Konrad Wachsmann.
Experimental structural web,
1953. (detail)

Network Fever

MARK WIGLEY

We are constantly surrounded by talk of networks. Every third message, article, and advertisement seems to be about one network or another. We are surrounded, that is, by talk on networks about networks. It is as if our technologies feed on a kind of narcissistic self-reflection. Everyone has become a kind of expert, ready to discuss the different types of nets (computer, television, telephone, airline, radio, beeper, bank . . .) or scales (global, national, infra, local, home . . .) or modes (cable, wireless, digital, optical . . .). And where would we be without our opinions about *the* Internet, a net of nets against which all others are now referenced? How many ways do we have to express our amazement at such a vast space in which any address is just a few clicks away from all the others? Attaching oneself to a seemingly marginal thread soon accesses an endlessly dense weave, as if a walk down a quiet country lane would suddenly bring one to the heart of a metropolis of unprecedented dimensions. In celebrating this new kind of territory, we recast questions of individual identity in terms of unimaginable levels of connectivity, ignoring the equally dramatic rise of new forms of inaccessibility to stage an institutionalized simulation of euphoria in which discourse about openness, democracy, free exchange, and speed dominates over that of control, surveillance, blockage, sedation, and crime.[1]

The message is clear. Nowhere escapes the net. A map of all the webs passing through any particular space would be impossibly dense. Invisible networks seemingly threaten visible means of defining space, dissolving the walls of buildings. The architecture of borders, walls, doors, and locks gives way to that of passwords, fire walls, public key encryption, and security certificates. Indeed, the idea of a space occupied by networks or superimposed by them has been replaced by that of overlapping networks within which physical space only appears as a fragile artifact or effect. Space itself can only be seen when caught in the net. It is as if the modern perforation and lightening up of architecture in the face of speed, industrialized technology, and mass production at the turn of the twentieth century has gone a step farther as buildings dissolve into information flow, to be either discarded as a relic of a previous time or nostalgically preserved as a quaint memento.

The Internet is relatively new, emerging out of ARPANET, a 1969 cold war operation of the U.S. Defense Department that combined the computers of four universities. It grew exponentially ever since and now

bounces from school to house to car to plane to beach. But what if we are actually at the end point of the network logic? What if contemporary discourse about the net simply realizes nineteenth-century fantasies that were acted out throughout most of the last century? What if the much-advertised dissolving of architecture occurred long ago? What if much of our net talk is just an echo? An echo of an echo?

Dancing Gurus

The radical confusion of architecture and networks can be marked by the July 6, 1963, meeting of a short man in dark pants, close-fitting white jacket, crisp shirt, and tie with a tall man in light pants and a loose-fitting summer shirt covered with a geometric pattern. The shorter man was born in the last decade of the nineteenth century and has been using communication networks as a model for architecture since the late 1920s. The taller one is a forty-year-old expert in communication who has just published a book on networks in which architecture plays a decisive but less obvious role. Photographed together on the deck of a boat, the architect is clearly no stranger to the sun but stands a little defensively, holding a text with two hands in front of him, as if about to deliver an important statement somewhere else. The communications expert is pale but leans casually toward the camera with his hands tucked behind his back, smiling openly as if he has nothing much to say and will stay on deck for as long as possible. Yet the odd couple take an instant liking to each other and quickly become a kind of intellectual tag wrestling team, tormenting colleagues and audiences around the globe until the younger man's death at the end of 1980. Both were regarded as entertaining but crazy in their respective fields. Both regarded their fields as crazy. But their mark is everywhere. They voiced so much of what is said today. They wrote a lot of our script.

Buckminster Fuller and Marshall McLuhan met for the first time after boarding the *New Hellas* in Athens for an eight-day boat trip around the Greek Islands. The two gurus of the electronic age had been invited on the trip, along with thirty-two other leading intellectuals from fourteen countries, by Constantinos Doxiadis, a Greek architect and urban planner. The idea was to have a "symposion," a radical mixing of intellectual activity and sensual pleasure as the boat traveled from island to island. Each morning, the group would have informal but intense discussions onboard about "the evolution of human settlements." In the afternoon and evening, they would leave the boat to go swimming, visit

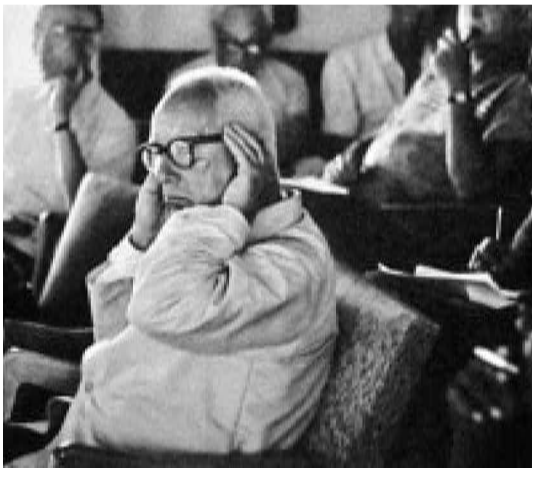
On board the New Hellas **in the Aegean, July 1963.**

famous historic sites, eat in restaurants, see performances, go dancing, and shop. High-level theoretical discourse was well lubricated with retsina and ouzo.

McLuhan and Fuller admired each other's eccentricity. McLuhan liked to speak in aphoristic punch lines thrown as grenades into the morning discussions. A pun was as likely as a formal statement. Fuller surprised the group by seeming uncomfortable with the rapid exchanges. Having difficulty following the conversation because of his bad hearing, he preferred to give speeches. He would talk for hours on end, continuing his line of thought during meals, while drinking, and while changing in the cabin—enthralling yet ultimately exhausting everyone.[2] He moved wildly when speaking but said McLuhan's moves were more extreme:

> After dinner on the Doxiadis ship we used to dance and Marshall would dance with his wife all over the place, so much so that he took up the whole dance floor. He thought we had all stopped to marvel at his and his wife's performance, but that wasn't it; the way he was dancing there wasn't room for the rest of us and we had to leave the floor.[3]

Even if the others on the boat regarded McLuhan as "outlandish," as he later wrote to a friend, his arguments had a marked effect. The group included some prominent architects and planners, but most came from outside the traditional limits of architectural discourse. Led by superstars like Margaret Mead and Barbara Ward, there were representatives of psychiatry, engineering, economics, sociology, anthropology, political science, language, law, metallurgy, animal genetics, meteorology, biotechnology, aesthetics, physics, history, philosophy, literature, agricultural science, and geography. Each field was seen to have an important contribution to make to architectural discourse. When Doxiadis sent his letter of invitation to McLuhan just seven weeks before the event, for example, he said that he had just read *The Gutenberg Galaxy* of the year before and saw ideas in it that are "essential" to a reconsideration of human settlements.[4] McLuhan had no problem seeing his work in that light. He wrote an unsuccessful fund-raising letter to another Canadian who had been invited to the event, citing the letter of Doxiadis and explaining that he was currently completing a book "which

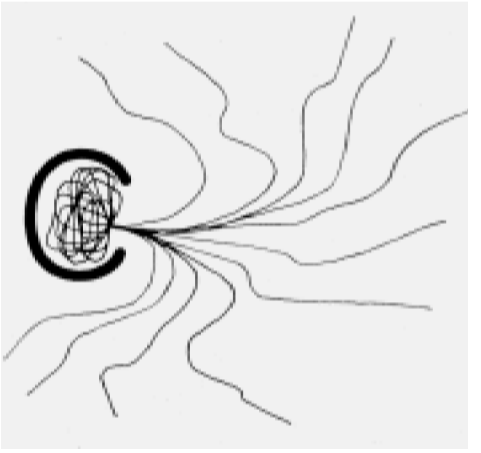


Talking and listening during the morning discussions.

includes matters of immediate concern in housing and town planning." Since the extension of the human nervous system in an electric age "confuses the problems of living space," his own participation in the event "could be of very real importance to the study of changing problems of our national housing."[5]

Once onboard, McLuhan used the event to explore the architectural implications of his work. The boat became an amplifier for his argument that electronics is actually biological, an organic system with particular effects. The evolution of technology is the evolution of the human body. Networks of communication, like any technology, are prosthetic extensions of the body. They are new body parts and constitute a new organism, a new spatial system, a new architecture. This image of prosthetics—which McLuhan had first presented a year earlier in *The Gutenberg Galaxy* and was busy elaborating for *Understanding Media: The Extensions of Man,* which would launch him to superstardom when it came out a year later—was now reframed as an architectural image. McLuhan only waited until the second morning of the boat trip to get up and present his work as a question of urban planning, insisting, in a paradoxical twist, that the latest technologies have expanded the body so far that they have shrunk the planet to the size of a village, creating a "tremendous opportunity" for planners.[6]

This was all too familiar to Fuller, who had been describing technology as an extension of the body ever since his first, but not well known, book, *Nine Chains to the Moon* of 1938, and had been insisting that traditional architecture had to give way to a "world wide dwelling services network" modeled on the telephone network. Indeed, Fuller had visualized global electronic networks long before they arrived. Unsurprisingly, he felt that his ideas, including the concept of the global village with which McLuhan would soon become famous, had been taken without acknowledgment. Yet a strong friendship was immediately established. This was greatly assisted by the fact that, as Fuller recalls it, McLuhan was carrying copies of his *Nine Chains to the Moon* (which had just been republished) and *No More Second Hand God* when they first met on the boat, declaring, "I am your disciple. . . . I have joined your conspiracy."[7] McLuhan, who had denied getting the idea of prosthetic extension from anyone until he met Fuller, later told his friends that Fuller was too much a "linear" thinker.[8] Fuller told his friends that McLuhan never had original ideas, nor claimed to.[9] He simply remixed available material in an original way. Yet a firm bond was established, and



Left to right:
Doxiadis. Diagram of basic shell, inhabited and extended by functions.

