

Introduction to Cyberspace: First Steps

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Cyberspace: A word from the pen of William Gibson, science fiction writer, circa 1984. An unhappy word, perhaps, if it remains tied to the desperate, dystopic vision of the near future found in the pages of *Neuromancer* (1984) and *Count Zero* (1987)—visions of corporate hegemony and urban decay, of neural implants, of a life in paranoia and pain—but a word, in fact, that gives a name to a new stage, a new and irresistible development in the elaboration of human culture and business under the sign of technology.

Cyberspace: A new universe, a parallel universe created and sustained by the world's computers and communication lines. A world in which the global traffic of knowledge, secrets, measurements, indicators, entertainments, and alter-human agency takes on form: sights, sounds, presences never seen on the surface of the earth blossoming in a vast electronic night.

Cyberspace: Accessed through any computer linked into the system; a place, one place, limitless; entered equally from a basement in Vancouver, a boat in Port-au-Prince, a cab in New York, a garage in Texas City, an apartment in Rome, an office in Hong Kong, a bar in Kyoto, a cafe in Kinshasa, a laboratory on the Moon.

Cyberspace: The tablet become a page become a screen become a world, a virtual world. Everywhere and nowhere, a place where nothing is forgotten and yet everything changes.

Cyberspace: A common mental geography, built, in turn, by consensus and revolution, canon and experiment; a territory swarming with data and lies, with mind stuff and memories of nature, with a million voices and two million eyes in a silent, invisible concert of enquiry, dealmaking, dream sharing, and simple beholding.

Cyberspace: Its corridors form wherever electricity runs with intelligence. Its chambers bloom wherever data gathers and is stored. Its depths increase with every image or word or number, with every addition, every contribution, of fact or thought. Its horizons recede in every direction; it breathes larger, it complexifies, it embraces and involves. Billowing, glittering, humming, coursing, a Borgesian library, a city; intimate, immense, firm, liquid, recognizable and unrecognizable at once.

Cyberspace: Through its myriad, unblinking video eyes, distant places and faces, real or unreal, actual or long gone, can be summoned to presence. From vast databases that constitute the culture's deposited wealth, every document is available, every recording is playable, and every picture is viewable. Around every participant, this: a laboratory, an instrumented bridge; taking no space, a home presiding over a world . . . and a dog under the table.

Cyberspace: Beneath their plaster shells on the city streets, behind their potted plants and easy smiles, organizations are seen as the organisms they are—or as they would have us believe them be: money flowing in rivers and capillaries; obligations, contracts, accumulating (and the shadow of the IRS passes over). On the surface, small meetings are held in rooms, but they proceed in virtual rooms, larger, face to electronic face. On the surface, the building knows where you are. And who.

Cyberspace: From simple economic survival through the establishment of security and legitimacy, from trade in tokens of approval and confidence and liberty to the pursuit of influence, knowledge, and entertainment for their own sakes, everything informational and important to the life of individuals—and organizations—will be found for sale, or for the taking, in cyberspace.

Cyberspace: The realm of pure information, filling like a lake, siphoning the jangle of messages transfiguring the physical world, decontaminating the natural and urban landscapes, redeeming them, saving them from the chain-dragging bulldozers of the paper industry, from the diesel smoke of courier and post office trucks, from jet fuel fumes and clogged airports, from billboards, trashy and pretentious architecture, hour-long freeway commutes, ticket lines, and choked subways. . . from all the inefficiencies, pollutions (chemical and informational), and corruptions attendant to the process of moving information attached to *things*—from paper to brains—across, over, and under the vast and bumpy surface of the earth rather than letting it fly free in the soft hail of electrons that is cyberspace.

Cyberspace as just described—and, for the most part, as described in this book—does not exist.

But this states a truth too simply. Like Shangri-la, like mathematics, like every story ever told or sung, a mental geography of sorts has existed in the living mind of every culture, a collective memory or hallucination, an agreed-upon territory of mythical figures, symbols, rules, and truths, owned and traversable by all who learned its ways, and yet free of the bounds of physical space and time. What is so galvanizing today is that technologically advanced cultures—such as those of Japan, Western Europe, and North America—stand at the threshold of making that ancient space both uniquely visible and the object of interactive democracy.

Sir Karl Popper, one of this century’s greatest philosophers of science, sketched the framework in 1972. The world as a whole, he wrote, consists of three, interconnected worlds. *World 1*, he identified with the objective world of material, natural things and their physical properties—with their energy and weight and motion and rest; *World 2* he identified with the subjective world of consciousness—with intentions, calculations, feelings, thoughts, dreams, memories, and so on, in individual minds. *World 3*, he said, is the world of objective, real, and public structures which are the not-necessarily-intentional products of the minds of living creatures, interacting with each other and with the natural *World 1*. Anthills, birds’ nests, beavers’ dams, and similar, highly complicated structures built by animals to deal with the environment, are forerunners. But many *World 3* structures, Popper noted,

are abstract; that is, they are purely informational: forms of social organization, for example, or patterns of communication. These abstract structures have always equaled, and often surpassed, the *World 3* physical structures in their complexity, beauty, and importance to life. Language, mathematics, law, religion, philosophy, arts, the sciences, and institutions of all kinds, these are all edifices of a sort, like the libraries we build, physically, to store their operating instructions, their “programs.” Man’s developing belief in, and effective behavior with respect to, the objective existence of *World 3* entities and spaces meant that he could examine them, evaluate, criticize, extend, explore, and indeed make discoveries in them, in public, and in ways that could be expected to bear on the lives of all. They could evolve just as natural things do, or in ways closely analogous. Man’s creations in this abstract realm create their own, autonomous problems too, said Popper: witness the continual evolution of the legal system, scientific and medical practice, the art world, or for that matter, the computer and entertainment industries. And always these *World 3* structures feed back into and guide happenings in *Worlds 1* and *2*.

