways closer to their own concerns. Star Trek fans in particular have produced a vast literature of alternate adventures over the thirty years since the original series aired. Women writers have created stories in which the female characters take over the ship or refuse the advances of the notoriously lecherous Captain Kirk. The romantic rivalry of the aggressive Worf and the egotistical Riker for the voluptuous Deanna Troi has inspired many more fan-written stories than episodes of the Next Generation series in which it was introduced. With the advent of the VCR, a new branch of fan literature has arisen in which actual scenes from the broadcast programs are reedited into new stories. Kirk and Spock, whose friendship is a centerpiece of the original series, have been reinterpreted as lovers through the magic of videotape. This "textual poaching," as media critic Henry Jenkins has called it, has become even more widespread on the World Wide Web, which functions as a global fanzine. Although some copyright holders have protested, fans have little trouble obtaining digital images and even digital video clips from their favorite series, which they put to their own use on personal Web pages. The imaginative involvement of fans gives them a strong sense of entitlement to the images associated with their favorite shows. When the Microsoft Network closed off its official Star Trek Web site, "Star Trek Continuum," to users with non-Microsoft Web browsers,
fans organized a protest campaign and enjoyed pointing out how superior their own Web pages were to the official site.

The most active form of audience engagement comes in role-playing clubs. Fans of fantasy literature from Tolkien to space operas have joined together for live-action role-playing (LARP) games in which they assume the roles of characters in the original stories to make up new characters within the same fictional universe. This youthful gaming world, which began with twelve-year-olds playing *Dungeons and Dragons* in the 1970s, has grown by the 1990s to include long-standing, organized role-playing groups composed of dozens of college students and young professionals. Some of these games, like a San Francisco vampire group of post-college-age players, last for several years, with players maintaining the same character over the course of the game. Others, like many of those created for the Assassins’ Guild, a role-playing club at MIT, can be over in an intense weekend. Some of the games focus on jousts and ambushes, others on elaborate political negotiation, and still others on skillful improvisations of dramatic scenes. In all of them, the players share a sense of exploring a common fictional landscape and inventing their stories as they go along.

Role-playing games are theatrical in a nontraditional but thrilling way. Players are both actors and audience for one another, and the events they portray often have the immediacy of personal experience. For instance, in a live-action game at MIT set in a world populated by characters based on Shakespeare’s plays, Seth McGinnis, a graduating senior, had the secret identity of Puck from *Midsummer Night’s Dream*. Puck was disguised from the other players as a member of a troupe of traveling actors who stage a performance of the Pyramus and Thisbe scene from *Midsummer Night’s Dream* with Puck playing the role of the lover Pyramus. Seth decided to take advantage of the confusion that occurs as everyone leaves the “theater” to use his fairy powers to create an illusionary wall between a prisoner and his guards, thus allowing the prisoner to escape. Puck’s wall actually consisted of one of the game masters standing for five minutes with arms
stretched across the entrance to a stairway leading from the MIT classroom designated as a town square to the MIT classroom designated as the tavern. Pyramus and Thisbe talk to one another through a similar illusory wall, portrayed by a comically clumsy actor who uses his fingers to make a chink through which the lovers whisper. The crudely portrayed wall is an endurably charming bit of stage business within the original play and a gentle reminder of the make-believe of theater itself. The wall in the game, like the wall in the play, was a consensual reality. The players joined in the creation of the illusion by poking at the wall, expressing amazement at its sudden appearance, and proclaiming that they could not see around it. But unlike actors in a play, the players were also genuinely puzzled about how the wall was created and by whom. Puck’s wall had the arresting presence of a spontaneous event. It will not last as long as Shakespeare’s, but for the people playing the game that night it was even more dramatically compelling.

Live theater has been incorporating the same qualities of spontaneity and audience involvement for some time. Improvisational groups solicit suggestions from audience members and offer them the pleasure of performance combined with the pleasure of witnessing creative invention. Participatory dinner theater casts the members of the audience as bit players in a group event, such as a comic wedding, jury trial, or wake. Mainstream audiences have recently accepted being addressed from the stage as schoolchildren or PTA members, and have even followed actors around a New York townhouse. Commercial role-playing games mix actors with paying guests who solve a mystery or enact a spy drama over a weekend at a vacation resort. In all of these gatherings, the attraction lies in inviting the audience onto the stage, into the realm of illusion. These are all holodeck experiences without the machinery.

And the machinery—all but three-dimensional holograms—seems not that far away. Since the 1980s, gaming environments called MUDs (Multi-User Domains) have allowed distant players on the Internet to share a common virtual space in which they can
“chat” with one another (by typing) in real time. Words typed by fellow players all over the planet appear on each player’s screen as the players improvise scenes together and collectively imagine fictional worlds. As the social psychologist Sherry Turkle has persuasively demonstrated, MUDs are intensely “evocative” environments for fantasy play that allow people to create and sustain elaborate fictional personas over long periods of time. Every day, and particularly every night, thousands of people forsake real life (RL) and meet in virtual space “in character” (IC) to play out stories based on favorite books, movies, or television shows. This new kind of adult narrative pleasure involves the sustained collaborative writing of stories that are mixtures of the narrated and the dramatized and that are not meant to be watched or listened to but shared by the players as an alternate reality they all live in together.

Movies in Three Dimensions

We do not have to wait for Star Trek’s fanciful molecular replication technology or the “emotional engineers” of Brave New World to see three-dimensional fictional characters standing before our eyes. The Sony IMAX Theater across from Lincoln Center in New York City is the very model of Huxley’s Alhambra. Entering a lobby ringed with video screens and ticket machines, you ascend through an atrium of multistory escalators and pass through a seemingly limitless expanse of theaters until you reach, at the very top, “the biggest movie screen on earth.” How big is it? A video monitor is winking away over the waiting area to bombard you with the statistics. The 3-D screen is eight stories high and 100 feet wide, the size of seven elephants; the special film is ten times the size of 35mm film, is stored in a canister that is 7.5 feet in diameter, and runs in a projector that weighs 500 pounds and uses 18,000 watts of electricity. Inside you sit in a cheerful, spacious, banked theater facing the indeed enormous screen, and though there are no feely knobs, you are provided with a pair of plastic 3-D goggles with liquid crystal lenses and built-in speakers that
create a "personal sound environment." The goggles are engineered so that an undetectable shutter action takes place many times a second, blanking out one eye and then the other, to send two separate images to the imaging centers of your brain. It is the combination of the slightly different left and right images that produces the appearance of three-dimensional space.

When the movie starts, the sensation is not of size or gadgetry but of a magical apparition, for the 3-D movies that are shown in this new Alhambra make conventional movies look like daguerreotypes. The world that is displayed through those lightweight and soon forgotten goggles has the depth and dimension of the actual world, where you can see around things, look left and right, and shift your focus from back to front within the same image. The size of the film means an increase in information, offering a richer and therefore more persuasive visual illusion. It is not merely a larger image but a more present reality.

For a short feature this sense of presence is exciting in itself. When I saw my first 3-D movie at Disney World's Epcot Center in the 1980s, I held my breath when a little blue bird flew out of the screen and landed right in front of my nose. I and everyone else in the audience reached out a hand to touch the bird, for we each, at our different locations, saw it right in front of us. During the viewing of a long feature, the reaching eventually subsides as the audience comes to take for granted a representational world with persuasive depth but no solidity. The question then becomes, What kinds of stories is such a high-sensory technology suited to tell us? Filmmakers have just begun to answer that question, but the first two feature films made with the IMAX technology look much more like Star Trek's Lucy Davenport than like Huxley's Three Weeks in a Helicopter.

Across the Sea of Time (1995) is a modest story of a Russian immigrant boy, Tomas, who has magically arrived in contemporary New York to trace the path of an immigrant relative with the help of stereopticon photos from the turn of the century. The story provides a pretext for spectacular photography, including the helicopter shots
Huxley was already lamenting in the 1930s, here accompanied by the sound of violin crescendos as we swing across the Brooklyn Bridge. But these panoramas, like the billboard ads and insurance blimps caught by the camera, are there to pay the rent by making the film serve as a good tourist attraction. They are not that much more striking than the familiar two-dimensional versions or the large-format films shown in amusement parks or planetariums. The three-dimensional panoramas do become striking, however, when they are anchored by the foreground figure of the young boy. When Tomas is standing on the parapet of a skyscraper and looking at the vast spaces of the city, we are taken out of the generic landscape of tourist spectacle and placed in a very present dramatic moment. Such moments indicate that this is a technology that is ready to tell more intimate stories.

A large part of the pleasure of the film lies in the original black-and-white stereopticon photos. Even though the people in these photos appear rather like cutouts in a diorama-like scene box, the establishing of multiple planes animates them. The three-dimensional projection becomes a resurrection of the dead; we are given the ability to see them and to see the world through their eyes with stunning immediacy. The joy of a particular day on the beach at Coney Island is made palpable in the way a pair of lovers are leaning toward one another and in the weight of a girl’s arm around her friend’s shoulder as they laugh and enjoy their holiday. The sensation of resurrection is even stronger in a photo taken of three workers, two white and one black, digging a tunnel for a subway. We enter the deep tunnel and feel the dank, claustrophobic confinement. We look at the posture and feel the exhausting labor. Here is the very antithesis of the feely, yet it is delivered in the exact technology Huxley distrusted. These stereopticon images wedded to film are used not to distance us from reality or to present oversized, dehumanized “stars,” but to bring us close to the plain working folk whose experiences make up the true but hidden history of a great city. The technology does not make them larger than life, only more present to us.
One of the reasons the subway scene works so well is that three-dimensional photography is particularly impressive for enclosed spaces. Perhaps the most successful dramatic moment comes early in the film when the boy is a stowaway on a boat leaving Ellis Island. As Tomas cowers in the cramped hull of the ship, surrounded by the cold metal of the ship's pipes and machinery, a huge but kindly-looking stranger opens the door of his hiding place, reaches forward and extends to the boy a paper lunch bag. Sitting in the audience I could almost feel the lunch bag in my lap, and I experienced the generosity of the moment almost personally because I was so physically grounded in the boy's surroundings. In a conventional movie such a moment would have to be emphasized by close-up shots of the boy's face expressing his feelings of gratitude. In a 3-D film, the audience can be so closely identified with the situation of a character that such reaction shots are unnecessary.

