# City of Bits

## Space, Place, and the Infobahn

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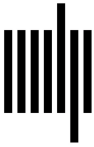

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The information infrastructure potentially redistributes access to services and opportunities: a prototype system for delivering surgical expertise to remote locations.

During the nineteenth and twentieth centuries, cities have been transformed by successive waves of transportation and communications technology. At each stage, new combinations of buildings, transportation systems, and communication networks have served the needs of the inhabitants. Now, as the infobahn takes over a widening range of functions, the roles of inhabited structures and transportation systems are shifting once again, fresh urban patterns are forming, and we have the opportunity to rethink received ideas of what buildings and cities are, how they can be made, and what they are really for. The challenge is to do this right — to get us to the good bits.

## GETTING TO THE GOOD BITS

### 1835: Pre-Industrial Settlements

"This will be a place for a village," intoned the explorer John Batman when he encountered Port Phillip Bay in 1835, as I recall from the Australian history that I learned so long ago in dusty country schoolrooms with the songs of magpies swirling in on the scorching, eucalyptus-laden breeze. We would take out our red plastic templates to trace maps of the island continent and its straggling river systems into our blue-lined exercise books, then we would meticulously mark the tracks of inland trailblazers and coastal navigators, locating the settlements that followed and inscribing the dates.

Much later, when I learned the age-old distinction between *civitas* and *urbs,* I realized that we had been rehearsing our own particular foundation myths — the ritualized tales of how our wandering ancestors had chosen sites and constructed places for their communities. We schoolchildren in the bush learned of the heroes who selected the spots, of the settlers who came to these places, and of how the first, rough tracks and shelters were laid out upon the freshly cleared ground. We were told of convict settlements and ports for communities of whalers and sealers along the coasts, of the gold-rush towns and agricultural centers that had sprung up in the interior, of how the railroad and telegraph systems had spawned remote and desolate villages, and of how merchant, industrial, and administrative cities had grown at favored locations in the emerging transportation network. And we heard how colonial bureaucrats and military officers — Hoddle, Light, and others — had plunked down the surveyed street grids that introduced the beginnings of urban form and order to the scrubby brown land.

## 1956: The Commuter City

By 1956, when I first made the long, slow rail journey to the distant big city — for the Olympics in Melbourne — industrial capitalism had firmly taken hold and the postwar immigrants were pouring in. Some hours after meat pie and tea at the Ballarat railway refreshment rooms (a beer for Dad), the grimy train steamed first through a ring of suburban housing, then penetrated what seemed an interminable zone of factories and warehouses to reach the heart of the metropolis. There I found department stores and shopping arcades, theaters, grand old hotels, government offices, the headquarters of banks and insurance companies, the fancy professional consulting rooms of Collins Street, crowds, and foreign voices. It was all there. And every day the trams and trains and streams of cars would wash a huge tide of workers into the city in the morning, then — with a brief pause for thirsty workers to grab a

drink at the pub (a custom known locally as the six o'clock swill) — would suck them out to suburbia again in the evening.

All these patterns and rhythms were generated by the need to put bodies in particular places, at particular times, for particular purposes. The convict settlements were intended to remove the undesirable and inconvenient to the antipodes — as far from English soil as possible, at places that had been picked out for their practicality as ports and their supposed potential for self-supporting agriculture. The gold-rush towns exploded into existence at just those spots where miners could dig the precious metal from the ground, and the cattle and sheep men were drawn to water and grazing lands. Often these special places were far from each other, and certainly they were all remote from the rest of the world — connected by lengthy and tenuous transportation routes along which passengers, products, and information slowly and sporadically flowed; their inhabitants had no way to escape the prison house of distance. By mid-twentieth century in the coastal capitals, the space of the city itself was subdivided into specialized places to live, places to go to work, and places to assemble for shopping and entertainment, all interconnected by roads and railway networks for moving bodies back and forth. And it mattered where you came from — the tree-lined pleasances of South Yarra or the grubby streets of Brunswick, Sydney, or the bush.

In the sixties, geography was destiny still, so many of my generation left the vast, isolated southern continent to be closer to the centers of things.

## 1994: TELEPRESENCE

Fast forward. The year is now 1994, and I am typing this text on a computer in my office at MIT. On the same screen, there is a video window open to the design studio upstairs where my students

are working, and there are additional windows to studios at universities in St. Louis, upstate New York, Vancouver, Hong Kong, and Barcelona. There is a small video camera on my desk, so that the students can also see me at work. We are all interconnected by the Internet, and the students in these different locations and time zones are working together on proposals for some new housing in an old area of Shanghai. Through their computer workstations, the students and their instructors can exchange CAD models and rendered images of proposals, get answers to queries about site and program, and discuss and criticize each other's work. For the moment, at least, we scattered souls have become an electronically linked virtual community. Bodily location is no longer an issue; for me, the students in Hong Kong are as much a part of it as are those to be found within walking distance of my office.