For Popper, in short, temples, cathedrals, marketplaces, courts, libraries, theatres or amphitheatres, letters, book pages, movie reels, videotapes, CDs, newspapers, hard discs, performances, art shows. . . are all physical manifestations—or, should one say, the physical components of—objects that exist more wholly in *World 3*. They are “objects,” that is, which are patterns of ideas, images, sounds, stories, data. . . patterns of pure information. And cyberspace, we might now see, is nothing more, or less, than the latest stage in the evolution of *World 3*, with the ballast of materiality cast away—cast away again, and perhaps finally.

This book explores the consequences and limits of such a development. But let it be said that, in accordance with the laws of evolution, and no matter how far it is developed, cyberspace will not replace the earlier elements of *World 3*. It will not replace but displace them, finding, defining, its own niche and causing the earlier elements more closely to define theirs too. This has been the history of *World 3* thus far. Nor will virtual reality replace “real reality.” Indeed, real reality—the air, the human body, nature, books, streets. . . who could finish such a list?—in all its exquisite design, history, quiddity, and meaningfulness may benefit from both our renewed appreciation and our no longer asking it to do what is better done “elsewhere.”

I have introduced Popper’s rather broad analysis to set the stage for a closer examination of the origins and nature of our subject, cyberspace. I discern four threads within the evolution of *World3*. These intertwine.

Thread One This, the oldest thread, begins in language, and perhaps before language, with a commonness-of-mind among members of a tribe or social group. Untested by dialogue—not yet brought out “into the open” in this way—this commonness-of-mind is tested and effective nonetheless in the coordinated behavior of the group around a set of beliefs held simply to be “the case:” beliefs about the environment, about the magnitude and location of its dangers and rewards, what is wise and foolhardy, and about what lies beyond; about the past, the future, about what lies within opaque things, over the horizon, under the earth, or above the sky. The answers to all these questions, always “wrong,” and always pictured in some way, are common property before they are privately internalized and critiqued. (The group mind, one might say, precedes the individual mind, and consensus precedes critical exception, as Mead and Vygotsky pointed out.) With language and pictorial representation, established some ten to twenty thousand years ago, fully entering the artifactual world, *World 3*, these ideas blossom and elaborate at a rapid pace. Variations develop on the common themes of life and death, the whys and wherefores, origins and ends of all things, and these coalesce ecologically into the more or less coherent systems of narratives, characters, scenes, laws, and lessons that we now recognize, and sometimes disparage, as myth.

One does not need to be a student of Carl Jung or Joseph Campbell to acknowledge how vital ancient mythological themes continue to be in our advanced technological cultures. They inform not only our arts of fantasy, but, in a very real way, the way we understand each other, test ourselves, and shape our lives. Myths both reflect the “human condition” and create it.

Now, the segment of our population most visibly susceptible to myth and most productive in this regard are those who are “coming of age,” the young. Thrust inexorably into a complex and rule-bound world that, it begins to dawn on them, they did not make and that, further, they do not understand, adolescents are apt to reach with some anger and some confusion into their culture’s “collective unconscious”—a world they already possess—for anchorage, guidance, and a base for

resistance. The boundary between fiction and fact, between wish and reality, between possibility and probability, seems to them forceable; and the archetypes of the pure, the ideal, the just, the good, and the evil, archetypes delivered to them in children's books and movies, become now, in their struggle towards adulthood, both magnified and twisted. It is no surprise that adolescents, and in particular adolescent males, almost solely support the comic book, science fiction, and videogame industries (and, to a significant extent, the music and movie industries too). These "media" are alive with myth and lore and objectified transcriptions of life's more complex and invisible dynamics. And it is no surprise that young males, with their cultural bent indeed mission-to master new technology, are today's computer hackers and so populate the on-line communities and newsgroups. Indeed, just as "cyberspace" was announced in the pages of a science fiction novel, so the young programmers of on-line "MUDS" (Multi-User Dungeons) and their slightly older cousins hacking networked videogames after midnight in the laboratories of MIT's Media Lab, NASA, computer science departments, and a hundred tiny software companies are, in a very real sense, by their very activity, creating cyberspace.

This is not to say that cyberspace is for kids, even less is it to say that it is for boys: only that cyberspace's inherent immateriality and malleability of content provides the most tempting stage for the acting out of mythic realities, realities once "confined" to drug-enhanced ritual, to theater, painting, books, and to such media that are always, in themselves, somehow less than what they reach for, mere gateways. Cyberspace can be seen as an extension, some might say an inevitable extension, of our age-old capacity and need to dwell in fiction, to dwell empowered or enlightened on other, mythic planes, if only periodically, as well as this earthly one. Even without appeal to sorcery and otherworldly virtual worlds, it is not too farfetched to claim that already a great deal of the attraction of the networked personal computer in general—once it is no longer feared as a usurper of consciousness on the one hand, nor denigrated as a toy or adding machine on the other—is due to its lightning-fast enactment of special "magical" words, instruments, and acts, including those of induction and mastery, and the instant connection they provide to distant realms and buried resources. For the mature as well as the young, then, and for the

purposes of art and self-definition as well as rational communications and business, it is likely that cyberspace will retain a good measure of mytho-logic, the exact manifestations of which, at this point, no one can predict.