Chicago Transportation Study. Cartographatrons of "Desire Lines," 1959.

Doxiadis. Electromagnetic maps of city growth, 1962.

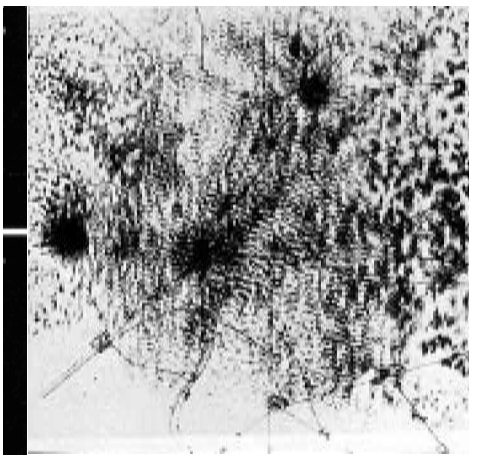
Doxiadis. USA as single city, 1963.

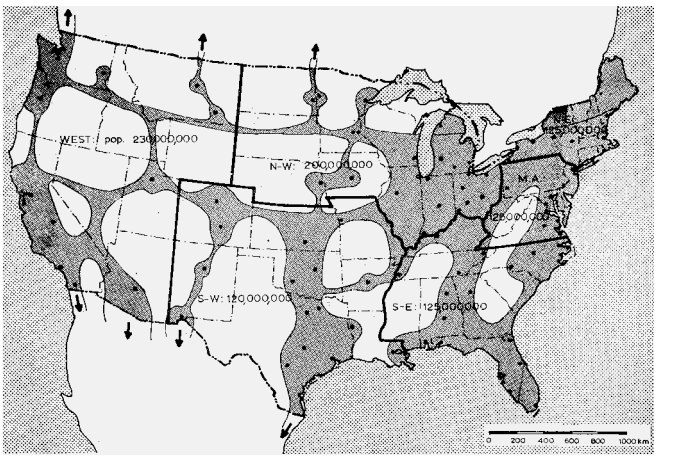
from then on they defended each other's work, seeking out any opportunity to be together and pursuing the global implications of prosthetics and networks to the limit.

Animate Nets

Doxiadis was ready for such sport. Like Fuller and McLuhan, he always thought at the scale of the planet. To say the least, he was a global architect. The design office that he started in Athens in 1951 had already completed major buildings, complexes, infrastructures, urban plans, and regional studies in Greece, Pakistan, India, Ghana, Spain, Denmark, Sudan, Libya, Syria, Venezuela, Lebanon, the United States, Australia, Iran, Jordan, and Iraq. After just a decade of work, he was able to publish a world map dotted by all his projects as if by a spreading virus.[10] Indeed, global spread was his obsession. Doxiadis was an expert in growth. His starting point was that cities were expanding out of control, as marked by the Tokyo Taxation Department's decision that it could only keep up with the spread of buildings by using aerial photography. Insisting that the speed and scale of such growth defied traditional analysis, Doxiadis launched the field of "Ekistics" in the mid-fifties and founded the Athens Technological Institute in 1958 as a research center and architecture school based on the idea of global statistics. The idea was to think at the largest possible scale by domesticating vast amounts of global information. If the data could be controlled, cities could be controlled. Courses in statistical analysis became "indispensable" for architectural training. Spatial patterns would follow from detecting patterns in the flow of information. Design would begin with precisely calibrated charts rather than artistic sketches.

For Doxiadis, a settlement is a continually evolving "organism," at once biological and technological, a technology with a biology. On the one hand, he keeps referring to the city as a body with nerves, arteries, and heart and uses the growth and multiplication of organic cells as a model—presenting images from biology textbooks to clarify the behavior of urban form. On the other hand, he represents the evolution of cities with sequences of "electromagnetic maps" and computerized "cartographatrons" showing shifting patterns and hidden force fields through time. The combination of biological and technological images creates the impression of a dynamic biotechnological organism, ever widening





its scale of operation until it becomes dysfunctional or extinct.

Doxiadis never tired of insisting that the real dimension of cities is not space, but time. What counts is a city's trajectory of development rather than its form. If a city simply grows radially outward from its center, as usually happens, pressure increases on the center until the organism collapses. "Surgery" on its "heart," like feeding new "arteries" as highways into the core, will only speed up its death. Doxiadis's prescription, as worked out in most of his projects since the mid-fifties, is that a city should grow in one direction. The core itself needs to move sideways and expand as the scale of the city increases. Such a city doesn't simply grow; it moves across the landscape. Growth becomes movement.

Settlements become a mobile species, and their movements are further accelerated by the multiple patterns of mobility made available by numerous overlapping networks. Despite designing many fixed buildings, complexes, and neighborhoods, Doxiadis rejected the traditional conception of architecture as a static self-contained object in favor of nomadic organizations animated by circulation patterns. The internal life of each building is extended by ever-larger-scaled networks, from the pedestrian journey to a neighbor's house to an airline flight to the opposite side of the planet. Doxiadis's basic image of a building is a minimal form, a single thick semicircular line defining a shelter containing a dense internal life that is extended out by the wandering tentacles of different forms of circulation. Buildings are but "shells" for movement patterns that reach out far beyond them. Whereas buildings house function, networks are pure function, function without shell. If modern architects are serious in their commitment to function, they will have to reduce their fixation on shells and become responsible for networks.

This concern for networks became clearest in the "City of the Future" project that Doxiadis launched in 1960 and kept working on until his death. First published just a month before the Delos event, it predicts the emergence of a single city covering the whole earth like a lava lamp network, a fluid biomorphic growth extending itself everywhere. The modern architects' fantasy of free-floating generic forms that could be dispersed anywhere on the planet gives way to a single planetary scaled dwelling: "a continuous network of centers and lines of communication" in which "all parts of the settlement and all lines of communication will be interwoven into a meaningful organism."[11]

And it is not just architectural form that turns into a network. Doxiadis draws the discipline of architecture in the same way as he draws the city. To survive the global explosion, architects must be as networked as the spaces they produce. The discipline must take the form of an efficiently webbed biotechnical organism capable of new forms of growth. Architects can only conquer the planet by becoming an animate global net.

Top to bottom:
Symposion ship off island.

Arriving on the Island of Delos.

Gathering at ancient theater of Delos.

Sigfried Giedion giving last speech at signing ceremony.

Floating Amplifier

The 1963 boat trip was intended to be such a networking operation. Experts from heterogeneous countries and disciplines were linked together in a tight web. Lines of communication were effectively drawn between every participant. Yet this web of global figures took the form of a withdrawal. To engage with the global networks whose key feature is that no point has any more value than any other, the group disconnected from those networks and returned to a very singular point, the ruins of the mythical source of western philosophy in the Greek islands.[12] In withdrawing to archaic origins, they withdrew from the media. All participants were warned before going that there would be no telephone, newspaper, or mail.[13] Once onboard, there were "no formal minutes or records, no stenographers and no tapes,"[14] just a set of handwritten notes. The body was used to record the group's analysis of the displacement of the body by new technologies of communication. The only concession was a mimeograph machine that was used to convert typed statements by participants into documents distributed to all the cabins, establishing a local net that only reached as far as the sides of the ship. The implied fantasy is that the boat is a pre- or postdisciplinary space, drifting freely between islands, unaffected by the explosive global growth it so earnestly addresses.

Yet the trip was ultimately a media event. The isolation was staged as such in the very networks supposedly left behind. Edited notes on the discussions, photographs, the boat's itinerary, and biographies of the participants were circulated to the international press and specialist journals in the represented fields. Each participant was sent the same material and encouraged to send further information to journals—which many of them did.[15] The event gathered information, accumulating expert opinion from diverse fields and countries, only to reorganize it and send it back out in a unified form. What was retransmitted around the world was the media image of a premedia event—reinforced by photographs of metropolitan experts in relaxed vacation clothes, basking in the sun, in

restaurants, ruins, and the water. It is as if the technological expansion of the body could only be faced by returning it to its original state.