We have reinvented the human habitat. Back when it took many months for an exchange of letters between an isolated Australian settlement and a foreign city, most of a citizen's interactions were necessarily with other inhabitants of that same settlement. Your community consisted of your close neighbors; you could love it or you could leave it. But as transportation and communications capabilities improved in the industrial era, maintaining contact with widely dispersed friends and family became much easier, and it became possible to participate actively in communities of interest that were not tied to your hometown. In the two centuries from the first convict fleet's arrival in Botany Bay to the formation of the Internet — 1788 to 1988 — the preindustrial relationship of *civitas* to *urbs* was radically restructured. Today, as telepresence augments and sometimes substitutes for physical presence, and as more and more business and social interactions shift into cyberspace, we are finding that accessibility depends even less on propinquity, and community has come increasingly unglued from geography. Our network connections are becoming as important to us as our bodily locations.

Cyberspace is opening up, and the rush to claim and settle it is on. We are entering an era of electronically extended bodies living at the intersection points of the physical and virtual worlds, of occupation and interaction through telepresence as well as through physical presence, of mutant architectural forms that emerge from the telecommunications-induced fragmentation and recombination of traditional architectural types, and of new, soft cities that parallel, complement, and sometimes compete with our existing urban concentrations of brick, concrete, and steel.

For designers and planners, the task of the twenty-first century will be to build the bitsphere — a worldwide, electronically mediated environment in which networks are everywhere, and most of the artifacts that function within it (at every scale, from nano to global) have intelligence and telecommunications capabilities. It will overlay and eventually succeed the agricultural and industrial landscapes that humankind has inhabited for so long.

This unprecedented, hyperextended habitat will transcend national boundaries; the increasingly dense and widespread connectivity that it supplies will quickly create opportunities — the first in the history of humankind — for planning and designing truly worldwide communities. Just as the ancient *polis* provided an agora, markets, and theaters for those living within its walls, the twenty-first-century bitsphere will require a growing number of virtual gathering places, exchanges, and entertainment spots for its plugged-in populace. Just as architects have traditionally designed schools, hospitals, and other service facilities to meet the needs of surrounding local areas, bitsphere planners and designers will structure the channels, resources, and interfaces of educational and medical service delivery systems for much more extended constituencies. Commercial, entertainment, educational, and health care

organizations will use these new delivery systems and virtual places to operate, cooperate, and compete on a global scale.

We will need rules for this emerging game. Like more familiar social and political units, international bitsphere communities will urgently require appropriate constitutions, institutions, public policies, and laws; perhaps there will be a specialized law of cyberspace, as there is now a law of the sea. At the same time, established, territorially defined nations, states, regions, and cities will have to adapt their pre-bitsphere structures and customs to the new context — one in which borders no longer have their old meaning, rights and powers may not be defined by spatial boundaries, property cannot be protected in traditional ways, and much of the economic, social, and cultural action has been attracted to the upstart venues of cyberspace.

Nations that seek to remain economically competitive and to provide high living standards for their citizens will race to embark on their National Information Infrastructure projects as, in the past, they have invested in their ports and shipping fleets, railroad networks, and highway systems. And as they do so, they will have to resolve fundamental questions about the political economy of cyberspace; the answers that they reach will largely determine the kinds of nations that they become. Democratic ideals (and the lessons of the telephone system) suggest that they should strive to provide universal access — affordable, ubiquitously present, high-bandwidth service to all their citizens. If equality of opportunity and symmetry of participation are valued, then all classes of users (not just privileged groups and institutions) should be able to create as well as receive information; this means that the infrastructure has to provide two-way digital pipes and allow anyone to set up a server. If bottom-up community development efforts and entrepreneurial enterprise are to be encouraged, then the infrastructure must have a carefully crafted open architecture; it should allow

a wide range of hardware companies, software developers, network service providers, content providers, and users to produce and integrate components which extend and add value to the system. And if the infrastructure is to encourage national coherence rather than a new kind of balkanization, then its development must be guided by policies and standards that assure interoperability between all the subnetworks of the national system.

These national information infrastructures will not come cheap, and policy makers will face the difficult question of how to pay for them. The various possible answers have profoundly differing social consequences, so the policy debates are likely to be contentious ones. Some will argue, from positions grounded on ideals of social justice, that universal access and attention to the public good should be guaranteed by treating national information infrastructures as public utilities paid for with tax dollars. Others will claim that only the private sector can mobilize the resources needed to construct these infrastructures quickly and run them efficiently and that private-sector service providers will therefore have to be motivated by opportunities for profits from toll charges and advertising sales. In the end, cyberspace development — much like real estate development — will probably progress through a complex and evolving blend of public policies and investments with private-sector responses to emerging opportunities.