Three of the authors in this book—Michael Heim, Allucquere Rosanne Stone, and David Tomas—take up the cultural-anthropological theme, the latter two with special reference to the changing meaning of the "technophilic" physical body. Chip Morningstar and F. Randall Farmer describe their experiences with on-line games, in particular, LucasFilm's Habitat. William Gibson's short piece also makes its contribution at this level, if more directly, as an allegorical work of fiction itself.

Thread Two Convolved with the history of myth is the thread of the history of media technology as such, that is, the history of the technical means by which absent and/or abstract entities—events, experiences, ideas—become symbolically represented, "fixed" into an accepting material, and thus conserved through time as well as space. Again, this a fairly familiar story, one whose detailed treatment is far beyond the scope of this introduction and this book. Nevertheless it is one worth rehearsing. It is also a topic that is extremely deep, for the secret of life itself is wrapped up in the mystery of genetic encoding and the replication and motility of molecules that orchestrate each other's activity. Genes are information; molecules are media as well as motors, so to speak ... But we cannot begin here, where the interests of computation theorists and biologists coincide. Our story best begins with evolved man's conscious co-option of the physical environment, specifically those parts, blank themselves, that best receive markings—such as sand, wood, bark, bone, stone, and the human body—for the purpose of preserving and delivering messages: signs, not unlike spoor, tracks, or tell-tale colors of vegetation or sky, but now intentional, between man and man, and man and his descendants. What a graceful and inspired step it was, then, to begin to produce the medium, to create smooth plastered walls, thin tablets, and papyrus, and to reduce the labor of marking—carving, chiseling—to the deft movement of a pigmented brush or stylus. As society elaborated itself and as the need to keep records and to educate grew, how much more efficient it was to shrink and conventionalize the symbols themselves, then to crowd them into rows and layers, "paper-thin" scrolls and stacks.

At this early stage already, the double movement towards the dematerialization of media on the one hand and the reification of meanings on the other is well underway. Against the ravages of time, nonetheless, and to impress the illiterate masses, only massive sculptures, friezes, and reliefs in stone would do. These are what we see today; these are what survive of ancient cultures and impress us still. But it would be wrong therefore to underestimate the traffic of information in more ephemeral media that must have sustained day-to-day life: the scratched clay tablets, the bark shards, graffitied walls, counters, papyri, diagrams in the sand, banners in the wind, gestures, demonstrations, performances, and, of course, the babble of song, gossip, rumor, and instruction that continuously filled the air. Every designed and every made thing was also the story of its use and its ownership, of its making and its maker.

This world sounds strangely idyllic. Many of its components, in only slightly updated forms, survive today. It was a period perhaps four thousand years long when objects, even pure icons and symbols, were not empty or ignorable but were real and meaningful, when craftsmanship, consensus, and time were involved in every thing and its physical passage through society. But first, with the development of writing and counting and modes of graphic representation, and then, centuries later, with the invention of the printing press and the spread of literacy beyond the communities of religious scholars and noblemen, the din of ephemeral communications came to be recorded at an unprecedented scale. More important for our story, these “records” came to be easily duplicable, transportable, and broadcastable.

Life would never be the same. The implications of the print revolution and the establishment of what Marshall McLuhan called the “Gutenberg galaxy” (in his book of the same name) for the structure and function of technologically advancing societies can hardly be overestimated. Not the least of these implications were (1) the steady, de facto, democratization of the means of idea production and dissemination, (2) the exponential growth of that objective body of scientific knowledge, diverse cultural practices, dreams, arguments, and documented histories called World 3, and (3) the fact that this body, containing both orthodoxies and heresies, could neither be located at any one place, nor be entirely controlled.

However, our double movement did not stop there, as we are all witness today. Although “printed matter” from proclamations to bibles to newspapers could, in principle, be taken everywhere a donkey, a truck, a boat, or an airplane could physically go, there was a limit, namely, time. No news could be fresh days or weeks later. The coordination of goods transportation in particular was a limiting case, for if no message could travel faster than that whose imminent arrival it was to announce. . . then of what value the message? Hence the telegraph, that first “medium” after semaphore, smoke signals, and light-flashing, to connect distant “stations” on the notion of a permanent network. Another related limit was expense: the sheer expenditure of energy required to convey even paper across substantial terrain. The kind of flexible common-mindedness made possible in small communities by the near-simultaneity and zero-expense of natural voice communications, or even rumor and leaflets, collapses at the larger scale. Social cohesion is a function of ideational consensus, and without constant update and interaction, such cohesion depends crucially on early, and strict, education in—and memory of—the architectures, as it were, of World 3.

With the introduction of the telephone, both the problem of speed and the problem of expense were largely eliminated. Once wired, energy expenditure was trivial to relay a message, and it was soon widely realized (interestingly only in the 1930s and 40s) that the telephone need not be used like a “voice-telegraph,” which is to say, sparingly and for serious matters only. Rather, it could be used also as an open channel for constant, meaningful, community-creating and business-running interchanges; “one-on-one” interchanges, to be sure, but “many-to-many” over a period of time. Here was a medium, here is a medium, whose communicational limits are still being tested, and these quite apart from what can be accomplished using the telephone system for computer networks.

Of course, the major step being taken here, technologically, is the transition, wherever advantageous, from information transported physically, and thus against inertia and friction, to information transported electrically along wires, and thus effectively without resistance or delay. Add to this the ability to store information electromagnetically (the first tape recorder was demonstrated commercially in 1935), and we see yet another significant and evolutionary step in dematerializing the medium and conquering—as they say—space and time.