This strategic primitivism was exemplified in the closing event, when everyone signed a collective "declaration" in the ancient theater on the island of Delos. A group of globe-trotting intellectuals gathered at sunset in a ruined amphitheater to solemnly endorse a manifesto for a global makeover. They sat in the first row, a semicircle of close packed expertise facing a piece of paper that rested at the center of the stage on a rustic altar improvised out of stacked stones. The sun dropped while they listened to speeches and, in a torchlight ceremony, solemnly stepped forward to leave their mark.

Unsurprisingly, the Delos Declaration ends by reaffirming Doxiadis's vision of a single global city growing out of control, with the human species portrayed as the victim of the uncontrolled growth of architecture.[16] The "Delians" had withdrawn from this destructive exploding organism to reaffirm their physical, intellectual, and emotional humanity in a symbolic display. Yet the whole point of their radical disconnection from the modern world was to set up a better reconnection, as became clear in Fuller's speech at the beginning of the signing ceremony. An ancient amplifier was being used for a global broadcast:

> The acoustics of the Greek theatre are phenomenal, and I believe that our voice here, relaying the voice of every man, will be heard around the world and that it will catalyze the efforts to prevent man from eliminating himself from his extraordinary role in the universe.[17]

This fantasy seemed to be realized when each participant became a kind of missionary, spreading the word "Ekistics" around the globe, and the Delos Declaration was reported extensively in newspapers and journals, was cited in discussions on housing at the United Nations, and was entered into the official records of the U.S. Congress—events that were eagerly monitored by the monthly in-house magazine of Doxiadis's design office.[18]

The model for all this was the fourth meeting of CIAM (The Congrès Internationaux d'Architecture Moderne) in 1933, the boat trip from Marseilles to Athens and back, out of which the famous Athens Charter on the future of the city emerged. Sigfried Giedion, the longtime secretary general of CIAM, was symbolically invited to the Delos event and was asked to give the last speech at the signing ceremony affirming the fundamental "continuity" between the Athens Charter and the Delos Declaration. He noted that the collegial atmosphere of the two meetings was very similar, insisting that "Greece has done it again!"[19] Ekistics had officially picked up the legacy of CIAM. There would be

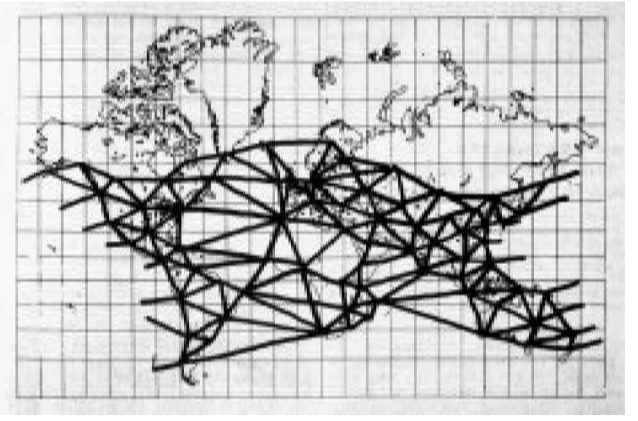
Top: Doxiadis. Airline "Network of the future," 1963.

Botttom: Doxiadis drawing for Margaret Mead, Lord Llewelyn Davis, Sir Robert Matthew, Delos 2, 1964.

twelve annual Delos meetings to match the ten CIAM congresses held between 1928 and 1956. But Doxiadis tried to go farther than his role model, networking a wide range of disciplines rather than just architects. Networks had to be taken to the next level.[20] In fact, the starting point of the Delos meetings was the call made at the end of the Athens Charter to improve the condition of transportation networks.

With each Delos meeting, more and more time was devoted to networks, and a collective attitude toward them evolved. In the fourth Delos in 1966, the participants accepted Doxiadis's claim that networks are historically the youngest element of settlements and will therefore change the most radically in the future, while other speakers emphasized that many of the key networks are invisible. By the eighth Delos meeting in 1970, networks had become the official theme, and Doxiadis was arguing that they are the single most important element in settlements: "the foundations of everyday life and the most decisive element for man's well-being."[21] He was even starting to describe buildings as networks. At one point in the morning discussions, he called a house "a network of walls," and at another point he referred to a theater as a "physical network between actor and audience."[22] Other speakers added the idea of social networks to the physical ones, arguing that there had to be an "interface" between them, and Doxiadis agreed that "every non-physical network requires a physical network for its delivery."[23] The final report of the meeting confirmed that networks "proliferate and interlock, crossing every barrier, physical and political, that has previously divided man. . . . Networks are the key to the making or breaking of cities."[24]

By the tenth Delos in 1972, networks had become the central focus of all urban design, with the final report insisting that their configuration determines the growth patterns of cities. Networks were now the beginning rather than the end point of city form. Everyone now agreed that many of the most decisive networks are invisible and that designers unwisely focus on the dense visible form rather than the diffuse communication patterns that extend that form to constitute the real settlement. Doxiadis argued that cities are simply the product of networks used to minimize effort to maximize contacts, yet typically it is only the shells that are designed. To demonstrate a necessarily wider role for the architect, he redesigned the invisible global airline



network to match the latest version of his visible global network on the ground, hanging an immaterial triangulated web over the planet that is linked to the physical web on the ground at a series of strategic nodes.[25]

Such an image of the invisible extension of the physical was always the central goal of the Delos meetings. Instead of sitting in front of finished drawings of projects, as in the CIAM meetings, the participants always sat around a blackboard, drawing and discussing diagrams of network flows. No matter what discipline the speakers represented, they all drew and energetically criticized one another's diagrams. Everyone was treated as a kind of architect—or, rather, the whole group tried to act as a single architect. The boat was a collaborative design studio. Following Doxiadis's lead, the Delos events were all about making a certain kind of drawing, trying to visualize the invisible by conjuring up a coherent picture of an unseen order.

From Scan to Plan

The major vehicle for disseminating these new kinds of pictures of invisible architecture was *Ekistics,* the journal that Doxiadis started toward the end of 1955. The latest attempt to come up with a network pattern often appeared on the cover—as a kind of hidden architecture of the month. Each Delos meeting was given a special issue, and the content of other issues often responded to developments at Delos or inspired them. The lines scribbled onto the onboard blackboard in response to the international scene, and repeatedly modified during the morning debates, were quickly sent back out to an international audience.

The special issue on the first meeting begins with a glossy foldout text of the Delos Declaration with all the signatures, followed by detailed notes on the daily debates interspersed with photographs of the morning onboard discussions, afternoon tourism, and evening entertainment. Intense discourse about the architectural implications of the latest technologies appears against the background of ancient ruins. There are photographs and short bios of each "Delian" and a collage of newspaper reports of the event. The issue closes with a copy of the original Athens Charter. The result is a carefully constructed image of strategic networking, a particular network trying to draw the very principles of networks.

Ekistics is itself a networking instrument. Indeed, it explicitly exaggerates the networking operations of all magazines. It only publishes abstracts of already published texts, repackaging and rebroadcasting existing data. The magazine is a scanning device, constantly monitoring information flow in other magazines. Whenever original material appears, like the annual special issues on the Delos meetings, a special explanation has to be offered, reversing the usual pattern in which

Clockwise from top left:
First Ekistics Grid, January 1965.

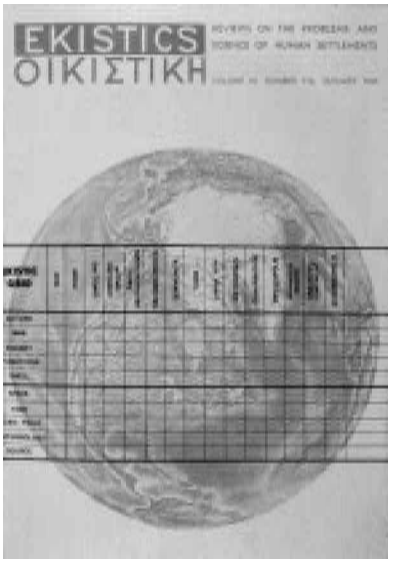
Network of Ekistics elements, 1966.

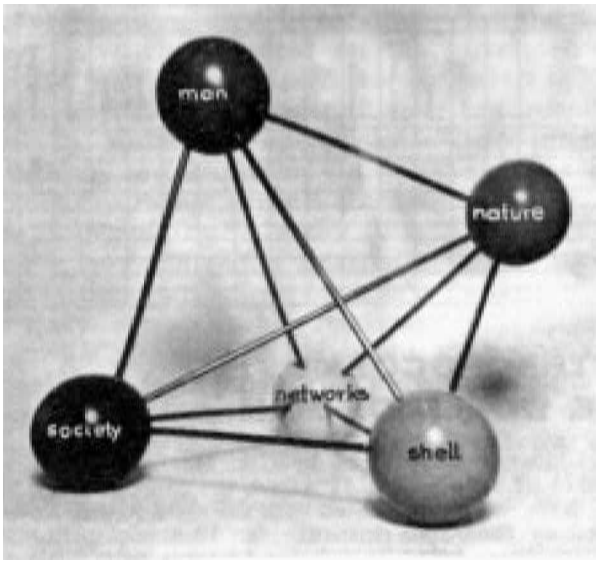
Networked Ekistics Grid, 1971.