But at this very moment in the film comes an event that I found quite jarring. When the lunch bag is placed before us, a small hand reaches, as if from behind us, to take it. The audience sees only the back of the hand, which we recognize as belonging to the boy—but I also immediately thought of operating it, as if it were a cursor in a videogame! Similarly, toward the end of the movie we are on a wonderfully realized street in contemporary Greenwich Village. It is a documentary shot—at street level, no spectacular helicopters, just life on that street corner at that moment. A couple in what would ordinarily be the background crosses the street. But there is no background. I am there. My attention is caught, and I want to follow that couple and see what their story is. Instead, the camera relentlessly drags me into a bar on the corner with the young boy. Again, I see a wonderfully detailed environment. Behind the bar are prints of some of the same stereopticon photos we have been seeing. I want to move closer, to lean into the shot and get a better view, but the camera stays with the dramatic action of the scene, namely, Tomas's conversation with the bartender. I am uncomfortable at these moments because the three-dimensional photography has put me in a virtual
space and has thereby awakened my desire to move through it auton-
omously, to walk away from the camera and discover the world on my own.

The tension between watching a movie and being in a virtual place is even stronger in the more ambitious but less successful Wings of Courage (1995), a full-length IMAX feature that tells the story of the pioneer aviator Henri Guillaumet, who crashed his bi-plane in the Andes in 1930 and walked for six days and five nights through the snow to his rescue. Huxley's helicopter rules again in spectacular flight sequences that emphasize the fragility of the small planes against the vastness of the lonely mountains. But my immersion in these scenes was constantly disrupted by the director's shifting from interior to exterior shots and from one point of view to another. Such frequent cuts would be good practice for a conventional film (they would help the audience see the full picture), but they are out of place in a three-dimensional film, which can place me so concretely in space I become dizzy when shifting my point of view.

Again, it is the smaller places in the film that are the most arrested—a romantic period café, a cluttered office, Henri's girlfriend's cozy parlor. When the camera puts the audience at the same café table as the actors, the edge of the table is in the foreground and we can see to the left and right as well as across the table. When the waiter moves around the table, we see him from all angles. It is only when the camera angle switches that we are unpleasantly jarred from our trance of feeling that we are actually there.

Perhaps the most compelling environment in the film is the cave that Henri makes beside the wreckage of the plane. It is here that I experienced a surprising intimation of the dramatic potential of this medium. The hero Henri is describing, in voice-over, his plans for survival, carefully calculating the distance he must walk to safety and the time it will take to get there, as if he is writing in a pilot's logbook. His public voice is full of stoic resolve. But from the back of my headset comes a fearful whisper: "It can't be done. It simply can't be done." The filmmaker has taken me inside Henri's mind with star-
thing effect. In some ways it is a Huxleyan moment. The audience is plugged into a sound machine, and it is goosing us. But in the context of the film, Henri's whisper of self-doubt is a moment of unmediated intimacy. It gave me chills not because of the gimmickry but because it brought me into unexpected closeness with this particular human being in his struggle for courage. At this one moment in an otherwise uninvolved story, I could sense the potential of this technology to take us seamlessly into a character's mind. The three-dimensional sound and images held out the possibility of a dramatic art form that can juxtapose the inner and the outer life as easily and gracefully as prose.

Riding the Movies

Huxley's fears are more fully realized in the sensation-oriented amusement park attractions that promise to let you "ride the movies." In this increasingly popular entertainment, the rider is placed on a hydraulically controlled movable platform or seat that tilts, twists, pitches, and shakes in synchronization with large moving images and environmental sound; an apparatus that seems very much like Huxley's pneumatic feely stalls. The concept of "riding" a movie fits the general strategy of entertainment industry conglomerates to create multiple "marketing windows" for the same imaginative product. If audiences loved to watch the DeLorean in Back to the Future or the motorcycle chases in Robocop or the magic carpet ride in Aladdin, they are primed to spend their money on rides based on these films. The first such attraction was the four-minute Star Tours, a ride developed in the early 1980s by two masters of cross-merchandising, Walt Disney Company and Lucasfilm. Star Tours was an immediate success.

The "movie ride" is engineered for strong visceral effects. It combines the surprises of the funhouse with the terrors of the roller coaster. According to Douglas Trumbull, who went from doing special effects in science fiction movies to making simulator rides, the
aim is "to create an environmental total sensory experience that throws you right into the screen and you go into the movie." As with three-dimensional films, the marketing emphasis is on the midway—bigger is better and biggest is best. So part of the attraction of Back to the Future, a ride that cost $16 million and uses three hundred speakers, twenty laser disc players, fifty miles of electrical wire, sixty video monitors, two 80-foot projection screens, and twenty computers, is that it is carefully engineered to provide the maximum thrill, to leave the rider breathless. "This ride can exert up to 1.8 Gs of force as it tilts and twists," says the Web page for the ride. "Compare the lowly airline jet, which rarely reaches 1.5 Gs!"

But the movie-rides are providing evidence that audiences are not satisfied by intense sensation alone. Once people do go "into" the movie, they want more than a roller-coaster ride; they want a story. Developers have lately been expanding the duration of the rides and are adding more characters and incidents to them to meet the rider's expectation of dramatic action. Most ambitiously, they are giving the rider more freedom to direct the ride and more opportunity to affect the unfolding story. The model is changing from one in which a rider is swept along in an exciting action to one in which a "guest" is paying a visit to an enticing place. For instance, on the Aladdin ride at Walt Disney World based on the animated feature film, you are seated on a magic carpet and allowed to move freely through the fantasy city of Agrabah. Because the developers had dynamically generated computer images rather than photographs, they were able to expand the world of film and to create an attraction that allows for multiple possible experiences. Guests are drawn into the town by the charm of its minarets, the mysteries of its back streets, and the presence of animated characters. They are given a role in the story, and their movements are motivated by the task of finding a hidden scarab. The Aladdin model suggests the possibility of a new kind of movie-ride, an adventure experience that is driven by the guest's curiosity and the beauty of the explorable world rather than by rushes of adrenaline.

Aladdin is an exception to the general trend, however, if only be-
cause of the high level of technical resources that Disney has poured into it, including special Silicon Graphics computers to generate the images in real time. For every one such attraction there will probably be hundreds of minirides based on limited movement, and much sketchier environments and focused on combat between customers within the virtual environment. Furthermore, the proliferation of even the high-end imaginative ride still raises the disconcerting specter of a universe of entertainment products that advertise one another. See the movie! Ride the simulator! Play the game! The more successful such tactics prove, the more often movies will incorporate action sequences designed specifically for development as other "market windows." This may produce an entertainment paradise for fifteen-year-old boys, but it would mean an emotionally impoverished narrative form composed of many helicopter shots and far fewer moments of closeness with a particular human being.

Dramatic Storytelling in Electronic Games

While linear formats like novels, plays, and stories are becoming more multiform and participatory, the new electronic environments have been developing narrative formats of their own. The largest commercial success and the greatest creative effort in digital narrative have so far been in the area of computer games. Much of this effort has gone into the development of more detailed visual environments and faster response time, improvements allowing players to enjoy more varied finger-twitching challenges against more persuasively rendered opponents. The narrative content of these games is thin, and is often imported from other media or supplied by sketchy and stereotypical characters. This lack of story depth makes even wildly popular figures like the Mario brothers of the Mortal Kombat fighters impossible to translate into successful movie heroes.

In fact, in many maze-based games the story works against involvement in the game. One teenage fan of the X-Men, for instance, enjoyed the fighting moves of the characters in the Clone Wars game,
which involves an invasion by the evil Phalanx, but found that the story line was inhibiting his ability to play. The game is structured so that the player is one of the X-men, who must save Earth from an invasion by the evil Phalanx forces. The X-men need the help of Magneto, a superhero who lives in a satellite stronghold. But in order to reach Magneto, the X-men must battle Magneto's soldiers in maze level after murderous maze level while receiving regular bulletins on the many countries that have fallen to the Phalanx. "Why should I want to kill these guys?" the player wanted to know. "We should all be working together." In order to make the conflict with the Phalanx the climax of the game, the developers had come up with a story of futile killing. As in many such games, the Clone Wars plot is contained in brief segments of text shown between the maze levels. The teenager wound up turning the story segments off altogether, as many players do with fighting games.

Electronic puzzle games rely less on violence than do twitch games. They also have a slower pace of engagement, since the player must figure out how to work the magic lever or where to search for the secret key. Although puzzle games can subordinate the story to the game play, just as the fighting games do, many puzzle games take advantage of this slower pace to offer a richer level of story satisfaction. In playing the early but still lovingly remembered text-based adventure game Planetfall (Infocom, 1983), you are a lowly deckhand on the spaceship Feinstein, which is soon destroyed by an explosion. Landing on a mysteriously deserted planet, you must survive long enough to figure out how to get away. In an abandoned laboratory, you find a deactivated robot, Floyd. Once you figure out how to turn Floyd on again, you are no longer alone. Wherever you go from then on within this baffling and dangerous world, Floyd is always there, chattering affectionately, begging for attention, playing with a rubber ball, and eagerly providing information and small services. After living through many adventures with Floyd, you reach the door of the radiation lab that contains a crucial piece of equipment. Inside the room are loud and dangerous mutants. As you stand outside the door
listening to the murderous clamor, Floyd volunteers with characteristic childlike loyalty—"Floyd go get," he says—and rushes into the deadly chamber without giving you a chance to stop him. After accomplishing his mission, Floyd emerges "bleeding" oil and dies in your arms.

At this point the game changes from a challenging puzzle to an evocative theatrical experience. The escape from the planet continues, but without Floyd’s company the player feels lonely and bereaved.

The memory of Floyd the Robot’s noble self-sacrifice remains with players even years later as something directly experienced. "He sacrificed himself for me," is the way one twenty-year-old former player described it to me. Even those who speak of it less personally ("When you get to that room, he goes in to save you") convey a sense of wonder at the unexpected and touching quality of the gesture. The death of Floyd is a minor milestone on the road from puzzle gaming to an expressive narrative art. It demonstrates that the potential for compelling computer stories does not depend on high-tech animation or expensively produced video footage but on the shaping of such dramatic moments.