But this was paralleled by a perhaps more significant development: wire-less broadcasting, that is, radio and television. Soon, encoded words, sounds, and pictures from tens of thousands of sources could invisibly saturate the world's "airwaves," every square millimeter and without barrier. What poured forth from every radio was the very sound of life itself, and from every television set the very sight of it: car chases, wars, laughing faces, oceans, volcanos, crying faces, tennis matches, perfume bottles, singing faces, accidents, diamond rings, faces, steaming food, more faces. . . images, ultimately, of a life not really lived anywhere but arranged for the viewing. Critic and writer Horace Newcomb (1976) calls television less a medium of communication than a medium of communion, a place and occasion where nightly the British, the French, the Germans, the Americans, the Russians, the Japanese. . . settle down by the million to watch and ratify their respective national mythologies: nightly variations on a handful of dreams being played out, over and over, with addicting, tireless intensity. Here are McLuhan's acoustically structured global villages (though he wished there to be only one), and support for the notion that the electronic media, and in particular television, provide a medium not unlike the air itself—surrounding, permeating, cycling, invisible, without memory or the demand for it, conciliating otherwise disparate and perhaps antagonistic individuals and regional cultures.

With cordless and then private cellular telephones, and "remote controls" and then hand-held computers communicating across the airwaves too, the very significance of geographical location at all scales begins to be questioned.

We are turned into nomads . . . who are always in touch.

All the while, material, print-based media were and are growing more sophisticated too: "vinyl" sound recording (a kind of micro-embossing), color photography, offset lithography, cinematography, and so on. . . the list is long. They became not only more sophisticated but more egalitarian as the general public not only "consumed" ever greater quantities of magazines, billboards, comic books, newspapers, and movies but also gained access to the means of production: to copying machines, cameras, movie cameras, record players, and the rest, each of which soon had its electronic/digital counterpart as well as a variety of hybrids, extensions, and cross-marriages: national newspapers printed

regionally from satellite-transmitted electronic data, facsimile transmission, digital preprint and recording, and so on. The end of our second narrative thread is almost at hand.

With the advent of fast personal computers, digital television, and high bandwidth cable and radio-frequency networks, so-called postindustrial societies stand ready for a yet deeper voyage into the "permanently ephemeral" (by which I mean, as the reader is well aware, cyberspace). As a number of chapters in this book observe, so-called online community, electronic mail, and information services (USENET, the Well, CompuServe, and scores of others) already form a technological and behavioral beginning. But the significance of this voyage is perhaps best gauged by the almost irrational enthusiasm that today surrounds the topic of virtual reality.

Envisaged by science fiction writer/promoter Hugo Gernsback as long ago as 1963 (see Stashower 1990) and explored experimentally by Ivan Sutherland (1968), the technology of virtual reality (VR) stands at the edge of practicality and at the current limit of the effort to create a communication/communion medium that is both phenomenologically engulfing and yet all but invisible. By mounting a pair of small video monitors with the appropriate optics directly to the head, a stereoscopic image is formed before the "user's" eyes. This image is continuously updated and adjusted by a computer to respond to head movements. Thus, the user finds himself entirely surrounded by a stable, three-dimensional visual world. Wherever he looks he sees what he would see were the world real and around him. This virtual world is either generated in real time by the computer, or it is preprocessed and stored, or it exists physically elsewhere and is "videographed" and transmitted in stereo, digital form. (In the last two cases the technique is apt to be named telepresence rather than virtual reality.) In addition, the user may be wearing stereo headphones. Tracked for head movements, a complete acoustic sensorium is thus added to the visual one. Finally, the user may wear special gloves, and even a whole body suit, wired with position and motion transducers to transmit to others—and to represent to himself—the shape and activity of his body in the virtual world. There is work underway also to provide some form of forcefeedback to the glove or suit so that the user will actually feel the presence of virtual "solid" objects—their weight, texture, and perhaps

even temperature (see Stewart 1991a for a recent survey, and Rheingold 1991). With a wishful eye cast towards such fictional technologies as the Holodeck, portrayed in the television series “Star Trek, the Next Generation,” devices sketched in such films as *Total Recall* and *Brainstorm*, and, certainly, the direct neural connections spoken of in Gibson’s novels, virtual reality/telepresence technology is as close as one can come in reality to entering a totally synthetic sensorium, to immersion in a totally artificial and/or remote world.

Much turns on the question of whether this is done alone or in the company of others; and if the latter, of how many, and how. Most of the chapters in this book tackle the question in one form or another. For, engineering questions aside, as the population of a virtual world increases, with it comes the need for consensus of behavior, iconic language, modes of representation, object “physics,” protocols, and design—in a word, the need for *cyberspace* as such, seen as a general, singular-at-some-level, public, consistent, and democratic “virtual world.” Herein lies the very power of the concept. In this volume, the chapters by Wendy A. Kellogg, John M. Carroll, and John T. Richards, by Steve Pruitt and Tom Barrett, by Meredith Bricken, and, again, by Michael Heim look specifically at the remarkable phenomenon of telepresence or “virtuality” as a prime component of the experience of cyberspace. Other authors in this volume imagine a viable cyberspace operating with less completely immersive techniques, although these nonetheless are thought of as considerably advanced over today’s rather simple, low-resolution, two-dimensional graphical and textual interfaces.

Thread Two, then, is drawn from the history of communication media. The broad historical movement from a universal, preliterate actuality of *physical doing*, to an education-stratified, literate reality of *symbolic doing* loops back, we find. With movies, television, multimedia computing, and now VR, it loops back to the beginning with the promise of a *postliterate* era, if such can be said; the promise, that is, of “post-symbolic communication” to put it in VR pioneer Jaron Lanier’s words (Lanier 1989, Stewart 1991b). In such an era, languagebound descriptions and semantic games will no longer be required to communicate personal viewpoints, historical events, or technical information. Rather, direct—if “virtual”—demonstration and interactive experience of the “original” material will prevail, or at least be a

universal possibility. We would become again “as children,” but this time with the power of summoning worlds at will and impressing speedily upon others the particulars of our experience.