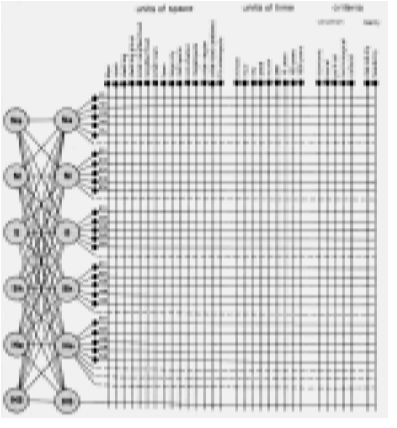
Ekistics itself as a network, 1971

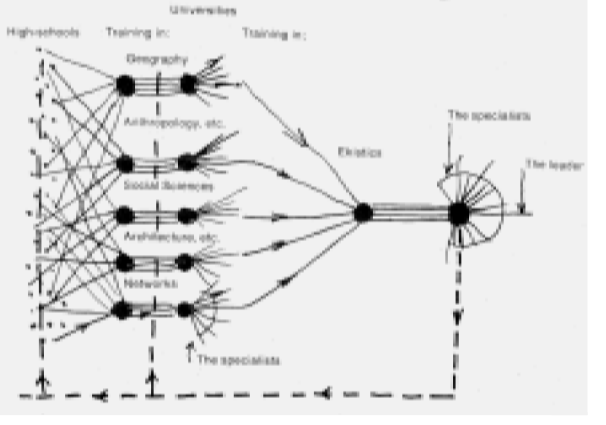
journals have to explain the republication of a text. Everything that is picked up in the scan is filtered: abstracted and reframed by editorials and introductions to individual articles. If all magazines are prosthetic extensions of their readers, far-reaching eyes monitoring a distant world for a particular community, *Ekistics* is a precise and efficient instrument.

This relentless networking logic is most evident in the Ekistics Grid, a classification system used by the magazine since January 1965. Everything that is republished in the magazine, discussed in conferences, studied in research projects, taught at the Athens Institute, and even the character of students, is codified as a visual pattern within the grid, a generic frame through which all planetary activity can be monitored. Once again, this is an extension of modernist ambitions, as it is based on the CIAM Grid that Le Corbusier introduced in 1949.[26] And again it is used to further intensify the obsession with networks. Within six months of its introduction, "Networks" was added to the four basic "elements" of settlements ("Nature," "Man," "Society," and "Shells") that it monitors. A year later, even "Networks" was placed into a network with all the other elements. Networks were no longer discrete. Everything was seen to be networked. Even the monitoring grid evolved into a tightly woven network—so tight that by 1971 it was







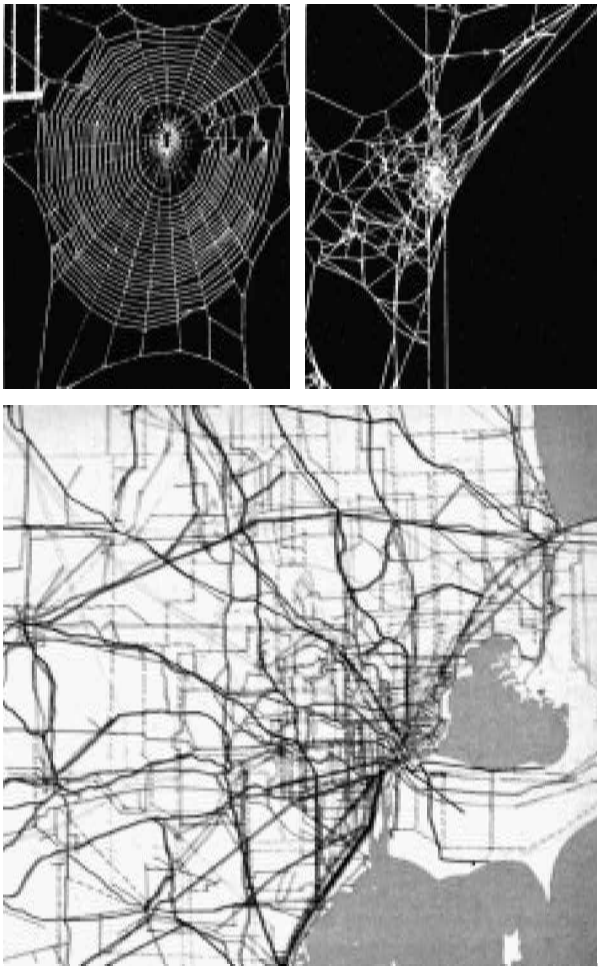


almost unusable. Likewise, the diagrams of Ekistics itself as a networking of diverse disciplines became denser and denser. The field had been overwhelmed by network fever.

In 1972, Doxiadis presented photographs of a spider's web before and after the animal had been drugged with amphetamines. The distorted organization of the doped spider was compared to a map showing "the chaos of networks" in the urban Detroit area.[27] Doxiadis's own design for a neatly geometric system of underground networks of transportation and utilities for the region tried to negotiate a compromise between the existing arrangement and that of an ideal spider. At this point, network fever had him firmly in its grip. As with the latest version of the grid, the central role of the architect was no longer just the form of networks but the connections between them: "We must coordinate *all* of our Networks *now*. All networks, from roads to telephones."[28] The architect is seen as a networked animal that networks networks that are themselves animate. In extending the body, networks have to extend its organic logic. Doxiadis bases design decisions for regional and global systems on the internal operations of the body. The architect elaborates the human body rather than houses it. Designing networks has become a biological necessity.

These associations are classical. The ancient forms of the word "network" were applied at once to the work of humans and that of animals—as in fishing nets and spiders' webs. In the eighteenth century, it was common to use the word to describe the inside of the body itself, as in the organization of veins, muscle bundles, etc., and in the nineteenth century it was a standard label for systems of rivers, canals, railways, cables, electricity, sewers, etc. Finally, it gets applied to organizations of immaterial things like property and groups of people. The word slides seamlessly from biology to technology to society. Any appeal to new networks in the organization of space or society carries some of the original biotechnical association.

Yet it is precisely for this reason that it remains significant that modern architects like Le Corbusier only used the word "network" to describe the old street pattern and the new ones that they proposed.



Top: Spider's Web, pre- and post-Amphetamine.

Bottom: "Chaos of Networks," Urban Detroit, 1972.

The full biological argument was not used beyond physical form. The key move of the Athens congress of CIAM was precisely to place greater emphasis on the idea of networks. At the first congress in 1928, the key functions of cities were identified as "Dwelling," "Working," and "Recreation." CIAM 4 added "Traffic" (*circuler*—circulation) and gave it a special coordinating relationship to the first three: "The fourth, that of traffic, should have only one objective: to bring the other three into effective communication with one another."[29] Transport networks become an organizing concept. In picking up where CIAM left off, Ekistics simply exponentially increased the role of networks.

The key figure in this escalation of network thinking was the urban planner Jacqueline Tyrwhitt, the editor of *Ekistics* since its first issue and a member of the planning committee of all the Delos meetings. In addition to playing a key role in the selection of the participants, Tyrwhitt was responsible for all organizational details during the events, and she attended every single session, taking the official notes of the discussions and editing them for publication. She typically sat to one side of the lead speaker but rarely spoke. While all heads are up in animated debate, hers is usually down. As "secretary–general," she is at the very center of the Delos events yet maintains a low profile, facilitating the interactions of others rather than displaying her remarkable expertise. Despite being the only person who attended all the meetings other than Fuller, she only reluctantly accepts the role of full participant in the tenth Delos, almost always adopting the stereotypical role of the ostensibly subordinate woman as secretary. Yet Tyrwhitt had a major effect on Doxiadis. It was not just that she was the one who chose and summarized all the articles in *Ekistics* and produced most of his books. Much of his position is actually coming through her, along with many of the key organizational strategies he deployed. The ever-public Doxiadis is unthinkable outside the ever-private Tyrwhitt.

In fact, it is Tyrwhitt who provided the key link with CIAM. Giedion was happy to come to Delos because it was Tyrwhitt who invited him. They had first met in 1947 at the sixth CIAM congress at Bridgewater. Tyrwhitt immediately became an integral part of the CIAM operations, being secretary to the Council of CIAM from 1948 and maintaining a tight circuit of communication between the ring leaders. Giedion, Le Corbusier, José Luis Sert, Walter Gropius, and Tyrwhitt constituted the "committee of five" at the heart of CIAM. Tyrwhitt played the same role at each CIAM congress that she would later play in their Delos descendants, being responsible for organization, communication,

Jacqueline Tyrwhitt taking notes while Edward Mason talks and P. Psomopoulos listens, Delos 5, 1967.

notes, and the editing of all the proceedings.[30] She maintained a particularly close working relationship with Giedion, collaborating, corresponding, and translating all the books he published from 1951 onward. For Giedion, coming to the first and third Delos was continuing the project with Tyrwhitt rather than signing on to a new venture with Doxiadis.