On the other hand, some game designers are making good use of film techniques in enhancing the dramatic power of their games. For instance, the CD-ROM game Myst (1993) achieves much of its immersive power through its sophisticated sound design. Each of the different areas of the game is characterized by distinctive ambient sounds, like the whistling of wind through the trees or the lapping of waves on the shore, that reinforce the reality of fantasy worlds, which are really just a succession of still images. Individual objects are also rendered more concrete by having them ping, thump, and whirr appropriately when manipulated. Wandering through a sinister fortress hideaway, I hear a musical motif that gets darker and more foreboding with each step and reaches an emotional peak when I uncover a severed head. The music track works as a game technique: it provides a clue that I am mouse-clicking along in the right direction, like the
hot and cold clues in a game of treasure hunt. But it is not gamelike in tone. Instead, the solemnity of the music reinforces my feeling of having come in immediate contact with a terrible act of depravity. The music shapes my experience into a dramatic scene, turning the act of discovery into a moment of dramatic revelation.

Games hold the potential for more powerful moments of revelation than they currently make use of. Some years ago I was drawn into playing a compelling arcade game while on vacation with my husband and children. We had just entered the game room to give the kids a treat, when I spotted a large-format TV screen in front of a laser gun in the shape of a six-shooter. On the screen a cowboy was standing in front of a low-cost version of the kind of TV Western set I spent much of my childhood watching. "Howdy, partner," he said, and asked for some help in running some bad guys out of town. I was immediately hooked. It was clear to me that this was the game I'd been waiting for all my life. I shot my way cheerily through the jail, saloon, livery stable, and bank, knocking off the bad guys not quite as fast as the game knocked off my supply of quarters. I was lost in a state of deep reverie. Eventually my son and daughter ran out of quarters and came to find me. As I turned toward them, I was conscious of being two very different people: the fervently pacifist mother who had taken them on peace marches and forbidden all military toys and guns and the six-shooting cowgirl who had grown up identifying with Annie Oakley and Wyatt Earp. I would not claim that Mad Dog McCree, the game I was playing, was a masterful piece of storytelling. But the moment of self-confrontation it provoked, the moment in which I was suddenly aware of an authentic but disquieting side of myself, seems to me to be the mark of a new kind of dramatic experience.

Although economic and social forces may never move the established game industry far past the lucrative shoot-'em-ups and puzzle mazes, there is no reason why more sophisticated developers could not make stories that have more dramatic resonance and human import to them, stories that, unlike Huxley's feelies, mean something, just as Floyd's death is meaningful in the adventure game Planetfall,
the revelation of murder is meaningful in Myst, and the revelation of my own capacity for violence was meaningful to me in that arcade.

Story Webs

The accessibility of the World Wide Web has introduced a growing audience to hypertext fiction. Hypertext is a set of documents of any kind (images, text, charts, tables, video clips) connected to one another by links. Stories written in hypertext can be divided into scrolling "pages" (as they are on the World Wide Web) or screen-size "cards" (as they are in a Hypercard stack), but they are best thought of as segmented into generic chunks of information called "lexias" (or reading units). Paper pages are bound into books in a single sequence; paper index cards must be arranged with no more than one card before and one after them even though they can be more easily searched in nonsequential order. But screen-based pages and cards become lexias: they occupy a virtual space in which they can be preceded by, followed by, and placed next to an infinite number of other lexias. Lexias are often connected to one another with "hyperlinks" (or "hot words"), that is, words that are displayed in color to alert the reader/viewer that they lead someplace else. For example, if I were writing this book as a hypertext, I would display the word lexias in the third sentence of this paragraph in color as a hot link instead of placing a superscript number next to it to indicate an endnote. Mouse-clicking on the word would bring up a new screen displaying the information on who invented the term and who applied it to electronic text, information that is now hidden at the back of the book. Another hyperlink might lead out of my book entirely and straight into a book by Roland Barthes or George Landow, or it could lead to a short bibliographical annotation that would pop up on the screen like a sticky note, appearing and disappearing at the will of the reader. A single lexia may contain many links, or it may contain no links at all, thereby gluing readers to the page or allowing them to move only forward or backward, as the pages of a book do. The existence of hy-
Hypertext has given writers a new means of experimenting with segmentation, juxtaposition, and connectedness. Stories written in hypertext generally have more than one entry point, many internal branches, and no clear ending. Like the multiform life stories imagined by Borges and Lightman, hypertext narratives are intricate, many-threaded webs.

Hypertext formats are not new as intellectual structures. The Talmud, for instance, is a giant hypertext consisting of biblical text surrounded by commentaries by multiple rabbis. Literary works are hypertextual in their allusions to one another. In the twentieth century the allusiveness has grown so dense that a work like James Joyce's Ulysses is almost impossible to understand without accompanying pointers to other works, including a map of Dublin. The Dictionary of the Khazars, one of the multiform texts discussed earlier, is a print-based hypertext with entries that point to one another, making possible many coherent reading sequences. Although hypertext is not new as a way of thinking and organizing experience, it is only with the emergence of the computer that hypertext writing has been attempted on a large scale.

The hypertext formats of the 1990s support many kinds of narrative writing, from voyeuristic soap operas aimed at advertising revenues to postmodernist experimental fiction for university students. The first widely successful hypertext narrative is The Spot, a sexually titillating soap opera about a group of West Coast yuppies living in a beach house who post their diary entries regularly on the Web. Readers can hop through the various diaries to compare different versions of the same event; can search through past events to catch up on the plot; and can even participate in the story by posting opinions, advice, or their own stories to a bulletin board in which the simulated characters participate along with fans. The characters in The Spot play to the prurient interests of the fans with a kind of self-mocking soft-core exhibitionism. For instance, in answer to one fan's challenge to prove that the diaries are being written in real time, a character posted a picture of herself, as directed, standing in a
bikini in front of the refrigerator and holding a strawberry. This cyberspace striptease, however appalling, is also indicative of the real innovation behind this otherwise banal and poorly written soap. The dramatic action is not in the canned story created by the writers alone but in the spontaneously improvised exchanges between the simulated characters and the participating fans. In defter hands such audience engagement could provide imaginative, not just sexual, excitement.

The literary publisher Eastgate Systems distinguishes its products from both pornographic “Web soaps” and games by calling them “serious hypertext.” The pioneering work in this genre is Michael Joyce’s *Afternoon* (1987), written in the Storyspace hypertext system, which he co-designed with Jay David Bolter and John Smith specifically for the purpose of writing narrative as a set of linked text blocks. *Afternoon* contains 539 carefully crafted lexias and begins with one (although it does not necessarily come first) entitled “I Want to Say”; this lexia consists of a single compelling sentence: “I want to say I may have seen my son die today.” From here the reader is sent clicking through the cardlike lexia to find out more.

There is a lot to learn about the narrator, Peter, and about his ex-wife, lovers, and friends, but most readers are not able to determine whether his son is alive or dead or what Peter may have seen at the site of a roadside accident. Instead, the reader circles through a complex web of lexia, each of which has several possible links to follow, including a default “next” lexia, which appears in answer to a tap of the return key. There is no overview of the work’s structure, and the “hot word” links do not offer much of a clue to the content to which they lead. To complicate things further, Joyce has programmed some of the links to force the reader to return to the same lexia again and again in order to be permitted to go to new places in the story. This continual circling through a confusing and contradictory space, freighted with anxiety about the death of a child and irritation at Peter’s self-absorbed behavior, is reminiscent of a familiar *Star Trek* plot—the one where the holodeck malfunctions; the characters act...
out of role; and no matter what the crew members try, they cannot get out of the system.

But to the postmodernist writer, confusion is not a bug but a feature. In the jargon of the postmodern critics, Joyce is intentionally "problematizing" our expectations of storytelling, challenging us to construct our own text from the fragments he has provided. In the most praised effect of the story, he conceals a key section in a way that mirrors the protagonist's self-deceit. Only after repeated evasions can readers reach the lexia in which Peter will call his therapist and face his memory of his own culpability in the accident. For readers who enjoy the textured verbal labyrinth of Afternoon, there is a particular pleasure in coming to this section, although it does not have the finality of an ending or of an unambiguous solution to a mystery. Instead it deepens the range of possible interpretations of Peter's morning and afternoon. The architectural playfulness of Afternoon, its construction as a series of discrete lexia linked by overlapping paths, and the poetic shaping of its individual lexia mark it as the first narrative to lay claim to the digital environment as a home for serious literature in new formats.

Much of the writing on the World Wide Web in 1996 is in standard short story format, perhaps with a few pictures or graphics added in; most writers have taken only limited advantage of the opportunity to write in hypertext structures. But the generation now in college grew up using encyclopedias on CD-ROMs and even making hypercard projects in the computer lab. In college, where they have an Internet connection that is faster than what they had at home, they use the World Wide Web as their primary source of reference material. They make their own hypertext self-portraits, in the form of personal "home pages," which they publish on the Web. Meanwhile, elementary and high schools are hooking up to the Internet in greater numbers every year. Unlike the first users of the medium, the next generation of writers will take the hypertext format for granted. As they come into greater expressiveness, they will bring the tangled structures of the current Web into more coherent order.
Computer Scientists as Storytellers

While dramatic and written narrative traditions have moved closer to the computer and computer-based entertainments have become more storylike, computer science itself is moving into domains that were previously the province of creative artists. Researchers in fields like virtual reality and artificial intelligence, who have traditionally looked to the military for technical challenges and funding, have recently turned from modeling battlefields and smart weapons to modeling new entertainment environments and new ways of creating fictional characters. These changes promise to greatly expand the representational power of the computer.

For instance, at Mitsubishi Electronics Research Laboratory researchers have created an appealing software environment that lets people at distant locations move through the same imaginary landscape. Diamond Park appears on large display screens as a grassy gathering place with bike trails, an outdoor restaurant, and inviting gazebos drawn in a vaguely turn-of-the-century style. The bike trails are important because one of the first interfaces to this environment is a stationary bicycle equipped with a video display screen. You can move along the virtual trails by pedaling, just as you would move down a racecourse in an arcade driving game by stepping on the pedals of the car. But the difference here is that instead of racing forward, you can move in any direction (even off the paths), and the picture before you will change appropriately, reflecting your own position. You will also appear on the screen of other users, and they will appear on your screen as “avatar” figures (in this case, as animated drawings of people riding bicycles). Wearing a small microphone and headphones, you can talk to the other people as they come near; you can also pick up ambient sound, like music playing in the café. The bicycle interface acts like the vehicles in a movie-ride in that it makes the distances seen on the screen seem much more concrete by tying the visual movement to a kinetic environment. However, here the world is not built for adrenaline rushes but for socializing and exploration.
Sites like these (with or without bicycles) mark the future of the MUDs and chat rooms of the current Internet.

