CYBERSPACE 1999: THE SHELL, THE IMAGE, AND NOW THE MEAT

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In an article titled "2001: Computers, Living Inside Your PC", in Discover magazine, November 1988, Alan Kay predicts the next decade of computing. He specified simulation ("most corporate executives, although they've never really thought about it, would much prefer to have a model of their company that they can actually pit against different situations") and head-mounted display ("change from being on the outside of the computer to being on the inside"). These are the components of cyberspace.

The following positive scenario explores the impact of cyberspace on our daily existence in the year 1999.

HOW MUCH IT WILL COST

(Note on dollar amounts: they are predictions. If you are pessimistic, double them. Or increase by a factor of ten, and assume cyberspaces are provided in rental hubs for $50/hour.)

Let's assume that an adequate hardware suite exists. For $6000, a person can buy a cyberspace graphics board that will display up to 2000 shaded polygons 20 times per second, in two stereoscopic images. This board permits easy conversion between display formats (RGB, NTSC, HDTV), maintains consistency of color and stereopsis, and manages graphics related chores. The board also has sufficient floating-point and symbolic computational power to perform matrix multiplication, pattern-matching and parameterization of space. For concreteness, imagine this board to be based on two 80860s and a parallel bank of Transputers.

For $2000, we can get a head-mounted display, containing two high-resolution display screens on a parabolic sheet. The housing is sturdy, comfortable, well-balanced and quite small, not unlike thick glasses. Head tracking is built in, as is stereo sound and a voice microphone. Overlay headmounts, optical fiber remote feeds, and other optical arrangements are optional.

For $2000, we can get an interface suite consisting of a magic wand, a force-feedback joystick, and a low-frequency body tracker. The wand emits a virtual ray which permits us to point at virtual objects, to fly in the direction we are pointing, to attach to points on objects and toggle our perspective, and to grasp, move, and rotate objects at the end of the ray. The joystick lets us steer a virtual car or airplane, feeling bumps, collisions and forces. The body tracker provides an image of our body in the virtual environment, our movements can be mapped onto virtual objects, into the command interface via a gesture language, and into a set of virtual

effectors which we regard as tools. All input devices are seamlessly integrated, sturdy and reliable.

For an additional investment, we can get special equipment to enhance our virtual realities and our experience within them. Room digitizers, tactile-feedback units, exercise bikes, interactive toys, and photorealistic display are all available to enrich the virtual world.

The hardware industry is booming. Folks are buying headmounts to watch conventional TV. (There is talk that the TV industry will update to broadcasting dual stereo images.) Folks are buying graphics boards to watch digital movies. (There is talk that the TV industry will update to digital broadcasting.) Folks are buying peripherals to play in worlds. (There is talk that the TV industry will update to interactive broadcasting.) And folks are buying the entire hardware suite to experience cyberspace.

The software industry is booming. Folks are buying simulated worlds, artificial realities. Some are non-interactive, designed experiences called digital movies. The digital movie business is a big consumer of Cyberspace Design Tools, software that helps them to craft a digital movie. These tools have evolved from image processing, graphics animation, and computer-aided design.

APPLICATIONS

Some interactive cyberspace experiences are focused on limited domains:

The Exercise CyberCycle (already in existence at Autodesk), for example, offers a scenic digital movie which varies only according to how fast you're pedaling.

CyberGolf permits you to walk around the links of your choice, and is integrated with a stationary physical ball which you hit in real space, and a treadmill.

Waterworld is an undersea digitized hub experience just installed at Marriott's Under Marine World Out Of Africa USA. The new tank is teeming with fish and exotica. The walls of the tank are Cyberports, each connected with a personal viewing chair and a headmount. Projected through the Cyberport is a digitized view of real underwater life. (Crowds are a thing of the past; folks believe that Cyberexperience is both real and comfortable.) Each paying customer has a personal, unobstructed, cozy view. There are 400 different Cyberports. Customers can switch to and open viewports electronically. For a price, the customer can interact with the real life, since the Cyberport on the wall of the tank has a food dispenser and a water jet.

Some applications of cyberspace emphasize massive databases:

The Tornado database, as an example, contains the path of each cubic meter of air from an actual tornado. Your can study it, ride it, convert it into velocity gradients, and sprinkle it with cars and houses.

The Mars database and the Moon database let you stroll in other worlds. The gravity in each world is realistic. For undersea adventure, gravity is negative, objects float upwards. By holding one's perspective steady, the available processors shift their computational burden from real-time tracking to image refinement. Staring at an object for a few seconds renders it at photorealistic quality.

The World database contains images of every meter of the Earth's surface. You can fly over it, stop and rest in Ankara, or try to find yourself in the image.

The Body database is a 3D human body, thinly sliced and digitized at the cellular level. It has boundary integrity, so that you can travel in the bloodstream under pressure.

The Library of Congress database is the territory of scholars. The search of literature is still an art, and only Librarians can use the esoteric tools that convert words to images. Some say that it leads to insanity, others to enlightenment.