In future computer-mediated environments, whether or not this kind of literal, experiential sharing of worlds will supersede the symbolic, ideational, and implicit sharing of worlds embodied in the traditional mechanisms of text and representation remains to be seen. While pure VR will find its unique uses, it seems likely that cyberspace, in full flower, will employ all modes. Thread Three Another narrative, this one is spun out of the history of architecture. The reader may remember that Popper saw architecture as belonging to World 3. This it surely does, for although shelter, beauty, and meaning can be found in “unspoiled” nature, it is only with architecture that nature, as habitat, becomes co-opted, modified, and codified. Architecture, in fact, begins with displacement and exile: exile from the temperate and fertile plains of Africa two million years ago—from Eden, if you will, where neither architecture nor clothing was required—and displacement through emigration from a world of plentiful food, few competitors, and no more kin than the earth would provide for. Rapid climatic change, increasing competition, and exponential population growth was to change early man’s condition irreversibly. To this day, architecture is thus steeped in nostalgia, one might say; or in defiance. Architecture begins with the creative response to climatic stress, with the choosing of advantageous sites for settlements (and the need to defend these), and the internal development of social structures to meet population and resource pressure, to wit: with the mechanisms of privacy, property, legitimation, task specialization, ceremony, and so on. All this had to be carried out in terms of the availability of time, materials, and design and construction expertise. Added to these were the constraints and conventions manufactured by the culture up to that point. These were often arbitrary and inefficient. But always, even as conventions and constraints transformed, and as man passed from hunting and gathering to agrarianism to urbanism, the theme of return to Eden endured, the idea of return to a time of (presumptive) innocence and tribal/familial/national oneness, with each other and with nature.

I bring up this theme not because it “explains” architecture, but because it is a principle theme driving architecture’s self-dematerialization. Dematerialization? The reader may be surprised. What is architecture, after all, if not the creation of durable physical worlds that can orient generations of men, women, and children, that can locate them in their own history, protect them always from prying eyes, rain, wind, hail, and projectiles... durable worlds, and in them, permanent monuments to everything that should last or be remembered?

Indeed these are some of architecture’s most fundamental charges; and most sacred among them, as I have argued elsewhere (Benedikt 1987), is architecture’s standard bearing, along with nature, for our sense of what we mean by “reality.” But this should not blind us to a significant countercurrent, one fed by a resentment of quotidian architecture’s bruteness and claustrophobia, which itself is a spilling over of the resentment we feel for our own bodies’ cloddishness, limitations, and final treachery: their mortality. Reality is death. If only we could, we would wander the earth and never leave home; we would enjoy triumphs without risks, eat of the Tree and not be punished, consort daily with angels, enter heaven now and not die. In the name of these unreasonable desires we revere finery and illumination, and reward bravery, goodness, and learning with the assurance of eternal life. As though we could grow wings! As though we could grow wings, we erect gravity-defying cathedrals resplendent with colored windows and niches crowded with allegorical life, create paradisiacal gardens such as those at Alhambra, Versailles, the Taj Mahal, Roan-Ji, erect stadia for games, create magnificent libraries, labyrinths, and observatories, build on sacred mountain tops, make enormous, air conditioned greenhouses with amazing flying-saucer elevators, leap from hillsides strapped to kites, dazzle with gold, chandeliers, and eternally running streams; we scrub and polish and whiten... all in a universal, crosscultural act of reaching beyond brute nature’s grip in the here and now. And this with the very materials nature offers us.

In counterpoint to the earthly garden Eden (and even to that walled garden, Paradise) then, floats the image of the Heavenly City, the new Jerusalem of the book of Revelation. Like a bejeweled, weightless palace it comes down out of heaven itself “its radiance like a most rare jewel, like jasper, transparent” (Revelation 21:9). Never seen, we know its geometry to be wonderfully complex and clear, its twelves and fours

and sevens each assigned a set of complementary cosmic meanings. A city with streets of crystalline gold, gates of solid pearl, and no need for sunlight or moonlight to shine upon it for "the glory of God is its light." In fact, all images of the Heavenly City-East and West-have common features: weightlessness, radiance, numerical complexity, palaces upon palaces, peace and harmony through rule by the good and wise, utter cleanliness, transcendence of nature and of crude beginnings, the availability of all things pleasurable and cultured. And the effort at describing these places, far from a mere exercise in superlatives by medieval monks and painters, continues to this day on the covers and in the pages of innumerable science fiction novels and films. (Think of the mother ship in *Close Encounters of the Third Kind*.) Here is what it means to be "advanced," they all say. From Hollywood Hills to Tibet, one could hardly begin to list the buildings actually built and projects begun in serious pursuit of realizing the dream of the Heavenly City. If the history of architecture is replete with visionary projects of this kind, however, these should be seen not as naive products of the fevered imagination, but as hopeful fragments. They are attempts at physically realizing what is properly a cultural archetype, something belonging to no one and yet everyone, an image of what would adequately compensate for, and in some way ultimately justify, our symbolic and collective expulsion from Eden. They represent the creation of a place where we might re-enter God's graces. Consider: Where Eden (before the Fall) stands for our state of innocence, indeed ignorance, the Heavenly City stands for our state of wisdom, and knowledge; where Eden stands for our intimate contact with material nature, the Heavenly City stands for our transcendence of both materiality and nature; where Eden stands for the world of unsymbolized, asocial reality, the Heavenly City stands for the world of enlightened human interaction, form and information. In Eden the sun rose and set, there were days and nights, wind and shadow, leaf and stone, and all perfumed. The Heavenly City, though it may contain gardens, breathes the crystalline gleam of its own lights, sparkling, insubstantial, laid out like a beautiful equation. Thus, while the biblical Eden may be imaginary, the Heavenly City is doubly imaginary: once, in the conventional sense, because it is not actual, but once again because even if it became actual, because it is information, it could come