How present could we be in such environments? We could have our actual faces photographed in real time and mapped onto the avatars in the software. We could experience the virtual world not as a flat screen but as a virtual reality (VR) "pod" that surrounds us on six sides, like the holodeck. Although we would not have a holodeck chair to sit on, we could have something like a feely knob. We could wear clothing equipped with “tactors” that push back at us with the same pressure and texture as real objects. We could even hook the tactors up to distant objects, so that wearing a special glove we would “feel” the weight of an actual moon rock being lifted by a robot equipped with special sensors. Or we could hook up surgical instruments with tactors and attach them to a computer model of a patient, so that the images we would see would be reinforced by the appropriate feel of living tissue. Gamemakers are already adopting tactor technology to make more viscerally satisfying joysticks, and although the joysticks will not convey the sensation of a kiss, they will make for a more satisfying gun recoil or car collision.

Even without these force sensors, some VR installations of the 1990s are so visually present that interactors think they have touched things in the virtual world, including one another, even when they have not. One of the most intriguing such installations is the Placeholder world created by Brenda Laurel and Rachel Strickland for Interval Research Corporation in California. Laurel, who holds the world's first Ph.D. in interactive narrative, has been designing games and user interfaces since the 1970s. A critic of the conventional VR navigation system (in which users navigate by moving their hand or jiggling their head), Laurel designed an environment in which the system follows the changing full-body positions of people who move around in a natural way. Interactors wear VR helmets (which contain the three-dimensional visual display) and body sensors and must limit their movements to a "magic circle" marked out by rocks on the floor (an echo of the fairy ring, which is a traditional place of enchant-
ment). Once inside the Placeholder world, they can enter the bodies of virtual animals and move as they move. For instance, if a woman in the crow’s body spreads her arms, she sees her crow wings extend and her perspective changes as her crow body lifts off the ground. By swooping and banking appropriately she can take an exhilarating flight along a waterfall. Placeholder uses visual and sound motifs from the world of mythology to encourage collaborative imaginative play between pairs of interactors. It purposely avoids the commercial characters and weapon-driven competitive games of the movie-rides and arcade-style simulators. Placeholder suggests that reality technology can create a kind of stage set for adult improvisational play.

Perhaps the least encumbered holodeck experience available right now is in front of the twelve-foot computer screen set up by the ALIVE project of MIT’s Media Lab as a “magic mirror” in which interactors see their own reflection placed beside the cartoon images of virtual characters designed in the lab. In one scenario a little puppetlike child follows you around and tries to get your attention. In another a hamster scurries around, coming to you when you pick up some virtual food and hiding behind you when a foxlike predator is released. In a third a frisky dog named Silas will play fetch with you. These attractive creatures live within the magic mirror as if it were a real three-dimensional space, an alternate reality echoing the rug area on which the interactor moves.

The Wonderland creatures on the other side of this looking glass are called “intelligent agents.” They are computer-based characters with complex inner lives who can sense their environment, experience appetites and mood changes, weigh conflicting desires, and choose among different strategies to reach a goal. They are persuasively alive because their behaviors are complicated and spontaneous. They are quite life-size and they appear to be in real space with the interactor. Although they are still a very long way from Captain Janeway’s romantic Lord Burleigh, such agents do have an independent existence of sorts and are significant steps on the road to believable holodeck characters.
When I play with Silas and his friends in front of the giant screen, they seem as alive as the animated figures in a movie—except that I am also in the movie. I have been prepared for this experience by watching so many movies that mix live and animated figures. However, it is much easier for me to suspend my disbelief in the existence of these creatures when someone else is interacting with me. The little puppet-like girl, for instance, came completely to life for me on the day when I was with a group showing the actress Lily Tomlin through the lab. Tomlin sat down on the carpet and patted the place beside her as the little figure shyly moved closer; the actress’s gesture turned the interaction into a relationship, the beginning of a story of a developing intimacy. But seeing myself in the mirror, in my own ordinary clothes, which tell me I am in Cambridge rather than in Wonderland, I have a harder time sustaining the illusion.

Nevertheless, a floor-to-ceiling computer screen is an impressive way to display a virtual world. When the Media Lab setup is not in use for these advanced projects, graduate students play Doom by projecting its cavelike landscape on the screen and standing in front of it holding a plastic gun. The camera attached to the screen tracks the player’s actions and sends messages to the game as if the player were holding a joystick. On the day I took a turn playing, the gun was not firing, but the fluid navigation through the enormous three-dimensional spaces was rapturous in itself.

In addition to creating vivid virtual worlds we can enter and fictional characters we can interact with, researchers are also developing complex computer models of plot. For instance, at Carnegie Mellon University, the Oz group, led by Joseph Bates, applies artificial intelligence techniques to storytelling. One project of the group is based on an existing text-based computer game called Deadline. Their goal is to customize the events of the murder mystery for each individual player so that the clues, red herrings, and revelations arrive at a satisfying pace, no matter what the player chooses to do. Deadline takes place in a mansion where there are suspects to be interviewed and physical evidence to discover. It is designed around a
time scheme, so that if the detective does nothing to prevent it, a second murder takes place midway through the story. The O2 group analyzed all of the possible paths a player might take through the story and identified the ones that are the most satisfying. They then fed this information to a complex mathematical procedure called "adversary search," which is similar to the algorithms used in chess-playing systems, and which can calculate the optimal response to any action of the player in order to coax the player toward the most interesting narrative paths. A story system based on this design would eliminate the confused thrashing that accompanies much computer game playing by moving the interactor forward, not necessarily toward the solution to the puzzle but toward the most dramatically engaging encounters.

All of this research is still in the laboratory for now, but it is exciting to think about what it might add up to if all these technologies are combined. Imagine a visit to an entertainment venue of the late twenty-first century, the equivalent of a movie theater. The equivalent of a hit movie for the year 2097 might perhaps begin with a walk through a three-dimensional projected environment looking much like the theme-based restaurants and parks of our time or like the digital sets that are increasingly common in contemporary movies. We would be able to move the images around by moving our hands; for example, we might pick an illusory apple from a bowl of fruit or move an illusory chair. We would feel the weight and texture of these objects, although we could not eat the apple or sit on the chair. We would meet characters within this world who would sense our presence and converse with us; they would become as familiar to us as the characters in a beloved book or film. We would enter the story, and the plot would change according to our actions while still sustaining its power to surprise and delight us. What would such stories be like? How would we know what to do if we found ourselves inside one? Although we cannot predict how far the technology will take us, it is irresistible to speculate on such possibilities.

Even the near-term prospects are compelling. We are on the brink
of a historic convergence as novelists, playwrights, and filmmakers move toward multiform stories and digital formats; computer scientists move toward the creation of fictional worlds; and the audience moves toward the virtual stage. How can we tell what is coming next? Judging from the current landscape, we can expect a continued loosening of the traditional boundaries between games and stories, between films and rides, between broadcast media (like television and radio) and archival media (like books or videotape), between narrative forms (like books) and dramatic forms (like theater or film), and even between the audience and the author. To understand the new genres and the narrative pleasures that will arise from this heady mixture, we must look beyond the formats imposed upon the computer by the older media it is so rapidly assimilating and identify those properties native to the machine itself.
Beyond “Multimedia”

The birth of cinema has long been assigned to a single night: December 28, 1895. A group of Parisians, so the legend goes, were gathered in a darkened basement room of the Grand Café on the Boulevard des Capucines when suddenly the lifelike image of a mighty locomotive began moving inexorably, astonishingly toward them. There was a moment of paralyzed horror, and then the audience ran screaming from the room, as if in fear of being crushed by an actual train. This no doubt exaggerated account is based on an actual event, the first public showing of a group of short films that included “Arrival of a Train at La Ciotat Station” by the Lumière brothers, who (like Edison in America) had just invented a reliable form of motion picture photography and projection. Film scholars have recently questioned whether the novelty-seeking crowd really panicked at all.¹ Perhaps it was only later storytellers who imagined that the first projected film image, the novelty attraction of 1895, could have carried with it the tremendous emotional force of the many thrilling films that followed after it. The legend of the Paris café is satisfying to us now because it falsely conflates the arrival of the representational
technology with the arrival of the artistic medium, as if the manufac-
ture of the camera alone gave us the movies.

As in the case of the printing press, the invention of the camera
led to a period of incunabula, of “cradle films.” In the first three
decades of the twentieth century, filmmakers collectively invented
the medium by inventing all the major elements of filmic storytelling,
including the close-up, the chase scene, and the standard feature
length. The key to this development was seizing on the unique physi-
cal properties of film: the way the camera could be moved; the way
the lens could open, close, and change focus; the way the celluloid
processed light; the way the strips of film could be cut up and re-
assembled. By aggressively exploring and exploiting these physical
properties, filmmakers changed a mere recording technology into an
expressive medium.

Narrative films were originally called photoplays and were at first
thought of as a merely additive art form (photography plus theater)
created by pointing a static camera at a stagelike set. Photoplays gave
way to movies when filmmakers learned, for example, to create sus-
pense by cutting between two separate actions (the child in the burn-
ing building and the firemen coming to the rescue); to create
character and mood by visual means (the menacing villain backlit and
seen from a low angle); to use a “montage” of discontinuous shots to
establish a larger action (the impending massacre visible in a line of
marching soldiers, an old man’s frightened face, a baby carriage toter-
ing on the brink of a stone stairway). After thirty years of energetic in-
vention, films captured the world with such persuasive power and told
such coherent and compelling stories that some critics passionately
opposed the addition of sound and color as superfluous distractions.

Now, one hundred years after the arrival of the motion picture
camera, we have the arrival of the modern computer, capable of
hooking up to a global internet, of processing text, images, sound,
and moving pictures, and of controlling a laptop display or a
hundred-foot screen. Can we imagine the future of electronic narra-
tive any more easily than Gutenberg’s contemporaries could have
imagined War and Peace or than the Parisian novelty seekers of 1895 could have imagined High Noon?

One of the lessons we can learn from the history of film is that additive formulations like "photo-play" or the contemporary catchall "multimedia" are a sign that the medium is in an early stage of development and is still depending on formats derived from earlier technologies instead of exploiting its own expressive power. Today the derivative mind-set is apparent in the conception of cyberspace as a place to view "pages" of print or "clips" of moving video and of CD-ROMs as offering "extended books." The equivalent of the filmed play of the early 1900s is the multimedia scrapbook (on CD-ROM or as a "site" on the World Wide Web), which takes advantage of the novelty of computer delivery without utilizing its intrinsic properties.