Tyrwhitt was a professor in planning at the University of Toronto when Doxiadis first met her in 1954 at a United Nations seminar on housing in Delhi that she was directing. Once again, it was Tyrwhitt making the invitation. And again, the sense of a shared venture was immediate.[31] Shortly afterward, Doxiadis asked if she could help put together a set of relevant readings on third world housing and planning for the use of the branches of his office. She started to do so in 1955, after taking a position at Harvard, and eventually the monthly set of mimeographed abstracts became a full-blown magazine.[32]

The collaboration with Ekistics literally picked up where CIAM left off. Tyrwhitt traveled directly from the final CIAM congress at Dubrovnik in August 1956 for the first of her annual summer-long working sessions with Doxiadis. The Athens Technical Institute was founded in 1958, a year before CIAM formally dissolved itself, and in 1960 Doxiadis was announcing all the major moves he had schemed up with Tyrwhitt. She played a key role in the teaching, research, and publication operations at the institute (especially the Athens Center of Ekistics, which was formally established within it in 1963), and she eventually left her position at Harvard in 1969 to take up permanent residence in Greece. Symbolically, she lived in a hillside house designed by her Harvard and CIAM colleague Jerzy Soltan, with a dome by Fuller and an extraordinary garden of her own design that would eventually be the subject of her last, posthumous, book.

If Doxiadis picked up the CIAM mentality, it was Tyrwhitt who affected the form of that pickup and maintained its trajectory. After all, she was really the supreme networking figure. The majority of the key people invited to Delos were from her own circles of London, CIAM, the United Nations, Toronto, Harvard, and MIT, and they shared her particular concerns. She was invaluable to Doxiadis because she had done it all before: launching teaching programs, conferences, proceedings, and books. Their collaboration was extremely fruitful for both because Tyrwhitt was using Doxiadis to continue her long-standing project just as much as he was using her for his.

Digital Traffic

The key move at Delos was to take the CIAM argument in the direction of electronics—starting with McLuhan's announcement on the second

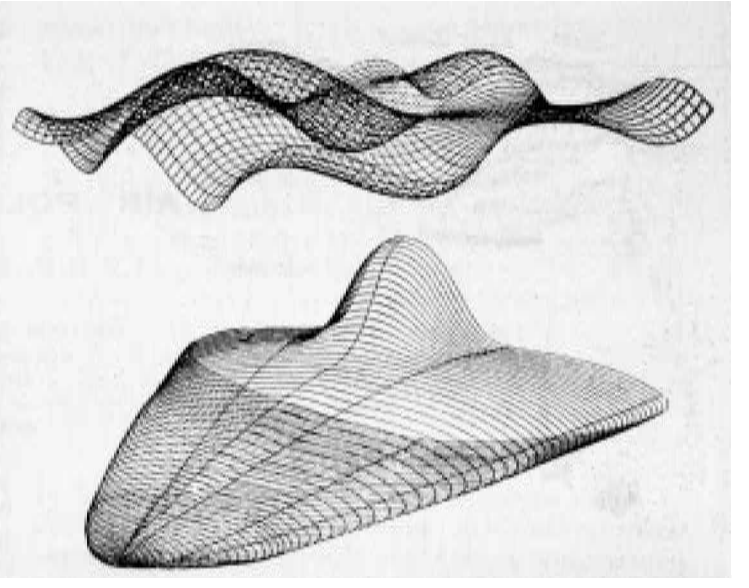
morning of the first Delos boat trip that electronics presents new challenges to planners because this latest prosthetic extension of the body defines an entirely new form of space. Tyrwhitt was yet again the link, having been a member of McLuhan's inner circle in Toronto since the end of 1952 (after Giedion had written a letter of recommendation to McLuhan).[33] From 1953 to 1955, Tyrwhitt was one of McLuhan's four colleagues working under a Ford Foundation grant to carry out an interdisciplinary study of the effects of the new media, the key project out of which McLuhan's famous arguments would emerge. It was while she was in the middle of that project and was one of the associate editors of *Explorations,* the group's magazine, that she met Doxiadis. The radical position that McLuhan brought to Delos in 1963, and would not become internationally renowned until the following year, had been very familiar to Tyrwhitt for a long time. They had been discussing the media's transformation of the world into "one city in space" since the mid-fifties. In December 1960, McLuhan's letter responding to Tyrwhitt's suggestion that he take a position at Harvard spells out the view that the traditional city has been displaced by the electronic extensions of the body that have constructed a "global village" in which traditional conceptions of space have been overturned. This already existing electronic village calls for the construction of a new form of physical world city by planners—"the job is to create a global *city,* as center for the village margins"—and McLuhan speculates that this post-Euclidean city will have to be assembled by computer in the same way that airports use computers to coordinate flights.[34]

When making these same points three years later at Delos, McLuhan was supported by Fuller and two former associates of Tyrwhitt, the planners Edmund Bacon and J. Gorynski. They agreed that the "electronic scale" had to be integrated with the human scale and that the latter could actually be maintained within man's "electronic extensions."[35] CIAM thinking had to be retooled for an electronic world. The Delos meetings would turn the CIAM idea of settlements held together by transportation networks into the idea of inhabitable information networks. But it took a while. The final point of the first draft of the *Delos Declaration* did include a reference to the concept of electronic extensions and its effect on the emergence of urban form.[36] But it did not survive the editing process. It is not until the fourth Delos of 1966 that the whole meeting accepts the basic point of Fuller, McLuhan, and Mead that communication networks have produced a single planetary society—that it is no longer possible to research the city without discussing electronics.

The trajectory from the physical city to the electronic one was even more evident in *Ekistics,* through the strategic selections of Tyrwhitt and

her unsigned editorials. Again, the first Delos appears to have acted as a catalyst. Momentum builds through the gradual accumulation of individual articles and then special issues on communication. Diverse media, including telephone, radio, television, telex, cable, closed circuit, and satellites, are analyzed. Particular attention is paid to their influence on the third world, where their transformative effect is most pronounced. The journal steadily and increasingly radically explored the displacement of the physical. There was a continuous feedback loop between the journal and the Delos events. On the one hand, the journal presented detailed studies into the questions raised each year at Delos. On the other hand, most of the participants appeared in the journal before being invited to participate. Between the conferences and the journal's monthly scan, an extraordinary discourse about the architecture of electronics developed.

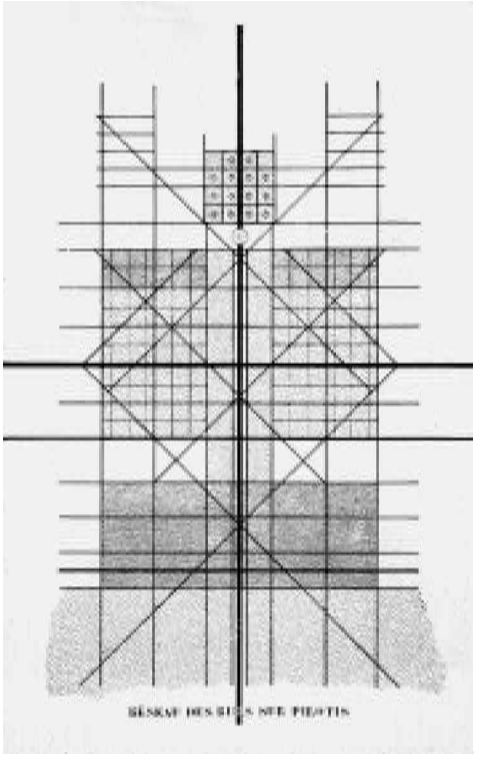
In fact, the journal's concern with electronics precedes the first Delos. The computer, for example, had been a theme in the magazine since the late fifties, starting with the editorial of the August 1959 issue that describes the usefulness of computerized analysis of data on punch cards and the graphic representation of that analysis on computer monitors, when introducing two articles on the "science fiction"-type machines that do this.[37] Doxiadis started using computers in 1962 to develop mathematical models of settlements, and after the first Delos, he wanted everything computerized and proudly published photographs of each new computer installed in his office. At the beginning of 1964, the report on the research projects at the Athens Institute said that the main emphasis was now on computer programming, data processing, and methodology. An "Electronic Computer Center" was set up in the office, and the ground floor of the building was actually used as a computer training center once Doxiadis discovered that no one in Athens was qualified to run the machines. The following year, *Ekistics* featured a special issue on "Architecture and the Computer," discussing computer design of buildings, computer conferencing, and so on.[38] The journal itself was soon computerized, with ever more detailed indexes becoming computer printouts, and in 1969 a special issue was needed on "Computers in the Service of Ekistics." By then, three shifts of workers were employed twenty-four hours a day to type in statistical data on cities in a room filled with punch card machines.[39]



Computer generated forms from Aerospace Division of Boeing, Ekistics **1965.**

The more philosophical discussions of the architecture of electronics at Delos were paralleled by their ongoing practical use.