into existence only as a virtual reality, which is to say, fully, only “in the imagination.” The image of The Heavenly City, in fact, is an image of World 3 become whole and holy. And a religious vision of cyberspace. I must now return briefly to the history of architecture, specifically in modern times. After a century of the Industrial Revolution, the turn of the twentieth century saw the invention of high-tensile steels, of steel-reinforced concrete, and of high-strength glass. Very quickly, and under economic pressure to do more with less, architects seized and celebrated the new vocabulary of lightness. Gone were to be the ponderous piers, the small wooden windows, the painstaking ornament, the draughty chimneys and lanes, the chipping and smoothing and laying! Instead: daring cantilevers, walls reduced to reflective skins, openness, light, swiftness of assembly, chromium. Gone the stairs, the horse-droppings in the street, and the cobbles. Instead, the highway, the bulletlike car, the elevator, the escalator. Gone the immovable monument, instead the demountable exhibition; gone the Acropolis, instead the World’s Fair. In 1924, the great architect Le Corbusier proposed razing half of Paris and replacing it with La Ville Radieuse, the Radiant City, an exercise in soaring geometry, rationality, and enlightened planning, unequalled since. A Heavenly City.

By the late 1960s, however, it was clear that the modern city was more than a collection of buildings and streets, no matter how clearly laid out, no matter how lofty its structures or green its parks. The city became seen as an immense node of communications, a messy nexus of messages, storage and transportation facilities, a massive education machine of its own complexity, involving equally all media, including buildings. To no one was this more apparent than to a group of architects in England calling themselves Archigram. Their dream was of a city that built itself unpredictably, cybernetically, and of buildings that did riot resist television and telephones and air conditioning and cars and advertising but accommodated and played with them; inflatable buildings, buildings on rails, buildings like giant experimental theaters with video cameras gliding like sharks through a sea of information, buildings bedecked in neon, projections, lasers beams. . . . These were described in a series of poster-sized drawings called architectural telegrams, which were themselves, perhaps not incidentally, early examples of what multimedia computer screens might look like tomorrow (Cook 1973). Although the group built nothing themselves, they were and are, nonetheless, very influential in the world of architecture.

Now, a complete treatment of the signs of the ephemeralization of architecture and its continuing capitulation to media is outside the scope of this introduction. It occurs on many fronts, from the wild "Disneyfication" of form, to the overly meek accommodation of services. Most interesting, however, is a thread that arises from thinking of architecture itself as an abstraction, a thread that has a tradition reaching back to ancient Egypt and Greece and the coincidence of mathematical knowledge with geometry and hence correct architecture. As late as the eighteenth century, architects were also scientists and mathematicians; witness Andrea Palladio, Sir Christopher Wren, and before them, of course, Leonardo da Vinci and Leon Battista Alberti. From the 1920s till the 1960s, the whole notion that architecture is about the experiential modulation of space and time—that it is "four dimensional"—captivated architectural theory, just as it had captivated a generation of artists in the 20s and 30s (Henderson 1983). This was something conceptually far beyond the simple mathematics of good proportions, even of structural engineering. It is an idea that still has force.

Then too there is the tradition of architecture seen for its symbolic content; that is, for not only the way it shapes and paces information fields in general (the emanations of faces, voices, paintings, exit signs, etc.) but the way buildings carry meaning in their anatomy, so to speak, and in what they "look like." After five thousand years, the tradition is very much alive as part of society's internal message system. In recent years, however, the architectural "message system" has taken on a life of its own. Not only have architectural drawings generated an art market in their own right—as illustrated conceptual art, if you will—but buildings themselves have begun to be considered as arguments in an architectural discourse about architecture, as propositions, narratives, and inquiries that happen, also, to be inhabitable. In its most current avant-garde guise, the movement goes by the name of Deconstructivism, or Post-Structuralism (quite explicitly related to the similarly named movements in philosophy and literary criticism). Its interests are neither in the building as an object of inhabitation nor as an object of beauty, but as an object of information, a collection of ciphers and "moves," junctions and disjunctions, reversals and iterations, metaphorical woundings and healings, and so on, all to be "read." This would be of little interest to us here were it not an

indication of how far architecture can go towards attempting to become pure demonstration, and intellectual process, and were it not fully a part of the larger movement I have been describing. (And we should remember that, as a rule, today's avant-garde informs tomorrow's practice. See Betsky 1990.)

But there is a limit to how far notions of dematerialization and abstraction can go and still help produce useful and interesting, real architecture. That limit has probably been reached, if not overshot (Benedikt 1987). And yet the impetus toward the Heavenly City remains. It is to be respected; indeed, it can usefully flourish... in cyberspace.

The door to cyberspace is open, and I believe that poetically and scientifically minded architects can and will step through it in significant numbers. For cyberspace will require constant planning and organization. The structures proliferating within it will require *design*, and the people who design these structures will be called *cyberspace architects*. Schooled in computer science and programming (the equivalent of "construction"), in graphics, and in abstract design, schooled also along with their brethren "real-space" architects, cyberspace architects will design electronic edifices that are fully as complex, functional, unique, involving, and beautiful as their physical counterparts if not more so. Theirs will be the task of visualizing the intrinsically nonphysical and giving inhabitable visible form to society's most intricate abstractions, processes, and organisms of information. And all the while such designers will be *rerealizing* in a virtual world many vital aspects of the physical world, in particular those orderings and pleasures that have always belonged to architecture.