For example, one early version of a Web soap about a group of friends living in New York offers diary pages of text spiced with sexually suggestive photos. The wordiness of the journal keeps us constantly scrolling through the screens, impatient for something to happen in the narrated story or for something to do, like clicking on a link to get something new. There are, in fact, clickable buttons in the journal, but instead of offering new information they merely allow us to hear (after time delays for downloading the sound clip and for installing the necessary software to play the sound file if we do not already have it) actors speaking exactly the same dialog printed on the screen. The audio snippets are amusing novelties at best, and at worst they work like so many small apologies for the limits of the printed text. Just as the photographed plays of early filmmakers were less interesting than live theater, this early Web soap continually reminds us of how much less vivid it is than the romance novels and television dramas it draws upon.

A more digitally sophisticated Web soap would exploit the archiving functions of the computer by salting each day's new episode with allusions (in the form of hot word links) to exciting previous installments. Our clicking would then be motivated not by curiosity about
the media objects (show me a video clip) but by curiosity about the plot (why does she say that about him?). The computer presentation would thereby allow pleasures that are unattainable in broadcast soaps. For example, we could follow a single appealing subplot while ignoring the companion plots that may drive us crazy, or we could come in at any time in the story and review important past events in all their dramatic richness. Instead of using audio redundantly to act out dialogue in a diary entry, a sophisticated Web soap might provide the audio as an integral part of the plotline—perhaps as the wiretap of a murder threat or a political negotiation or as a phone message that carries information of hidden romantic liaisons.

Some Web stories are already using such techniques, and no doubt all of them will in time. Their adoption is part of the inevitable process of moving away from the formats of older media and toward new conventions in order to satisfy the desires aroused by the digital environment. We are now engaged in thousands of such discoveries in all the subgenres of electronic narrative, the result of which will be the development of narrative pleasures intrinsic to cyberspace itself. Therefore, if we want to see beyond the current horizon of scrapbook multimedia, it is important first to identify the essential properties of digital environments, that is, the qualities comparable to the variability of the lens, the movability of the camera, and the editability of film, that will determine the distinctive power and form of a mature electronic narrative art.

ELIZA Comes to Life

Well before the advent of multimedia, there was a moment in the history of the computer that demonstrated its representational and narrative power with the same startling immediacy as the Lumière's train did for the motion picture camera. This is the famous but often misunderstood moment in which the first completely computer-based character was created.
In 1966, Joseph Weizenbaum, a professor of computer science at MIT, created, as an experiment in natural language processing, a computer program called ELIZA that carried on a conversation by replying to typed-in statements with printed words. Since this was before the widespread use of computer screens, the program used a form of teletype device connected to one of the first time-sharing computer networks. The resulting persona, Eliza, was that of a Rogerian therapist, the kind of clinician who echoes back the concerns of the patient without interpretation. She also displayed a narrowly Freudian interest in topics like sex and the family. In a research paper describing the program, Weizenbaum included this remarkably coherent sample conversation:

*Patient:* Well, my boyfriend made me come here.
*Eliza:* YOUR BOYFRIEND MADE YOU COME HERE.
*Patient:* He says I'm depressed much of the time.
*Eliza:* I AM SORRY TO HEAR YOU ARE DEPRESSED.
*Patient:* It's true. I am unhappy.
*Eliza:* DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY?
*Patient:* I need help, that much seems certain.
*Eliza:* WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP?
*Patient:* Perhaps I could learn to get along with my mother.
*Eliza:* TELL ME MORE ABOUT YOUR FAMILY. 2

Eliza proved astonishingly persuasive. Soon a creation legend started to circulate that was based on an incident involving a researcher at a Cambridge think tank who left an early version of ELIZA running on his computer, which a vice president of the company thought was typing out a communication being transmitted by his colleague from home. (Just as the Lumière train story is a staple of film history, the Eliza story in its several versions appears in many textbooks and computer science lectures, often told as if it happened to Weizenbaum himself.) The conversation takes place at nine on a Saturday morning:
Vice president: Do you think that I can use the computer this morning?
Teletype: WHY DO YOU ASK?
Vice president: I might be able to make some additional telcomp (computer system) sales.
Teletype: WHY AREN'T YOU SURE?
Vice president: My prospective customers have never seen a demonstration of the system.
Teletype: DOES THIS MEAN VERY MUCH TO YOU?
Vice president: Of course it does.
Teletype: YOU SEEM VERY POSITIVE ABOUT THAT.
Vice president: This is ridiculous.
Teletype: WHAT DO YOU MEAN THIS IS RIDICULOUS?
Vice president: Is there any reason why I can't use the computer now?
Teletype: TELL ME MORE ABOUT YOUR PROSPECTIVE CUSTOMERS.
Vice president: Please dial me up on 491-1850
But because the vice president forgets to type in a final period, the machine does not answer him. Infuriated, he calls his colleague on the phone, resulting in this predictable exchange:

Vice president: Why are you being so snotty to me?
Researcher: What do you mean, why am I being so snotty to you?
(Explosion of anger)³

The story has become a legend because it discharges the anxiety aroused by the fear that Weizenbaum had gone too far, that he had created a being so much like an actual person that we would no longer be able to tell when we were talking to a computer and when to a human being. This is very much like the fear that people would mistake film images for the real world.

Eliza was not just persuasive as a live conversationalist; she was also remarkably successful in sustaining her role as a therapist. To Weizenbaum's dismay, a wide range of people, including his own sec-
retary, would “demand to be permitted to converse with the system in private, and would, after conversing with it for a time, insist, in spite of [Weizenbaum's] explanations, that the machine really understood them.” Even sophisticated users “who knew very well that they were conversing with a machine soon forgot that fact, just as theatergoers, in the grip of suspended disbelief, soon forget that the action they are witnessing is not ‘real’ ” (p. 189). Weizenbaum had set out to make a clever computer program and had unwittingly created a believable character. He was so disconcerted by his achievement that he wrote a book warning of the dangers of attributing human thought to machines.

Without any aid from graphics or video, Eliza’s simple textual utterances were experienced as coming from a being who was present at that moment. What was the representational force that allowed the computer to bring her so compellingly to life?

The Four Essential Properties of Digital Environments

When we stop thinking of the computer as a multimedia telephone link, we can identify its four principal properties, which separately and collectively make it a powerful vehicle for literary creation. Digital environments are procedural, participatory, spatial, and encyclopedic. The first two properties make up most of what we mean by the vaguely used word interactive; the remaining two properties help to make digital creations seem as explorable and extensive as the actual world, making up much of what we mean when we say that cyberspace is immersive.

Digital Environments Are Procedural

Eliza was brought to life by the procedural power of the computer, by its defining ability to execute a series of rules. It is surprising how often we forget that the new digital medium is intrinsically procedural. Although we may talk of an information highway and of bill-
boards in cyberspace, in fact the computer is not fundamentally a wire or a pathway but an engine. It was designed not to carry static information but to embody complex, contingent behaviors. To be a computer scientist is to think in terms of algorithms and heuristics, that is, to be constantly identifying the exact or general rules of behavior that describe any process, from running a payroll to flying an airplane.

Weizenbaum stands as the earliest, and still perhaps the premier, literary artist in the computer medium because he so successfully applied procedural thinking to the behavior of a psychotherapist in a clinical interview. It is the cleverness of Weizenbaum's rules that creates the illusion that Eliza understands what is said to her and that induces the user to continue the conversation. For example, if the user says, "Everybody laughs at me," the program can apply the rule that deals with me statements to echo the remark as, "You say that everybody laughs at you." This general rule models the neutrality of the Rogersian therapist, who reflects the patient's statements without judgment. Or, more cleverly, the program can select the specific rule for the word everybody, and reply, "Who in particular are you thinking of?"

Weizenbaum made sure the program would select the more specific reply by writing a rule that gives everybody a higher priority as a "key word" than me. Eliza's language processing includes no representation of syntax or meaning. Most of the time Eliza merely listens for key words such as everybody or depressed or father. Yet she is more believable than many programs with a more detailed representation of linguistic structure. Her credibility is the result of Weizenbaum's adroitness in formulating rules of discourse that are based on the ways in which a therapist would behave.

Eliza is not a neutral procedural model but a comic interpretation. Just as an actor might use makeup to emphasize a large nose or an owlish look, Weizenbaum used procedural notation to give parodic emphasis to some familiar absurdities of therapy itself. Like any classic type, Eliza is predictable in a way we instantly recognize and savor.
She is a descendent of the vaudeville doctor who bungles the exam, of the comic simpleton whose role is to misunderstand whatever is happening around her, and of the enjoyably repetitive flat characters in Dickens who repeat the same tag lines or behavior whenever we see them (“I never will desert Mr. Micawber,” chimes the wife of the pompous screwup in *David Copperfield*). The very rigidities of the computer are exploited for comic effect because they echo the rigidities of certain psychotherapeutic methodologies. The joke is on the therapists.

By mirroring the artificial constraints of therapy talk, Eliza makes them ridiculous. Consider, for instance, the following exchange:

*Eliza*: Tell me more about your family.
*Patient*: My mother is very motherly.
*Eliza*: Who else in your family is very motherly?
*Patient*: I am very motherly.
*Eliza*: Is it because you are very motherly that you came to see me?
*Patient*: Do you need a mother?
*Eliza*: We are discussing you, not me.  

Eliza will reflect back any “I am X” statement with a formulation like “Is it because you are X that you came to see me?” Here, the patient responds to the suggestion by playfully challenging the shrink. But, Eliza invokes her rule for you questions, redirecting the conversation back to the patient like any well-trained therapist. Putting these two rules together creates a coherent dramatic dialogue with a punch line. Such dialogues are easy to generate and irresistible to attempt. They amount to a kind of collaboratively written comedy skit. Few people would now perceive Eliza as a real psychotherapist. But as an improv partner, Eliza is still quite popular, available on most computer networks and sometimes sending a bill by e-mail after the session.

The lesson of ELIZA is that the computer can be a compelling medium for storytelling if we can write rules for it that are recognizable as an interpretation of the world. The challenge for the future is
how to make such rule writing as available to writers as musical notation is to composers.

Digital Environments Are Participatory

The energy with which people enter into dialog with Eliza is also evidence of a second core property of the computer: its participatory organization. Procedural environments are appealing to us not just because they exhibit rule-generated behavior but because we can induce the behavior. They are responsive to our input. Just as the primary representational property of the movie camera and projector is the photographic rendering of action over time, the primary representational property of the computer is the codified rendering of responsive behaviors. This is what is most often meant when we say that computers are interactive. We mean they create an environment that is both procedural and participatory.