Does development of national and international information infrastructures, and the consequent shift of social and economic activity to cyberspace, mean that existing cities will simply fragment and collapse? Or does Paris have something that telepresence cannot match? Does Rome have an answer to *Neuromancer?* Most of us would bet our bottom bits that the reserves of resilience and adaptability that have allowed great cities to survive (in changed form) the challenges of industrialization and the automobile will similarly enable them to adapt to the bitsphere. Though immersion in

electronically propelled bits will progressively reduce our reliance on bodily presence and material exchange, thus altering the ways in which we use physical space and weakening many of the activity linkages that now hold large urban agglomerations together, there is no reason to think that this novel condition will make us indifferent to our immediate surroundings or suddenly eliminate our desire for face-to-face human contact in congenial settings. We will still care about where we are, and we will still want company. So cities and towns will probably find opportunities to restructure themselves — to regroup housing, workplaces, and service facilities into reinvigorated small-scale neighborhoods (both urban and rural) that are effectively nourished by strong electronic links to a wider world, but simultaneously prize their differences from other places, their local institutions and hangouts, and their unique ambiences and customs. A community's capacity to connect globally can yield renewed opportunity for its citizens — freed from the need to seek employment and services in distant urban centers — to know their neighbors and to participate in local affairs.

As the development of pioneering campus and community networks has already suggested, there will be an important role here for local subnetworks of the national and international systems — electronic Main Streets that provide places for citizens to present themselves in their communities, to exchange greetings and gossip with neighbors, and to transact local business. Bitsphere civic design will encompass not only traditional matters of roads and sidewalks, sewers, and land-use zoning, but also development of local network infrastructure and creation of electronic venues for local communication and interaction.

By redirecting access to services and opportunities, the growing information infrastructure has the potential to create winners and losers on a vast scale. It is pleasant to imagine a nation of networked Aspens and cyberspaced Santa Monicas peopled by convivial,

bicycle-riding locals, but the obvious danger is that such restructuring will instead produce electronic Jakartas — well-connected, well-serviced, fortified enclaves of privilege surrounded by miserable hyperghettoes, where investments in information infrastructure and appliances are not made, electronically delivered services do not reach, and few economic opportunities are to be found. The poor could be left with the obsolete and decaying urban remnants and isolated rural settlements that the more privileged no longer need. Surely the most fundamental challenge in building the bitsphere will be to deploy access according to principles of social equity — not in ways that heighten the privilege of the haves and further marginalize the have-nots.

Within bitsphere communities, there will be subnetworks at a smaller scale still — that of architecture. Increasingly, computers will meld seamlessly into the fabric of buildings and buildings themselves will become computers — the outcome of a long evolution. Pre-industrial buildings were not much more than supporting skeletons and enclosing skins. With the Industrial Revolution, they acquired increasingly complicated mechanical physiologies; soon they were routinely equipped with water supply and sewage systems, heating and air-conditioning systems, electrical systems, safety systems, and more. Now they are getting electronic nervous systems — network connections, cabling in the woodwork, and information appliances. As the speed at which bits zip around a building approaches that at which they are moved inside today's computers, as different sorts of specialized sensors and input devices harvest bits at arbitrary locations, as processors are embedded wherever they happen to be needed, and as all the various displays and appliances are integrated into building-wide, digitally controlled systems, it will become meaningless to ask where the smart electronics end and the dumb construction begins; computers will burst out of their boxes, walls will be wired, and the

architectural works of the bitsphere will be less structures with chips than robots with foundations.

Architects will increasingly confront practical choices between providing for bodily presence and relying on telepresence. They will be forced to explore the proper respective roles of physically constructed hardware and symbolically encoded software, and of actual space and virtual places. And eventually they will find new ways to accommodate human needs by recombining transformed fragments of traditional building types in a matrix of digital telecommunication systems and reorganized circulation and transportation patterns. From the sidelines, no doubt, technoromantic theoreticians will egg them on to Gibsonian gestures of dematerialization and radical renunciation of traditional architectural means, while materiality chauvinists will provide ringing denunciations of a world that they see going to hell in a handheld device.

And finally, there will be the intimate bits. Just as clothing has traditionally formed a first interface to the physical world, so our personal electronic devices and bodynets will become interfaces between flesh and nervous system and the bitsphere. Hand-held remote control devices will be used to interact with digital televisions and other information devices. Personal digital assistants and laptop computers will wirelessly exchange bits with the surrounding infrastructure. Body-mounted and implanted medical monitoring devices will transmit data to environmental control systems. Miniature storage devices will hold vital medical records, identification, and digital cash. Our electronic accouterments will range from headphones to sensor gloves and the latest fashions in smart sneakers. And their designers will create the most immediate, private digital environments — our personal cyberspace.

Networks at these different levels will all have to link up somehow; the body net will be connected to the building net, the building

net to the community net, and the community net to the global net. From gesture sensors worn on our bodies to the worldwide infrastructure of communications satellites and long-distance fiber, the elements of the bitsphere will finally come together to form one densely interwoven system within which the knee bone is connected to the I-bahn.

The uncertainties and dangers of the bitsphere frontier are great, but it is a place of new opportunity and hope. So forget the global couch-potato patches that Marshall McLuhan surveyed back in the sixties. *This* will be the place for a global village.

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