Some applications of cyberspace are extremely practical:

The Air Traffic Controller lives in a cyberspace of radar tracking information. He stands as a sentinel to the airfield, half a mile in the sky. He boards the virtual information that is the plane, and rides on its wing through the landing, checking visually for other aircraft and for weather conditions.

The Architectural Engineer is designing and constructing buildings in cyberspace. He explores his constructions, testing for code violations and modifying them on the spot. He evaluates the aesthetic feel of his construction, and repositions windows and doors to enhance views and flows.

The Mechanical Engineer is interested in testing assemblages, virtual machines. Which portions of the engine block will need reinforcement, how would the horsepower change if these cylinders were slightly smaller, what temperature should we expect at the manifold? Cyberspace would not only provide the computational substrate for realistic modeling, it would provide the viewing and interaction tools required to convey the meaning of the computations visually and intuitively to the engineer.

The Space Scientist sits comfortably on the ground, manipulating a remote robot in orbit. His movements and gestures are mimicked by his telerobotic counterpart in the physically hostile environment. And whatever happens to the robot is conveyed and experienced, risk-free, by the human operator. Delicate adjustments to the nuclear reactor in the void of space are accomplished directly; pressing interruptions on Earth are addressed merely by removing the headmount.

The Business Executive has virtually eliminated air travel from the busy agenda. Offices in New York and Paris and Tokyo and San Francisco each have virtual conference rooms, areas that are identical in furnishings and shape, but right down the hall to everyone. At conference time, executives take their chairs, don their headmounts, and greet the images of their counterparts as if they were all in the same room. A communal interface translates gestures into a common international standard, reducing differences in cultural cues. Facial expressions indicating pleasure, surprise, anger and enthusiasm are displayed explicitly. Business in the virtual conference is efficient and clear, and local privacy is available at the flip of a switch.

On the World Stock Market, traders step efficiently among the 24-hour exchanges which cover the globe. The Japan headmount puts a broker on the floor of the Japanese Exchange; the London headmount permits travel across the world in an instant.

Some uses of cyberspace are deeply humane:

The Family Gathering places relatives and friends a phone call away. Not only voice and image, but full interaction. Virtual games, virtual parties, virtual reunions. Yes, Aunt Sally's image may look a little flat, and very thin form the side, but it is Aunt Sally, in real time. We cannot share the same plate of turkey, but we can share our mutual enjoyment. Pass the Magic Wand, please.

Virtual limbs provide the disabled with experiences unobtainable in physical reality. Ah, the feeling of unencumbered movement, of enhanced abilities, of full functionality.

The Psychoanalyst finds cyberspace to be an invaluable. Depression, the most common cognitive disturbance, is expressed as powerlessness, as a helpless feeling. Virtual reality empowers the depressed, providing unlimited abilities to create and construct, to experiment with positive action. Psychodrama can be acted out on a neutral, plastic stage. Trauma can be reconstructed and faced directly. Phobias can be desensitized in a safe and controllable manner. Cyberspace biofeedback provides direct cures to modify behavior; the PostureReminder renders a clear bright world when the body is erect, and degrades through shades of grey as the body slumps. Virtual

psychoanalysis provides tools for identification and modeling of problems, for experience with options, for safe feedback and for success.

The Personal Interaction Virtual Reality permits cyberspace to be used as an empathy mapper. Here is the way I see it, I have constructed my model of our mutual situation. Will you swap places with me, look at it through my eyes? And I would like to see how you see it. Why don't we meld our virtual models, join our separate perspectives into one? Look, we agree on most of the context, but over here, in our image of the children, we differ. What needs to change so that we see it the same?

The Tranquil Ground is a cyberspace designed for relaxation and meditation. Beautiful pastel shades murmur across the ferns, sunlight and moonlight intermix in the babbling brook. I feel like melting, I am melting, joining with the undulation, becoming one with the waves, falling into the Void.

The MetaMystic database is actually a cellular automata program, refined to look like ecstatic thought in three dimensions. Meditative participants can chose to be On or Off.

Some interactive cyberspace experiences are dynamic and creative:

The Virtual Decorator customizes your home with wallpaper selections and furniture arrangements. For a modest fee, you can have your home digitized. Then come down to the friendly, home-decorating hub, and stop into Cyburbia and into your own virtual living room at the same time. Ever wonder how that modern painting would look over your mantelpiece? Thinking about moving that heavy couch all the way into the den? Don't' move it until you've seen it moved. Let's try the striped wallpaper and green carpet in the he den. No, let's change that to the polka-dot wallpaper. Come on down! All qualified buyers can use the Cyburbia hub for free.

At the Virtual Concert, every seat is the best in the house. Design the ideal auditorium, craft the sonic space of your choice. Send the sound into impossible cavities, into the Grand Canyon, and wait for the echo. Want more drums? Then move the drummer closer. Or switch eyes with the guitar player and give the air guitar concert yourself. Or be the guitar being strummed, the feeling of resonance is indescribable. Get into the beat, be the acoustic wave, shape the auditorium to fit your harmonic. Color the sound and watch the music unfold.