Eliza's responsiveness is limited by her poor understanding of language, which makes her liable to nonsense utterances. Her direct successors are therefore mostly in research environments. It fell to another group of MIT computer scientists to develop a fictional universe that structures participation more tightly, resulting in a more sustained engagement.

A few years after the invention of ELIZA, researchers at the MIT Laboratory for Computer Science brought forth a widely popular computer-based story, the adventure game Zork, which is based on the Dungeons and Dragons tabletop game. In Zork, the computer plays the role of dungeon master by providing an invisible landscape that serves as the game board and by reporting to players on the effects of their actions. Within Zork's fantasy world, players move through dungeon rooms by typing in navigational commands (north, south, east, west, up, down), look for objects that can be manipulated (by typing appropriate commands, such as "read book," "take sword," "drink potion"), solve riddles, and fight off evil trolls. The game (which, like ELIZA, is still a popular feature of university networks) begins like this:
Welcome to Zork.
West of House.
You are in an open field west of a big white house with a boarded front door. There is a small mailbox here.

Interactor>
Go north.
North of House.
You are facing the north side of a white house. There is no door here, and all the windows are barred.

Interactor>
East.
Behind House.
You are behind the white house. In one corner of the house there is a small window which is slightly ajar.

Interactor>
Open the window.
With great effort, you open the window far enough to allow entry.

Interactor>
Go in.
Kitchen.
You are in the kitchen of the white house. A table seems to have been used recently for the preparation of food. A passage leads to the west, and a dark staircase can be seen leading upward. To the east is a small window which is open. On the table is an elongated brown sack, smelling of hot peppers. A bottle is sitting on the table. The glass bottle contains:
A quantity of water.

In making a fantasy world that responded to typed commands, the programmers were in part celebrating their pleasure in the increasingly responsive computing environments at their disposal. Before the 1970s most complex programming was done by writing a set of commands on a piece of paper; transferring them to keypunch cards; and taking the stack of cards to a mainframe computer (in an uncomfortably chilly room dedicated to keeping the machines from
overheating), from which, much later, a cumbersome paper printout would emerge. Only one person could use a machine at a time. Whenever a program crashed (which was often), the output consisted of a “core dump”—a long series of 0’s and 1’s arranged in eight-digit units, showing what each bit and byte in the computer memory looked like at the moment the computer quit. Debugging a program in this environment was time-consuming and tedious.

In the mid-1960s research labs began developing the current computing environment of a display device and a keyboard (originally a telex machine) linked up to a time-sharing network that let programmers send input directly to a running program and receive a response. They were also making wide use of programming languages that were interpreted rather than compiled. All programming code written in higher-level languages (with commands like “If a = 1, then print file”) must be translated into machine language instructions (with commands that look a lot like the raw 0’s and 1’s of the bits themselves) by either a compiler or interpreter program. Compiling your code before running it is like writing a book and then hiring someone to translate it for your readers. Using an interpreter is the equivalent of giving a speech with simultaneous translation. It provides more direct feedback from the machine and a more rapid cycle of trial and revision and retrial. The particular programming language in which both ELIZA and Zork were written, LISP (L1st Processing Language), was developed at MIT in the 1950s for artificial intelligence. Running LISP on a time-sharing system meant that its dynamic “interpreter” could immediately “return” an “evaluation” of any coded statement you typed into it, much as a calculator immediately returns the sum of two numbers. The result was a more conversational structure between the programmer and the program, a dialogue in which the programmer could test out one function at a time and immediately receive the bafflingly inappropriate or thrillingly correct responses. Both ELIZA and Zork reflected this newly animated partnership.

Whereas ELIZA captured the conversational nature of the pro-
grammer-machine relationship, *Zork* transmuted the intellectual challenge and frustrations of programming into a mock-heroic quest filled with enemy trolls, maddening dead ends, vexing riddles, and rewards for strenuous problem solving. ELIZA was focused on the cleverness of the machine-created world; *Zork* was focused on the experience of the participant, the adventurer through such a clever rule system. *Zork* was set up to provide the player with opportunities for making decisions and to dramatically enact the results of those decisions. If you do not take the lamp, you will not see what is in the cellar, and then you will definitely be eaten by the grue. But the lamp is not enough. If you do not take water with you, you will die of thirst. But if you drink the wrong water, you will be poisoned. If you do not take weapons, you will have nothing with which to fight the trolls. But if you take too many objects, you will not be able to carry the treasure when you find it. In order to succeed, you must orchestrate your actions carefully and learn from repeated trial and error. In the early versions there was no way to save a game in midplay, and therefore a mistake meant repeating the entire correct procedure from the beginning. In a way, the computer was programming the player.

Part of the pleasure of the participant in *Zork* is in testing the limits of what the program will respond to, and the creators prided themselves on anticipating even wildly inappropriate actions. For instance, if you type in “eat buoy” when a buoy floats by on your trip up a frozen river in the magic boat, then the game will announce that it has taken it instead and will add, “I don’t think that the red buoy would agree with you.” If you type in “kill troll with newspaper,” it will reply, “Attacking a troll with a newspaper is foolhardy.” The programmers generated such clever responses not by thinking of every possible action individually but by thinking in terms of general categories, such as weapons and foods. They made the programming function associated with the command word *eat* or *kill* check the player’s typed command for an appropriate object; a category violation triggers one of these sarcastic templates, with the name of the inappropriate object filled in.
Because LISP programmers were among the first to practice what is now called object-oriented software design, they were well prepared to create a magical place like the world of *Zork*. That is, it came naturally to them to create virtual objects such as swords or bottles because they were using a programming language that made it particularly easy to define new objects and categories of objects, each with its own associated properties and procedures. The programmers also exploited a programming construct known as a “demon” to make some things happen automatically without the player’s explicit action; for instance, in *Zork* a magic sword begins to glow if there is danger nearby, a stealthy thief comes and goes at his own will, and a fighter troll attacks the adventurer at unpredictable times. The programmers were also prepared by research on automatons to keep track of the state of the game, which allowed them to guess at the context of commands that would otherwise be ambiguous. For instance, if a player types “attack,” the program looks around for a nearby villain and a weapon; if there are two weapons, it asks which one the player wants to use. These techniques, which were taken from simulation design and artificial intelligence work, allowed the *Zork* programming team to create a dynamic fictional universe.

By contrast, more conventional programmers of the 1970s were still thinking in terms of the branching trees, fixed subroutines, and uniform data structures that go back to the early understanding of the computer as a means of encoding information purely in the form of yes/no decisions. In fact, most interactive narrative written today still follows a simple branching structure, which limits the interactor’s choices to a selection of alternatives from a fixed menu of some kind. The *Zork* dungeon rooms form a branching structure, but the magical objects within the dungeon each behave according to their own set of rules. And the interactor is given a repertoire of possible behaviors that encourage a feeling of inventive collaboration. The *Zork* programmers found a procedural technology for creating enchantment.

The company they formed, Infocom, is, though long out of business, still revered by players. Many fans attribute the imaginative
superiority of Infocom games to the predominance of text over graphics, just as nostalgic radio fans prefer the sightless “theater of the imagination” to television. But though the writing in its games was skillful, it was not the true secret of Infocom’s success. What made the games distinctive was the sophisticated computational thinking the programmers brought to shaping the range of possible interactions.

The lesson of *Zork* is that the first step in making an enticing narrative world is to script the interactor. The *Dungeons and Dragons* adventure format provided an appropriate repertoire of actions that players could be expected to know before they entered the program. The fantasy environment provided the interactor with a familiar role and made it possible for the programmers to anticipate the interactor’s behaviors. By using these literary and gaming conventions to constrain the players’ behaviors to a dramatically appropriate but limited set of commands, the designers could focus their inventive powers on making the virtual world as responsive as possible to every possible combination of these commands. But if the key to compelling storytelling in a participatory medium lies in scripting the interactor, the challenge for the future is to invent scripts that are formulaic enough to be easily grasped and responded to but flexible enough to capture a wider range of human behavior than treasure hunting and troll slaughter.

*Digital Environments Are Spatial*

The new digital environments are characterized by their power to represent navigable space. Linear media such as books and films can portray space, either by verbal description or image, but only digital environments can present space that we can move through. Again, we can look to the 1970s as the period that made this spatial property apparent. At Xerox PARC (Palo Alto Research Center) a group of visionaries created the first graphical user interface, the image of a desktop filled with file folders, which is currently the worldwide standard for computer file management. At Atari, inventors created the
first graphics-based games, first Pong and then PacMan, which established the computer as a spatial game board and paved the way for today's videogames and CD-ROMs. At MIT the Architecture Machine Group, led by Nicholas Negroponte, created the first "surrogate travel system" by making a "movie map" of Aspen, Colorado, a photographic record of the town that could be "walked through" on the computer (each press of an arrow key or mouse click indicated a step forward) in simulation of an actual visit. All of these were important steps toward the current digital environment, as was the concurrent growth of the ARPANET (Advanced Research Projects Agency NETwork), the precursor of the Internet funded by the U.S. Department of Defense, which was mapping out a virtual space that was increasingly real to those who used it. We recognize the fruit of all of these developments in our conceptualization of the digital domain as "cyberspace," an environment with its own geography in which we experience a change of documents on our screen as a visit to a distant site on a worldwide web.

Although this spatial property has been widely exploited in graphical applications, it is in fact independent of the computer's ability to display maps, pictures, or even three-dimensional models. It is also independent of its communicative function in linking geographically distant places. The computer's spatial quality is created by the interactive process of navigation. We know that we are in a particular location because when we enter a keyboard or mouse command the (text or graphic) screen display changes appropriately. We can verify the relation of one virtual space to another by retracing our steps. The text-based dungeons of Zork, the sequenced stills of the enchanter's isle of Myst, the flat worlds of the multilevel maze games, the crow's waterfall visible in the Placeholder VR helmet, the continuous three-dimensional world of the new videogame dreamscapes—all are realized for the interactor by the process of navigation, which is unique to the digital environment.

Let us return to Zork to see how this navigational creation of space lends itself to dramatic engagement:
Interactor> West.
Living Room.
You are in the living room. There is a door to the east, a wooden door with strange gothic lettering to the west, which appears to be nailed shut, and a large oriental rug in the center of the room . . .

Interactor> Look under rug.
Underneath the rug is a closed trapdoor.

Interactor> Move the rug.
With a great effort, the rug is moved to one side of the room. With the rug moved, the dusty cover of a closed trapdoor appears.