The appeal of the computer is that it offered a new viewing point to survey the explosive rise of ever larger and less visible networks. If the uncontrolled growth of the city had first demanded the surveillance view from the airplane and then the view from outer space, the growth of invisible networks demanded new scanning instruments. The computer was the ideal mechanism to negotiate between the visible and the invisible. The computer is both a means of diagnosis and a symptom, both a mechanism that reveals hidden patterns in an overwhelming conglomeration and one of the forces that dematerializes or transforms the occupation of that physical organization. Ekistics oscillated between using electronics to expose hidden circulation patterns and producing images of hidden electronic patterns.



Basically, Ekistics radicalized the logic of traffic and moved it into the world of electronics. At the fourth Delos trip, it was argued that "modern transport networks extend far beyond the visual horizon."[40] This shift became clear in "From Man's Movements to His Communications," the May 1970 special issue of *Ekistics,* whose foreword speaks of the "more complete move from a mechanical to an electronic environment." At the Delos meeting of that year, it was argued that physical transportation might go away when moving ideas replaces moving bodies. This had become a mantra by the June 1973 special issue on "Networks: Information, Communication and Transportation." The editorial insists that they are inseparable, and the cover conveys McLuhan's basic point by showing the progressive exponential shrinkage of the world to a small point. Electronics is the new form of traffic and therefore the new form of the city.

In the end, this was the key move with which Ekistics transformed the CIAM mentality. Le Corbusier, for example, was acutely aware of the role played by new systems of communication like the telephone and often refers to it.[41] He even had images of the dense weave of the international telephone network in his files in the twenties, but *La Ville Radieuse* of 1933 only uses the word "network" to refer to the visible traffic patterns of the

Top: International telephone network. From Le Corbusier's file cabinet collection of material for L'Esprit Nouveau.

Bottom: Le Corbusier. Traffic "network" of Radiant City, 1933.

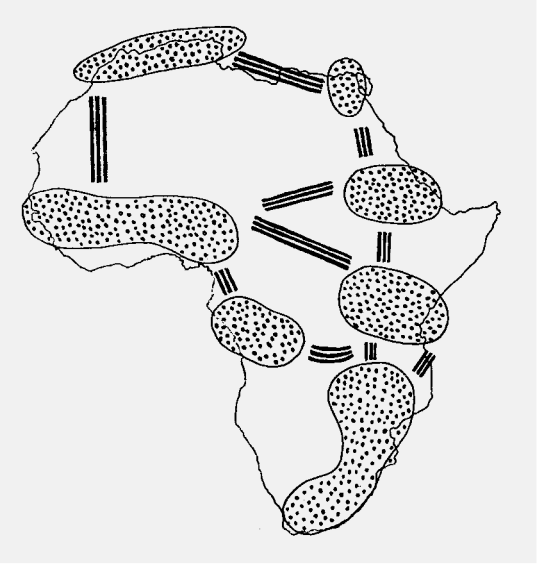
city.[42] When the Athens Charter ends by referring to the inadequacy of the "existing network of urban communications," the issue is likewise only physical traffic. Doxiadis, Tyrwhitt, and their friends set out to multiply the concepts of traffic. Traffic was conceived as information flow. Symptomatically, drawings of cities, continents, disciplines, and computers tended to be the same.

The Biology of Information

The new traffic of electronic exchange was seen as biological, once again hyperextending parts of the established discourse of modern architecture rather than abandoning it. A blurring of biology and information occurred throughout the Delos meetings. At the signing of the first *Delos Declaration,* Conrad Waddington, a renowned animal geneticist who would be a central figure in most of the meetings, said that the type of world city being envisioned by the group would be "a new level of organization of the living material of the universe."[43] This echoed the discussions of the second morning when, in response to McLuhan's first statements about media extensions of the body, he joined with geographer Walter Christaller and psychiatrist Leonard Duhl in inventing urban schemes by comparing the evolution of electronic networks to that of animals:

> As animals become more complex they develop increasingly differentiated limbs and organs and a highly efficient communications center. Should we move towards a newly constructed type of organization with highly differentiated centers tied together by a complex communications network, each center having special functions and a special location?[44]

Waddington, whose books Fuller had followed closely since the late forties, read evolution in cybernetic terms. The growth of electronic systems of communication is biological in exactly the same terms that biological growth is itself an evolution of systems of communication. Waddington relentlessly applied this model at most of the Delos meetings, often using spiders' webs as a model system of organization.[45] He was supported by Margaret Mead, who had been a pioneering member of the key group that had established cybernetics after the war. At the second Delos, they got further support in connecting this model to architectural form from Richard Meier, who had published *A Communication Theory of Urban Growth* in 1962, a cybernetic account of the city as a living organism and



Doxiadis. Transportation network for Africa, 1964.

information system to be analyzed in biological terms.[46] Meier had come to Tyrwhitt's attention when he was writing the book in 1959–60 at the Joint Center for Urban Studies at MIT and Harvard, of which she was a member. He became one of the leading researchers in the City of the Future project. Already in a January 1962 discussion of the project, Doxiadis said cybernetics and information theory would be necessary,[47] a point repeated at the very end of his 1963 report on the project just before the first Delos, but apart from referring to the city as an "organism" he was not yet talking that much about either biology or information.

In fact, the biological argument rose very slowly in Doxiadis's writing. This is most obvious in the City of the Future project, which gradually becomes a vast prosthetic. Working closely with Meier, Doxiadis rationalizes the new city in 1964 with Fulleresque charts showing the exponential increase in "the average speed of man's displacement since 10,000 BC" and "the extension of man's vision through mechanical means."[48] He eventually starts talking of the possibility of developing new organs for the city. The biological organism is capable of improvement. The genetics can be rearranged. A new body can and should be developed. Cities can be helped to reach an ever higher biological order. Networks, particularly electronic ones, are the means of this upgrade. Doxiadis used computerized traffic control as a model for cities to be higher-order biological individuals than plants, animals, and humans.[49] With each year, he went deeper into the prosthetic logic.

The Delos discussions clearly had an effect. McLuhan's initial image of prosthetic growth was elaborated in more and more detail as the annual boat trips gradually embraced the centrality of electronics. At the second Delos, for example, Fuller reasserted his old line about prosthetic networks in a lengthy argument about the way computers augment the human brain, before rolling around on the floor to make his point about synergy. He concluded that the human's "externalized organics (the world industrial network)" will eventually become as unconscious as the automated operation of internal organs.[50] In immediate agreement was sociologist Edward Hall, who had been invited to the second Delos after McLuhan suggested it to Tyrwhitt and had located architecture as one of the tools within the array of bodily extensions in his 1959 book, *The Silent Language.* McLuhan was citing the passages in his latest book and identifying them as the inspiration for his use of the prosthetic argument. But Hall in turn had been inspired by Fuller, having been a close friend of the Fullers ever since he became a college teacher of their daughter Allegra. Margaret Mead was likewise no stranger to the prosthetic argument from her years in the cybernetics debates. This was a very persuasive group, and by the eighth Delos everyone was able to agree with them that "information systems today

have more power in social systems than ever because computers have magnified the capabilities of the human senses." And at that point, the discussion of prosthetics had become extreme, embracing genetically grown limbs, "brain extension" systems, and so on.

Tyrwhitt's journal relentlessly pursued this more radical view of prosthetics, embracing engineering psychologist J. C. R. Licklider's theory of future "symbiosis" of human and computer and his drawings of the possible interface between the two organisms, with the human network entangled with the electronic.[51] In this line of argument, it is not so much that the latest technology has constructed a new world for us to inhabit. The global city is the global body. We inhabit our own hyperextended body. When Ekistics calls for a redesign of networks, it is calling for a redesign of the human body—network, city, and body being the same thing.

This equivalence of prosthetics and architecture is exemplified in a 1969 essay in *Ekistics* by engineer Koichi Tonuma analyzing contemporary flows of information, with charts of telephone and telex communication within the main island of Japan, to predict the transformation of the island into a single continuous "living space," a vast urban network that looks like a nervous system. The invisible electronic lines connecting people become the matrix on which a visible biomorphic form emerges. The necessary correlate of this biological vision of electronics and buildings is a technological vision of the human body, when "our organs are being replaced with artificial tools."[52] It is the confusion of the body and its extensions that explodes a single biotechnical infrastructure across the landscape. Tonuma presents a sequence of drawings, showing settlements' gathering size and complexity from single cells to complete biological organisms, that are similar to those of Doxiadis. In fact, Tonuma spent two years in Athens doing research at the center. Japan played a key role in Ekistics, as a model for contemporary statistical trends and as a site for imagining radical futures, featuring prominently in the City of the Future project from the beginning.