Two chapters in this volume "come out of" architecture, my own and Marcos Novak's. My chapter attempts to discuss cyberspace in terms of certain basic design principles and then show some visualized examples; Novak discusses the idea of cyberspace as a poetic medium that, among other things, creates a "liquid architecture," an architecture of information, being less a proposition about designing buildings, of course, than a prelude as to how we might evolve legible forms in the context of a user-driven and self-organizing cyberspace system.

Thread Four This thread is drawn from the larger history of mathematics. It is the line of arguments and insights that revolve around

(1) the propositions of geometry and space, (2) the spatialization of arithmetical/algebraic operations, and (3) reconsideration of the nature of space in the light of (2).

Since Aristototle, operating alongside this “spatial-geometrical” thread in mathematics has been a complementary one, that is, the development of symbolic logic, algebraic notation, calculus, finite mathematics, and so on, to modern programming languages. I say “complementary” because these last-named subjects could (and can still) proceed purely symbolically, with little or no geometrical, spatial interpretation; algebra, number theory, computation theory, logic. . . these are symbolic operations upon symbolic operations and have a life of their own.

In practice, of course, diagrams, which are spatial and geometrical, and symbol strings (mathematical notation, language) are accepted as mutually illuminating representations and are considered together. But the distinction between them, and the tension, still remain. There are those who think most easily and naturally in symbolic sequences, and linear operations upon them; there are those who think most easily and naturally in shapes, actions, and spaces. Apparently more than one type of intelligence is involved here (West 1991, Gardner 1983, Hadamard 1945). Be this as it may, cyberspace clearly is premised upon the desirability of spatialization per se for the understanding of information. Certainly, it extends the current paradigm in computing of “graphic user interfaces” into higher dimensions and more involving experiences, and it extends current interest, as evidenced by the popularity of Edward Tufte’s books (1983, 1990), in “data cartography” in general and in the field of scientific visualization. But, more fundamentally, cyberspace revivifies and then extends some of the more basic techniques and questions having to do with the spatial nature of mathematical entities, and the mathematical nature of spatial entities, that lie at the heart of what we consider both real and measurable.

Rigorous reasoning with shape—deductive geometry—began, as we all know, in ancient Greece with Thales around 600 B.C., continuing through 225 B.C. with Pythagoras, Euclid, and Apollonius. The subject was twin: (1) the nature (and methods of construction) of the idealized forms studied—basically lines, circles, regular polygons and polyhedra, although Apollonius began work on conic sections—and (2) the nature of perfect reasoning itself, which the specifiability and universality of

geometrical operations seemed to exemplify. The results of geometrical study had practical use in building and road construction, land surveying, and what we today call mechanical engineering. Its perfection and universality also supported the casting of astrological/cosmological models along geometrical lines.

The science and art of geometry has developed sporadically since, receiving its last major “boost” of renewed interest—after Kepler and Newton—in the late nineteenth century, with Bolyai and Lobatchevsky’s discovery of non-Euclidean geometry. Soon, however, with the concept of pure topology and the discovery of consistent geometries of higher dimensionality than three, first Euclidean geometry and then geometry in general began to lose something of its luster as a science wherein significant new discoveries could be made. All statements of visual geometrical insight, it seemed, could be studied more generally and accurately in the symbolic/algebraic language of analytical mathematics—final fruit of Descartes’ project in *La Géométrie*, which was precisely to show how the theorems of geometry could be transcribed into analytical (algebraic) form.

Of course the linkage, once made, between geometry and algebra, space and symbol, form and argument, is a two-way one. Descartes had both “algebraized” geometry and “geometrized” algebra. (And it is this second movement that is of most interest to us here.) With one profound invention, he had built the conceptual bridge we today call the Cartesian coordinate system. Here was the insight: just as the positions of points in natural, physical space could be encoded, specified, by a trio of numbers, each referring to a distance from a common but arbitrary origin in three mutually orthogonal directions, so too could the positions of points in a “mathematical space” where the “distances” are not physical distances but numerical values, derived algebraically, of the solution of equations of (up to) three variables. In this way, thousands of functions could accurately be “graphed” and made visible.

Today, procedures based on Descartes’ insight are a commonplace, taught even at good elementary schools. But this should not mask the power of the implicit notion that space itself is something not necessarily physical: rather that it is a “field of play” for all information, only one of whose manifestations is the gravitational and electromagnetic field of play that we live in, and that we call the real world. Perhaps no examples are more vivid than the beautiful forms that emerge from

simple recursive equations—the new science of “fractals”—and recent discoveries of “strange attractors,” objects of coherent geometry and behavior that “exist” only in mathematical spaces (coordinate systems with specially chosen coordinates) and that economically map/describe/prescribe the behavior of complex, chaotic, physical systems. Which reality is the primary one? we might fairly ask.

Actually, why choose?

Modern physicists are sanguine: Minkowski had shown the utility of mapping time together with space, Hamiltonian mechanics lent themselves beautifully to visualizing the dynamics of a physical system in n-dimensional state or phase space where a single point represents the entire state of the system, and quantum mechanics seems to play itself out in the geometrical behavior of vectors in Hilbert space, in which one or more of the coordinates are “imaginary” (see Penrose 1989 for a recent explication).