Interactor> Open trapdoor.
The door reluctantly opens to reveal a rickety staircase descending into darkness.

Interactor> Go down.
It is pitch-black. You are likely to be eaten by a grue. Your sword is glowing with a faint blue glow.

Interactor> Turn on lamp.
The lamp is now on.
Cellar.
You are in a dark and damp cellar with a narrow passageway leading east, and a crawlway to the south. On the west is the bottom of a steep metal ramp which is unclimbable. The trapdoor crashes shut, and you hear someone barring it.

You, as player/interactor, have walked into a dungeon that someone is sealing shut behind you! The moment is startling and immediate, like the firing of a prop gun on the stage of a theater. You are not just reading about an event that occurred in the past; the event is happening now, and, unlike the action on the stage of a theater, it is happening to you. Once that trapdoor slams, the only navigational commands that work are the ones that lead further and deeper into
the troll-filled lower world. The dungeon itself has an objective reality that is much more concrete than, for instance, the jail on the Monopoly board or a dungeon in a tabletop game of *Dungeons and Dragons*—or even a dungeon in a live-action role-playing game—because the words on the screen are as transparent as a book. That is, the player is not looking at a game board and game pieces or at a *Dungeons and Dragons* game master who is also in his or her algebra class or at a college classroom or campsite in the real world. The computer screen is displaying a story that is also a place. The slamming of a dungeon door behind you (whether the dungeon is described by words or images) is a moment of experiential drama that is only possible in a digital environment.

The dramatic power of navigation is also apparent outside the realm of the adventure game. For instance, Stephanie Tai, a student in my course on writing interactive fiction wrote a first-person poetic monologue about a sleepless night. Each screenful of text is a stanza and ends with a sentence fragment that connects syntactically with two or more stanzas, which are reached by clicking on arrows placed at the midpoint of the top, bottom, left, and right margins of the screen. Mouse-clicking through the mind of the insomniac is like a walk through a labyrinth. There are multiple endpoints to the maze, including one with just the single word *asleep* and another with the words *alone in this misery* in white letters on a black background. The poem is satisfying because the action of moving by arrows around a maze mimics the physical tossing and turning and the repetitive, dead-end thinking of a person unable to fall asleep. The movement through the cards makes a coherent pattern, but it is not one that could be modeled in physical space because the movement between links is not necessarily reversible. The navigational space of the computer allows us to express a sequence of thoughts as a kind of dance.

Stuart Moulthrop’s ambitious hypertext novel *Victory Garden* (1992), whose title intentionally echoes the Borges story, is also in the shape of a labyrinth. Similar to a thick Victorian novel, it follows many characters with intersecting lives during the Gulf War. At the
very center of Moulthrop's web is the death of Emily Runiebird, an army reserve soldier who is killed in her barracks by an enemy missile. The attack itself is represented by a striking image of shattered text, as if the enemy shell itself had landed on the previous block of writing. We reach this image by following a continuous story thread, mouse-clicking through the screens automatically as if turning the pages of a book. The shattered screen stops us dead in our tracks. The effect of moving from the intact lexia to the shattered one is like an animation of the landing of the shell. The instant of time it takes to go from one screen to the other takes on a poignancy that reflects the abruptness of the soldier’s death.

These very dramatic moments mark the beginning of a process of artistic discovery. The interactor’s navigation of virtual space has been shaped into a dramatic enactment of the plot. We are immobilized in the dungeon, we spiral around with the insomniac, we collide into a lexia that shatters like a bomb site. These are the opening steps in an unfolding digital dance. The challenge for the future is to invent an increasingly graceful choreography of navigation to lure the interactor through ever more expressive narrative landscapes.

Digital Environments Are Encyclopedic

The fourth characteristic of digital environments, which holds promise for the creation of narrative, is more a difference of degree than of kind. Computers are the most capacious medium ever invented, promising infinite resources. Because of the efficiency of representing words and numbers in digital form, we can store and retrieve quantities of information far beyond what was possible before. We have extended human memory with digital media from a basic unit of portable dissemination of 100,000 words (an average book, which takes up about a megabyte of space in its fully formatted version) first to 65,000,000 words (a 650-megabyte CD-ROM, the equivalent of 650 books) and now to 530,000,000 words (a 5.3 gigabyte digital videodisc, equivalent to 5,300 books), and on upward.
Once we move to the global databases of the Internet, made accessible through a worldwide web of linked computers, the resources increase exponentially.

Just as important as this huge capacity of electronic media is the encyclopedic expectation they induce. Since every form of representation is migrating to electronic form and all the world's computers are potentially accessible to one another, we can now conceive of a single comprehensive global library of paintings, films, books, newspapers, television programs, and databases, a library that would be accessible from any point on the globe. It is as if the modern version of the great library of Alexandria, which contained all the knowledge of the ancient world, is about to rematerialize in the infinite expanses of cyberspace. Of course, the reality is much more chaotic and fragmented: networked information is often incomplete or misleading, search routines are often unbearably cumbersome and frustrating, and the information we desire often seems to be tantalizingly out of reach. But when we turn on our computer and start up our Web browser, all the world's resources seem to be accessible, retrievable, immediate. It is a realm in which we easily imagine ourselves to be omniscient.

The encyclopedic capacity of the computer and the encyclopedic expectation it arouses make it a compelling medium for narrative art. The capacity to represent enormous quantities of information in digital form translates into an artist's potential to offer a wealth of detail, to represent the world with both scope and particularity. Like the daylong recitations of the bardic tradition or the three-volume Victorian novel, the limitless expanse of gigabytes presents itself to the storyteller as a vast tabula rasa crying out to be filled with all the matter of life. It offers writers the opportunity to tell stories from multiple vantage points and to offer intersecting stories that form a dense and wide-spreading web.

One early indication of the suitability of epic-scale narrative to digital environments is the active electronic fan culture surrounding popular television drama series. As an adjunct to the serial broadcast-
ing of these series, the Internet functions as a giant bulletin board on which long-term story arcs can be plotted and episodes from different seasons juxtaposed and compared. For instance, the Web site for the intricately plotted space drama *Babylon Five* contains images of the cast and plot summaries that document the many interwoven stories portrayed over multiple seasons, allowing a newcomer to understand the large cast of characters and the richly imagined array of alien races, each with its own culture and dramatic history. But it is not only science fiction programs that attract this interest. Even viewers of the mainstream television sitcom *Wings* use Web sites and Internet newsgroups to trace plot developments that extend over several years—like Joe and Helen’s on-again, off-again courtship—and that may be confusingly jumbled in syndication; they also share digitized clips of favorite moments, such as the couple’s comic wedding vows. The presence of such groups is influencing these shows, holding them to greater consistency over longer periods of time. In the past this kind of attention was limited to series with cult followings like *Star Trek* or *The X Files*. But as the Internet becomes a standard adjunct of broadcast television, all program writers and producers will be aware of a more sophisticated audience, one that can keep track of the story in greater detail and over longer periods of time. Since the early 1980s, when Steven Bochco introduced multiple story arcs with *Hill Street Blues*, television series have become more complex, involving larger casts and stories that take anywhere from one episode to several years to conclude. Some stories even remain open-ended after the series is over (especially if the writers were not expecting cancellation). In some ways, television dramas seem to be outgrowing broadcast delivery altogether. To join *Babylon Five* in its second or third season or *Murder One* in midsession is to immediately want to flip back or rewind to earlier episodes. The Internet serves that purpose, making a more capacious home for serial drama than the broadcast environment affords.

Making even fuller use of the computer’s properties, by combining its spatial, participatory, and procedural elements with its
encycopedic coverage, are the many on-line role-playing environments in the adventure games tradition. By the 1980s, Zork-like games had grown to accommodate simultaneous multiple players, turning them into Multi-User Dungeons or MUDs, which combine the social pleasures of interplayer communication with the standard command-driven adventures. In the MUDs of the 1990s players are no longer limited to navigating a preexisting dungeon but can use a simple programming language to build their own dungeon or adventure maze and link it up with those of other players by creating objects out of common building blocks. The MUD itself is a collective creation—at once a game, a society, and a work of fiction—that is often based on a particular encyclopedic fantasy domain, such as Tolkien’s Middle Earth or Star Trek’s twenty-fourth century. For instance, TrekMuse, founded in 1990 with over two thousand players, had five hundred people enrolled in its virtual Star Fleet Academy in 1995, each of whom had made up his or her own character, based on the existing Star Trek races. The digital narrative environment extends the fictional universe of the television shows and films in a way that is consistent with the canonical version of the story but personifies it for each of the players.

Some hypertext stories successfully use the encyclopedic extent of the computer to develop multithreaded stories composed of many intersecting plots. In Victory Garden, for instance, we can follow a radical professor and his colleagues and graduate students through the same time period as they intersect with one another in the classrooms, offices, and coffee bars, or we can follow them home to witness their tangled domestic lives; we can listen to the official coverage of the Gulf War (with CNN transcripts) or read Emily Runebird’s letters. In The Spot and similar Web soaps, we can read through the conflicting accounts of the same love affairs and deceptions in the journals of various friends. In on-line murder mysteries like Crime Story, we can delve through various document files, including crime scene photos, interview transcripts, and newspaper accounts. We can even leap out of the story altogether and find
ourselves in the "real" world, following a reference to the University of Mississippi right to its own Web site, or finding that the name of a witness seen in the company of the fleeing suspect belongs to a real-life software engineer whose Web page has nothing to do with the fictional crime. Not only does the weblike structure of cyberspace allow for endless expansion possibilities within the fictional world, but in the context of a worldwide web of information these intersecting stories can twine around and through the nonfictional documents of real life and make the borders of the fictional universe seem limitless.

However, the encyclopedic nature of the medium can also be a handicap. It encourages long-windedness and formlessness in storytellers, and it leaves readers/interactors wondering which of the several endpoints is the end and how they can know if they have seen everything there is to see. Most of what is delivered in hypertext format over the World Wide Web, both fiction and nonfiction, is merely linear writing with table-of-contents links in it. Even those documents designed explicitly for digital presentation, both fiction and nonfiction, often require too much superfluous clicking to reach a desirable destination or so much scrolling that readers forget where they are. The conventions of segmentation and navigation have not been established well enough for hypertext in general, let alone for narrative. The separation of the printed book into focused chapters was an important precondition of the modern novel; hypertext fiction is still awaiting the development of formal conventions of organization that will allow the reader/interactor to explore an encyclopedic medium without being overwhelmed.