The Clothiers Mirror lets you watch your own image. Ever wonder what that hat looks like from behind? What if I changed the color of these shoes? Would I look better if I lost ten pounds? Gee, I love my magic CyberSelf.

The Virtual TravelAgent has digitized versions of wherever you might fancy for your vacation. No more doubt abut what you will see or where you will stay. Explore the exotic world of Tahiti, first virtually, and if you like

it, in reality. Or take the deluxe, two-day, one-night, all-expense-paid trip of a lifetime to the North Pole. Avoid the crowds, avoid the cold, avoid the travel. Just take home our dozen laserdiscs of the Polar Experience, take the phone off the hook, and prepare to play with the polar bears.

The Air Travel Companion is a cyberspace port attached to the remote control telescope under the plane. Why watch a movie when you can watch the details of reality roll by?

For the kids, we have CyberDreams, featuring the Purple Crayon. "Ho-hum, another dullish day. I need a moon." The Purple Crayon can draw in cyberspace. A circle is sketched by a wave of an arm, idealized (made perfectly circular) by a punctuated dot of the finger, and spun into three dimensions by a flick of the wrist. The moon appears. "Brighter, please, moon. And may I have my worlds from yesterday, and the new Taj Mahal, and..."

The Virtual School redefines learning. Students build their knowledge, then explore their understanding. Knowledge is redefined in terms of formal models, curriculum development becomes identified with knowledge engineering. What was ancient Greece really like? We may never know, but we can pretend, and we can do a whole lot better than those dusty old words. Can't afford the chemicals for that exotic reaction? Virtual Chemistry lets you swim among the molecules of your choice. What do those equations mean? Come find out, slide down the exiting exponential function, poke the triangle to prove that it is stable. Students participate as raindrops in the Earths' water cycle, to gain ecosystem credits. They peel away strata to study geology. Teachers are embedded in each world. Students experience learning directly. The graze on hypertext. They read only pictures.

The Virtual Artist has at his command all the tools of digital painting, millions of shades and hues, arbitrary resolution and detail, digital realism and Boolean abstraction. Once specified in cyberspace, machines can duplicate a piece of electronic art indefinitely. Aesthetics for the masses.

Virtual Sports provide team games of an entirely new flavor. Tennis handicaps might be expressed as different gravitational constants for each player. A cross between the hand-eye coordination of videogames and the strategic skills of chess will define new competitive challenges. Body tracking will allow full physical activity without physical contact. Rules can be enforced by virtual reality rather than by the players. Playing fields will be available to all.

Of course, the cyberspace videogame market will capture the hearts and monitors of every home with children. The cyberspace Personal Fantasy will capture the hearts of every home with adults.

And in the not too distant future, neuropsychologists will begin to connect the measurement of cortical activity with cyberspace construction commands. MindMirror will evolve, the first cyberspaces constructed by mental activity alone. Open-mindedness takes on an entirely new meaning.

CONSTRUCTION TOOLS

Not everyone will want to construct realities. It is, after all, very exacting and time-consuming to account for everything. For the most part, specialists will build ready-made realities, emphasizing utility, or adventure, or challenge, or education, or fun, or whatever the marketplace will require.

The makers of realities, passive and interactive, specialized and general, will require digital tools that are particularly well-suited for each of their specific construction tasks. Subject experts and cyberspace programmers will work in teams to design and construct realities that are easily modified along a small number of domain-specific parameters, and robustly invariant along most other dimensions. These folks will be the applications developers of cyberspace.

Applications developers will rely on a singular modular suite of tightly integrated programs. The programs will permit design, construction and processing of digital databases that can be interpreted as 2-or 3-dimensional scenes.

In the general case, the CyberProgrammer will want complete control over the fabric of space, and over the behavior of objects within space. A bridge could break under a load, the load could vary with rush hour. In general, the Cyberspace Construction Kit must be a complete modeling kit for the real world and for parameterized versions of reality.

MORE THAN REALITY?

We describe innovations in terms of what they replace. Only after decades do we come to understand the pervasive impact of new technologies on our culture. The automobile was first the horseless carriage. It replaced the carriage, looked like a carriage, and moved at the speed of a horse. Decades later, the automobile has transformed our landscapes, the pace of our travels, and our concept of space. The television replaced the radio. Television programs were first radio programs with pictures. Decades later, the television has transformed our evenings, the pace of our senses, and our concepts of news and entertainment. The computer is first a symbol processor. Although decades have barely passed, it is reshaping our models of information and information processing. But the computer itself has yet to be understood for what it is in itself; we still view it from the

impoverished model of what it replaces. McLuhan said that computers extend our central nervous system. But our CNS is not a symbol processor, it is a reality generator. The essence of the computer revolution is yet to come; computers are essentially generators of realities. Cyberspace, virtual reality, embodies this fundamental nature of computers, the creation of a diversity of realities. We have seen the shell, the narrowness of sequential computation, in the processing of one-dimensional strings of symbols. Zeros and Ones. We have seen the image, the flatness of pixel computation, in the desktop metaphor. Icons and Mouseclicks. Now we can prepare to see the meat, the sensory surround of situated computation, in cyberspace. Inclusion and Unconstrained Realities.