In the meantime, the more common art of diagrams and charts proliferated—from old maps, schedules, and scientific treatises, to the pages of modern economics primers, advertisements, and boardroom “business graphics.” Many of these representations are in fact hybrids, mixing physical, energetic or spatiotemporal, coordinates with abstract, mathematical ones, mixing histories with geographies, simple intervallic scales with exponential ones, and so on. The practice of diagramming (surely one whose origins are earlier than writing) continues too, today enhanced by the mathematics of graph theory with its combinatorial and network techniques to analyze and optimize complex processes. What, we may ask, is the ontological status of such representations? All of them—from simple bar charts and organizational “trees” through matrices, networks, and “spreadsheets” to elaborate, multidimensional, computer-generated visualizations of invisible physical processes—all of these, and all abstract phase-, state-, and Hilbert-space entities, seem to exist in a geography, a space, borrowed from, but not identical with, the space of the piece of paper or computer screen on which we see them. All have a reality that is no mere picture of the natural, phenomenal world, and all display a physics, as it were, from elsewhere.

What are they, indeed? Neither discoveries nor inventions, they are of *World 3*, entities themselves evolved by our intelligence in the world of things and of each other. They represent first evidence of a continent about which we have hitherto communicated only in sign language,

a continent “materializing,” in a way. And at the same time they express a new etherealization of geography. It is as though, in becoming electronic, our beautiful old astrolabes, sextants, surveyor’s compasses, observatories, orreries, slide rules, mechanical clocks, drawing instruments and formwork, maps and plans—physical things all, embodiments of the purest geometry, their sole work to make us at home in space—become environments themselves, the very framework of what they once only measured.

The contributions by Tim McFadden, Carl Tollander, and Alan Wexelblat are partially woven from this thread, as is a good part of my own. McFadden examines the idea of cyberspace as an informational Indra’s Net, a universe of pointlike beads, infinite in number, each of which reflects all the others. Here cyberspace is an evolving, fourdimensional hologram of itself. (It was this ancient Hindu image of Indra’s Net that also informed Leibniz’s Monadology, as Heim discusses.) Tollander introduces Edelman’s Neuronal Group Selection theory into the design of a noncentralized system of computational “engines” to create cyberspaces that can evolve in a “natural” way. (Novak also discusses this notion). Wexelblat examines the nature of coordinates in abstract spaces in general, in modern personal computing, and then, extrapolated, in terms of cyberspace specifically considered as an outgrowth of these.

My account of the intertwining “threads” that seem to lead to cyberspace is, of course, impressionistic and incomplete, and not just for lack of space in this introduction. Cyberspace itself is an elusive and future thing, and one can hardly be definitive at this early stage.

But it is also clear that the “threads” themselves are made of threads, and that there are others. For example, the history of art into modern times tells a related story, fully involving mythology, changing media, a relationship to architecture, logic, and so on. It is a thread I have not described, and yet the contribution of artists—visual, musical, cinematic—to the design of virtual worlds and cyberspace promises to be considerable, as Nicole Stenger, poet and animation artist, attests in this volume. Similarly, the story of progress in telecommunications and computing technology—the miniaturizations, speeds, and economies, the new materials, processes, interfaces and architectures—is a thread in its own right, with its own thrusts and interests in the coming-to-

be of cyberspace. This story is well chronicled elsewhere (Rheingold 1985, Gilder 1988). Then there is the sociological story, and the economic one, the linguistic one, even the biological one . . . and one begins to realize that every discipline can have an interest in the enterprise of creating cyberspace, a contribution to make, and a historical narrative to justify both. How could it be otherwise? We are contemplating the arising shape of a new world, a world that must, in a multitude of ways, begin, at least, as both an extension and a transcription of the world as we know it and have built it thus far.

Another reason that my account is impressionistic and incomplete, however, is that the very metaphor of threads is too tidy and cannot support all that needs to be said. Scale aside, something deeper and more formless is going on. Consider: if information is the very stuff of space and time, what does it mean to manufacture information, and what does it mean to transfer it at ever higher rates between spatiotemporally distinct points, and thus dissolve their very distinctness? With mature cyberspaces and virtual reality technology, this kind of warpage, tunneling, and lesioning of the fabric of reality will become a perceptual, phenomenal fact at hundreds of thousands of locations, even as it falls short of complete, quantum level, physical achievement. Today intellectual, tomorrow practical, one can only guess at the implications.

Finally, my "narrative of threads" has not done justice to the authors represented in this volume. Each has their own perspective, expertise, and interest, and each draws inspiration from matters I have not mentioned, and stories I have not sketched or have only touched upon. Rather than extend this introduction with fuller discussion of each chapter, however, I recommend that the reader turn to them forthwith! Many are expanded and revised versions of presentations made at The First Conference on Cyberspace.¹ Others are written especially for the present collection.² All the authors address themselves to the topic with extraordinary seriousness, acumen, and enthusiasm, even though—and perhaps because—the varieties of cyberspace they imagine, describe, and sometimes criticize, do not yet exist. Indeed, the very definition of cyberspace may well be in their hands (or yours, dear reader). Of this much, one can be sure: the advent of cyberspace will have profound effects on so-called postindustrial culture, and the

¹Held on May 4 and 5, 1990, at The University of Texas at Austin. The Second (International) Conference on Cyberspace was held April 18-19, 1991, at The University of California at Santa Cruz.

²Gibson, Tomas, Stone, and Wexelblat.

material and economic rewards for those who first and most properly conceive and implement cyberspace systems will be enormous.

But let us set aside talk of rewards. With this volume, with these “first steps,” let us begin to face the perplexities involved in making the unimaginable imaginable and the imaginable real. Let the ancient project that is cyberspace continue.

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