The encyclopedic impulse and the dangers of the encyclopedic expectation are also apparent in simulation games. For instance, SimCity (1987) presents the player with a schematic picture of a riverside city site, and places him or her in the role of mayor. The player is free to build the city however he or she would like, by adding to the model on the screen office buildings, factories, homes, a sewer system, electric power plants, a public transportation system, highways, schools, and so on. The software calculates the effects of each change by using
models very like the ones used by social scientists and policymakers to study urban systems. Truly bad decisions in SimCity can bring critical newspaper articles, social unrest, and even electoral defeat. Well-built cities prosper through multiple decades. Because of the importance of the role in SimCity, the mayor is closer in power to God than to any real-life political leader, and the player's sense of omniscient awareness of consequences and omnipotent control of resources is part of the allure of such games.

Well-designed simulations like SimCity allow for multiple styles of play. One young programmer friend of mine spent hours building the most prosperous skyscrapered downtown possible. When I asked him about the game, he delighted in showing me the detail in which the city's underground service grid was specified. His wife, who is also a computer professional, took a different approach. Her favorite city was a sprawling environment with tree-lined family neighborhoods whose growing population gratified her tremendously and whose children she could easily imagine happily greeting each newly built playground. When they realized how much their efforts fell along gender lines, they laughed, but they pointed out that there was a more radical difference. For the husband, the program was a satisfyingly complex engineering problem, reinforcing his habitual sense of competence. For the wife, it was a narrative, in which the little parades and cheers of her contented townsfolk were the most memorable dramatic events. And, in fact, later versions of the game have been expanding this narrative quality by allowing the player to live inside a more detailed three-dimensional city rather than only manipulate it from on high.

Both the narrative possibilities and the godlike pleasures of simulation format are further developed in Sid Meier's Civilization, a game that puts the player in the role of leader of a civilization over the course of many centuries, while the computer plays the role of adversary civilizations that compete with the player for global resources and technical advancement. Like SimCity, Civilization allows multiple strategies of play and can accommodate the idealistic seeker of social
harmony as well as the warrior player. The narrative interest of the
game consists of creating multiple possible versions of an Earth-like
history. For instance, it is possible to invent the railroad in B.C. times
or to become an undefeated Napoleon. Winning the game is defined
as either conquering all the other civilizations (in which case you are
rewarded with pictures of the other leaders frowning at you) or send-
ing twenty thousand people into space (in which case you see the
spaceport).

Simulations like these take advantage of the authority bestowed by
the computer environment to seem more encyclopedically inclusive
than they really are. As its critics have pointed out, the political as-
sumptions behind SimCity are hidden from the player.10 This is less
true in Sid Meier’s Civilization, whose title alerts us to the fact that we
are receiving a particular person’s interpretation of human history
rather than a scientific formula. The game also explicitly informs us
that the behavior of each of the leaders is the result of three variables:
their degree of aggression/friendliness, of expansionism/perfectionism,
and of militarism/civilization. Since these are assumptions that players
are aware of, they are free to accept or reject them as a reflection of
the real world. Nevertheless, the basic competitive premise of the
game is not emphasized as an interpretive choice. Why should global
domination rather than, say, universal housing and education define
the civilization that wins the game? Why not make an end to world
hunger the winning condition? Why is the object of the game to com-
pete with other leaders instead of to cooperate for the benefit of all the
civilizations without jeopardizing any one country’s security?

In an interactive medium the interpretive framework is embedded
in the rules by which the system works and in the way in which par-
ticipation is shaped. But the encyclopedic capacity of the computer
can distract us from asking why things work the way they do and why
we are being asked to play one role rather than another. As these sys-
tems take on more narrative content, the interpretive nature of these
structures will be more and more important. We do not yet have
much practice in identifying the underlying values of a multiform
story. We will have to learn to notice the patterns displayed over multiple plays of a simulation in the same way that we now notice the worldview behind a single-plot story. Just as we now know how to think about what made Tolstoy propel Anna Karenina in front of that train or what made the producers of Murphy Brown offer her happiness as a single mother, we need to learn to pay attention to the range of possibilities offered us as interactors in the seemingly limitless worlds of digital narrative.

Digital Structures of Complexity

Like every human medium of communication, digital media have been developed to perform tasks that were too difficult to do without them. Hypertext and simulations, the two most promising formats for digital narrative, were both invented after World War II as a way of mastering the complexity of an expanding knowledge base. The mathematician Vannevar Bush put it this way in his landmark 1945 magazine article, "As We May Think": "The summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent maze to the momentarily important item is the same as that used in the days of square-rigged ships" (p. 102).

Bush’s solution was “associational indexing” in a kind of magical desk based on microfilm files, a solution he called a “memex” and described as follows:

The owner of the memex, let us say, is interested in the origin and properties of the bow and arrow. Specifically he is studying why the short Turkish bow was apparently superior to the English long bow in the skirmishes of the crusades. He has dozens of pertinent books and articles in his memex. First he runs through an encyclopedia, finds an interesting but sketchy article, leaves it projected. Next, in a history, he finds another pertinent item, and ties the two together. Thus he goes building a trail of many items. Occasionally he inserts a com-
ment of his own, either linking it into the main trail or joining it by a side trail to a particular item... Thus he builds a trail of his interest through the maze of materials available to him.

And the trails do not fade. (P 107)

This earliest vision of hypertext reflects the classic American quest—a charting of the wilderness, an imposition of order over chaos, and the mastery of vast resources for concrete, practical purposes. In Bush’s view, the infinite web of human knowledge is a solvable maze, open to rational organization.

By contrast, Ted Nelson, who coined the term hypertext in the 1960s and called for the transformation of computers into “literary machines” to link together all of human writing, has been more in love with the unsolvable labyrinth. He sees associational organization as a model of his own creative and distractible consciousness, which he describes as a form of “hummingbird mind.”11 Nelson has spent most of his professional life in the effort to create the perfect hypertext system, which he has appropriately named Xanadu. He describes this pursuit as a quixotic quest, “a caper story—a beckoning dream at the far edge of possibility that has been too good to let go of, and just too far away to reach, for half my life.”12 Nelson’s vision of hypertext is akin to William Faulkner’s description of novel writing as a futile but noble effort to get the entire world into one sentence. Those like Nelson who take delight in the intricacies of hypertext, the twisting web rather than the clear-cut trail, are perhaps seeing it as an emblem of the inexhaustibility of the human mind: an endless proliferation of thought looping through vast humming networks whether of neurons or electrons.

The allure of computer simulations comes from a similar attempt to represent complexity. Three years after Bush’s suggestion of the memex machine, Norbert Wiener founded the discipline of system dynamics with his book Cybernetics. Wiener observed that all systems, whether biological or engineered, have certain characteristics in common, such as the intertwining of multiple cause-and-effect re-
relationships and the creation of feedback loops for self-regulation. Wiener called attention to parallels, for instance, between the way the body keeps a constant internal temperature by instituting changes (like sweating) and monitoring their effects (like feedback on skin temperature) and the way a home thermostat maintains a set temperature. Over the past fifty years, systems thinking has been applied to everything from family structure to frog ponds. It is now commonplace for us to think of the earth itself as a giant ecosystem, in both biological and political terms.

The computer has developed during this time into a versatile tool for modeling systems that reflect our ideas about how the world is organized. Early uses of computer simulations involved putting different values into a constant model and running the system through several “time steps" to see, for example, what would happen to crime statistics five, ten, and fifteen years down the line if police presence went up and cocaine prices went down. These systems were run in batch jobs, which spit out big chunks of numerical data. Other more responsive systems modeled a dynamically changing world open to real-time interaction, like the cockpit simulations used for training airplane pilots. In recent years, computer scientists have designed networked systems that are like a society full of autonomous individuals who talk and work with one another but have no single leader or controller.

In the late 1970s computer system design reached an intriguing milestone with a simple but elegantly conceived program that seemed to simulate life itself. The system is based on a checkerboard grid with markers that are white on one side and black on the other. The markers begin in a random arrangement and are then turned over according to a set of rules that makes decisions based on the colors of a marker's neighbors. Each round of turning causes more turning on the next round, eventually causing remarkable patterns to emerge and move across the board. The Game of Life system does not require a computer, but the patterns look particularly striking on the computer screen, which can run through multiple turns very quickly.¹³
Although no one would claim that such a system is alive in the same way as an animal or plant, it does capture one of the chief attributes of life—the creation of large patterns as a result of many smaller effects. Computer simulations like this are tools for thinking about the larger puzzles of our existence, such as how anything as soulless as a protein can give rise to something as complex as consciousness.

T. S. Eliot used the term objective correlative to describe the way in which clusters of events in literary works can capture emotional experience. The computer allows us to create objective correlatives for thinking about the many systems we participate in, observe, and imagine. The rules for artificial life forms can be described as a kind of a game, but the knowledge about the world that the model offers us is not gamelike. It is a behavioral artifact that speaks to one of the most profoundly important aspects of our lives. The more we see life in terms of systems, the more we need a system-modeling medium to represent it—and the less we can dismiss such organized rule systems as mere games.

Current narrative applications overexploit the digressive possibilities of hypertext and the gamelike features of simulation, but that is not surprising in an incunabular medium. As digital narrative develops into maturity, the associational wildernesses will acquire more coherence and the combat games will give way to the portrayal of more complex processes. Participating viewers will assume clearer roles; they will learn how to become orients in the complex labyrinths and to see the interpretive shaping in simulated worlds. At the same time as these formal qualities improve, writers will be developing a better feel for which patterns of human experience can best be captured in digital media. In this way a new narrative art will come into its own expressive form.

The process by which this new art form will emerge is already under way and is itself interactive. Each time developers create new genres of digital stories or more immersive games, interactors try them out and grow frustrated or enchanted. Most often these incunabular products arouse expectations they cannot yet fulfill—for
more encyclopedic coverage, for greater freedom of navigation, for more direct manipulation of the elements of the story. Every expressive medium has its own unique patterns of desire; its own way of giving pleasure, of creating beauty, of capturing what we feel to be true about life; its own aesthetic. One of the functions of early artifacts is to awaken the public to these new desires, to create the demand for an intensification of the particular pleasures the medium has to offer. Therefore, the next step in understanding what delights or dangers digital narrative will bring to us is to look more closely at its characteristic pleasures, to judge in what ways they are continuous with older narrative traditions and in what ways they offer access to new beauty and new truths about ourselves and the world we move through.