Yet this biotechnical vision is not simply projected onto Japan as a unique experiment of the Athens laboratory. Tonuma's whole argument, even its prosthetic aspect, is coming from specific architectural proposals made in Japan in the early sixties. All it does is to add particular statistical readouts of information flow and particular drawings of biological cells to an existing scheme that had its own flow readouts and cell drawings. It is crucial to remember that Ekistics is only ever a networking operation, a scanning mechanism coordinating and editing already existing ideas, not just in the sense of design as statistical analysis of given information rather than artistic innovation, but also

Clockwise from top left: J.C.R. Licklider. Drawing of man/computer symbiosis, 1965.

Louis Kahn. Philadelphia Traffic Study, 1953.

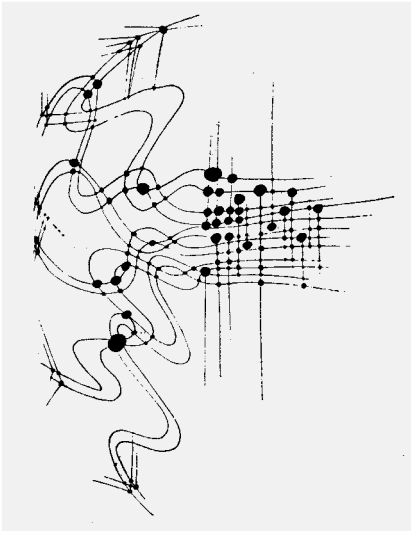
Kisho Kurokawa. Metamorphosis project for single city Japan, urbanization scheme, 1965.

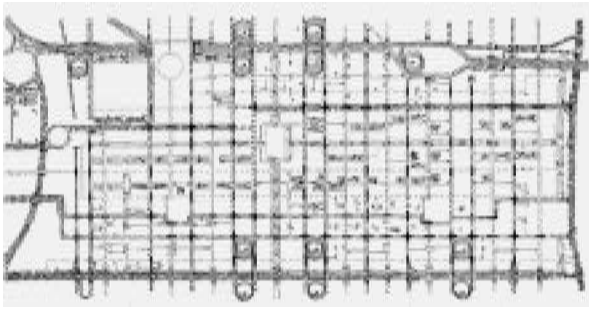
Peter Smithson. "Ideogram of net of human relations," undated.

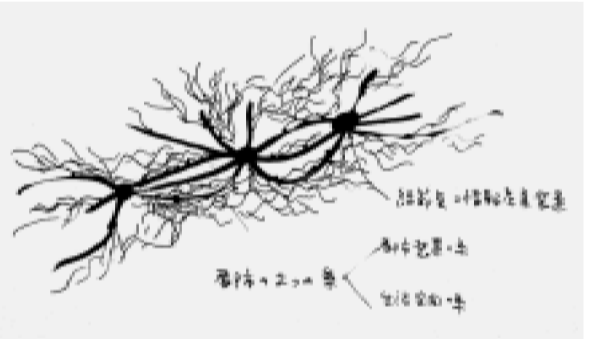
Koichi Tonuma. Flow of Telex and Telephone messages between capital cities in Japan, 1969.

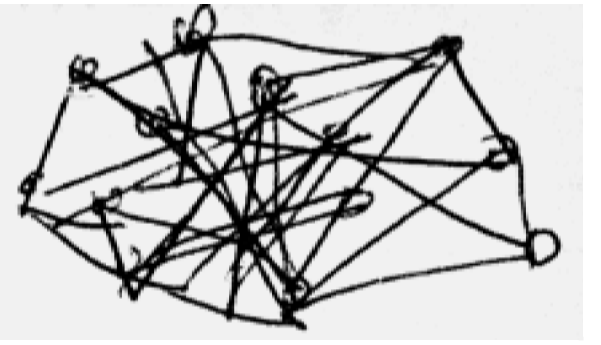
Koichi Tonuma. Japan as single network city, 1969.

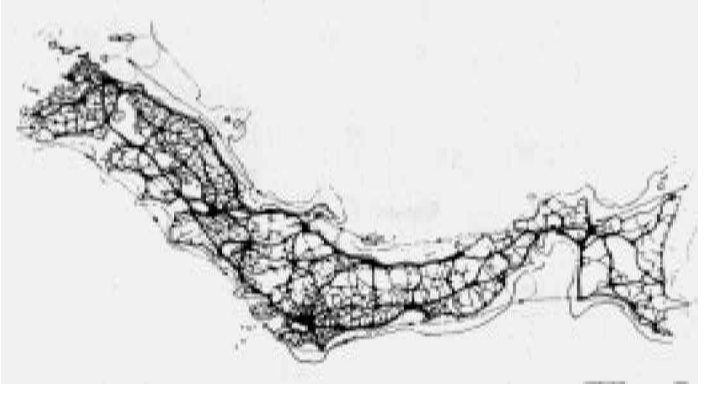
Kenzo Tange. Tokyo Bay Plan, 1960.

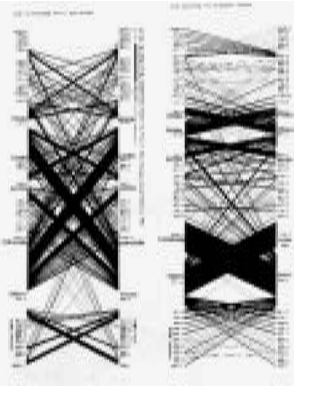












design as the recirculation of tested strategies. The network fever in Ekistics can be found in the work of numerous architects. Indeed, the fever was endemic to architectural discourse during those years. The specific contribution of Ekistics was simply to relentlessly monitor it and thereby feed it.

Nerve Design

A major accelerant of the fever was Kenzo Tange, the preeminent Japanese architect. As one of the passengers on the fourth Delos boat trip in 1966, for example, he addressed the "tentacles" of the communication network in biological and evolutionary terms. To inhabit the modern city is to inhabit the information system of an artificial brain:

> Society is evolving into a more advanced state, as plants evolved into animals, and animals into men. We have begun to create a new nervous system in society using the advanced communication technology that will enable the social brain to function more effectively. In large contemporary urban complexes, communications networks twist and interlink into a complex which must be something like the nervous system of the brain. . . . whirling around in these brains are the people and the information. The citizens are like electrons flowing in an electronic brain.[53]

Tange drew on cybernetics to discuss the influence of all the contemporary systems of communications—arguing, in McLuhanesque fashion, that there has been a second industrial revolution, an information revolution that prosthetically extends the nervous system in the same way that the first one physically extended the body.[54] He predicts that Japan can only maintain its "organic life" by eventually turning into a single colossal city through the linkup of physical, social, and information networks into a single "central nervous system."

Tange's spoken statements were actually taken from an article he had published the year before, entitled "Tokaido-Megalopolis: The Japanese Archipelago in the Future," which presented charts of the "evolution" of media use (telegraph, telephone, radio, and computer) and maps of flow in each "communication network" of Tokaido (rail, car, mail, and telephone) before drawing the island as one colossal biomorphic city.[55] His drawing of the shape of this new organism is similar to those that Doxiadis had been publishing since 1962, but Doxiadis's idea of network form had itself been informed by the earlier work of Tange. The July 1961 *Ekistics* had devoted an unprecedented ten pages to Tange's renowned Tokyo Bay project of 1960, in which a vast floating linear "network of elevated lattices" blurring traffic and building is grafted onto the radial network of the traditional city, and the whole

organization is "tied together by the invisible cords of a communication system" (telephone, radio, portable telephone, video telephone). Alongside images from biology textbooks of the growth of spines, Tange describes the project as an "organism" precisely because "communication is the factor that gives organic life to the organization." The paradoxical rationale of the network is that the possibility of infinite extension actually produces density. In an argument that resembles that which McLuhan will present three years later in the first Delos, Tange insists that the capacity of networks to extend anywhere actually produces the need for concentration: "People say that organization man is alone, but even more alone is the man who is separated from this network. It is in order to connect themselves to this network that people gather in the cities."[56] Tange was an important reference point in taking the discourse about urban networks toward electronics.

Tyrwhitt was very familiar with this discourse; Tange's work had been shown by others at CIAM 8 in 1951, and he had taken part in the 1959 meeting in Otterloo where CIAM dissolved. Her editorial on the Tokyo Bay scheme said that the project was the direct outcome of experimental plans that he developed with MIT students in 1959, which she had seen firsthand and had already published, along with his Boston Harbor project, the scheme based on the growth of plants that is generally accepted as the first move in the so-called megastructure movement.[57] At the third Delos in 1965, Giedion singled out the Tokyo Bay project when embracing "the youngest generation" for two concepts that handle variable density: "megastructure" and "group form."[58] Tange exemplified the former, while the latter was introduced in the first Metabolist manifesto of 1960 by Fumihiko Maki, the architect who was also the first to publish the term "megastructure," with Tange as the central example, in a little-known 1962 publication that was immediately republished in *Ekistics* because Maki was teaching with Tyrwhitt at Harvard from 1962 to 1965.[59] As a parallel line of research into networks, all the Japanese experiments were closely monitored by *Ekistics* and had their effect on the field's evolving doctrine.

Another parallel trajectory monitored by the journal was that of Team 10, the dissident younger faction of CIAM. Alison and Peter Smithson, for example, had been designing webbed urban projects since the late fifties, including the extremely influential Hapstaudt Berlin scheme of 1957.[60] Already at CIAM 9 in 1953 they had been insisting against their elders that "the street and the network of streets has to be seen as the arena in which social relationships were played out" rather than a mode of efficient connection.[61] Georges Candilis and Shadrach Woods likewise developed huge "mat buildings" as infrastructural weaves of movement patterns and wrote key articles on the principle of "the web"

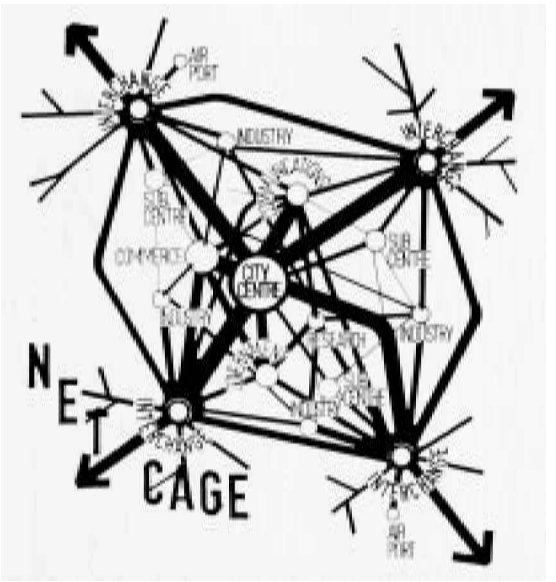
in 1961.[62] Aldo van Eyk saw the role of the architect to provide a "network of crevices." And so on. A different attitude toward the network—both in terms of physical form, social structure, communication system, and analytical concept—was precisely what differentiated the young group from CIAM and led to their separation from it and the subsequent dissolution of the old organization. As Alison Smithson (who seemingly took over Tyrwhitt's role) puts it at the very beginning of her account of the separation, it was decided by the older generation at CIAM 9 that "life falls through the net of the four functions" but "we wanted a more delicate, responsive, net."[63] When the group became independent, much of the talk was about networks. The 1962 meeting of Team 10 at Royamount, for example, is dominated by it, as exemplified by Stefan Wewerka's description of cities as "compact bundles of overlaid net-structures."[64] A major influence in this discourse, as it was for the parallel Japanese experiments, was Louis Kahn and Anne Tyng's 1953 traffic scheme for Philadelphia, which dematerializes the physical form of the city in favor of pure flow, like an electrical circuit. Streaming arrows become more solid than buildings. The image was a key reference point. The new generation of architects was under the spell of its radicalization of CIAM's long-standing commitment to traffic. But the next step of blending physical network and information flow would only start to become evident in the work of an even younger generation.

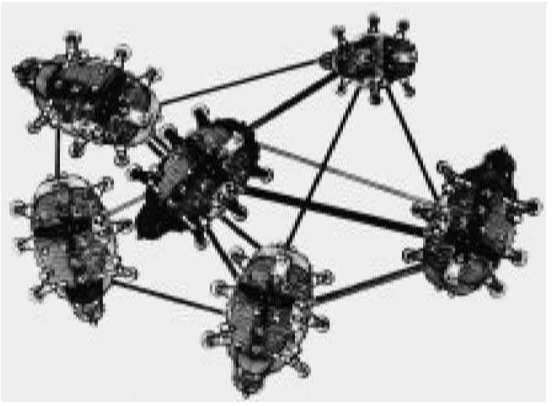
The bio-informational language that Tange had used since the Tokyo Bay project had actually come from his assistants on the project: Arata Isosaki, Kisho Kurokawa, and Sadao Watanabe, some of whom were part of the group setting up the Metabolist movement, presenting their founding manifesto with images of organic cell development in the same year at the World Design conference in Tokyo. The group would write extensively on biology, symbiosis, cyborgs, cybernetics, and prosthetics throughout the sixties.[65] Their projects were drawn as delicate systems of intersecting fibers—architecture as biological circuitry.

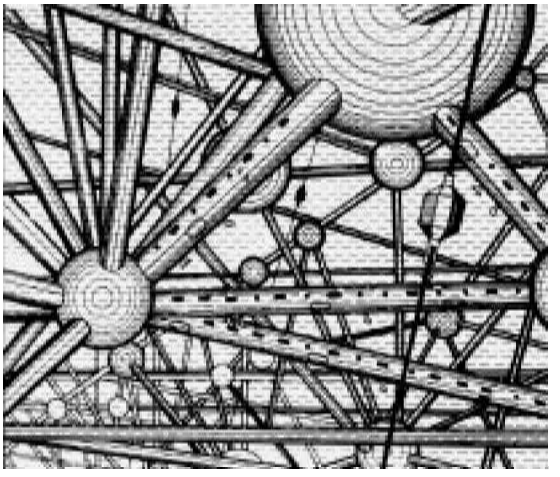
In fact, all these groups were networked together. Tange had shown the first Metabolist projects (Kiyonori Kikutake's 1959 Marine City and Cell City, "a complete network of living facilities," based on a "move-net" in which fixed structures allow building units to "grow and die and grow again") alongside his own megastructure at the Otterloo meeting where Team 10 began its independent life. The Smithsons included Tange in their Team 10 survey for *Architectural Design* in May 1960; and the conference in Tokyo of the same year, in which the Metabolists launched themselves with Tange speaking as the father figure, was also attended by Kahn and the Smithsons. The younger architects became linked to the evolving Team 10 discourse. Maki was

invited to the Team 10 meeting in 1960, and Kurokawa would talk about "nets" at the 1962 and 1966 meetings. A global network of experimental architects devoted to networks was established.

Most of the network organizations dreamed up by these groups were periodically scanned by Tyrwhitt in *Ekistics* as a kindred post-CIAM research.[66] When Team X had started its assault on the older generation at the last CIAMs, Tyrwhitt had initially resisted on behalf of the rest of the central committee, but she eventually embraced the idea of handing over to the next generation. When doing so, she circulated a text to Giedion by her close colleague McLuhan on the need for interdisciplinary research to open up unknown horizons through a cubist multiplicity of viewpoints.[67] The impact of electronics represented a shared threshold. The Smithsons, for example, had been in the middle of intense discussions of the new systems of communication in the early fifties with their Independent Group colleagues in London, very much under the influence of McLuhan's first book, *The Mechanical Bride*. Yet electronics was never an overt feature of their projects, nor those of their colleagues. This would be the task of their respectfully rebellious students.







Invisible Pictures

It was only with the post-1963 work of the young Archigram group that information flow became visible as such. Where the Metabolists emphasized the biological side of the biotechnological equation, Archigram emphasized the technological. Architecture became indistinguishable from communication. Warren Chalk and Ron Herron's City Interchange project of 1963 is just a "net" of intersecting forms of traffic, including invisible traffic: "electronic data transmission, traffic control and administration, radio-telephone tower, communication and news service relay station, inter-commercial closed circuit television hook ups, public television and telstar redif-

Top to bottom:
Warren Chalk and Ron Herron. City Interchange project, 1963.

Ron Herron. Walking City project, 1964.

Warren Chalk. Underwater City project, 1964.

fusion center."[68] This principle underlies all the subsequent Archigram work and starts to take a particular form, as can be seen in the 1964 projects that *Ekistics* scanned in 1965. What counts in Ron Herron's Walking City, Peter Cook's Plug-in City, and Warren Chalk's Underwater City is movement in a diagonal net. In Walking City, it is the usually overlooked network of diagonal links between the huge mobile animals that makes the system possible. Plug-in City is likewise a "giant network-structure . . . with diagonals of lifts making up the grid," and in Underwater City, to leave the diagonal structure/movement system is of course to drown. In each project, the diagonal weave becomes the main event. Activity occurs within the net itself.

Even dense, blurry, psychedelic events like the Instant City "traveling metropolis" of 1968 are actually based on a triangulated network plan covering England. Each of its intense explosions of sound, smell, and color occurs on the node of a net or constructs such a node. A series of six drawings showing an Instant City descending on a "sleeping town" concludes with one entitled "Network Takes Over." The apparatus has moved on, but the infiltrated town has become hooked up to all the others by landline and wireless transmitters. Already in 1963, the group raised the possibility that expendable and flexible communication networks would invalidate fixed physical ones,[69] and projects like Peter Cook and David Greene's Ideas Circus, published by *Ekistics* in August 1969, were "offered as a tool for the interim phase until we have a really working all-way information network."[70] When Archigram folds soon afterward, it is not by chance that Peter Cook starts the Art Net forum in London and names its journal *Net*—unconsciously echoing McLuhan's 1951 proposal to start a newsletter called *Network*.

In all these projects, the grid gives way to the web. Movement in the spaces defined between intersecting lines gives way to flow within lines. Triangulation rules. Of all of Doxiadis's hundreds of charts, he kept presenting one from 1962 that showed that grids were the most efficient form of network at the smallest scales of rooms and neighborhoods, that hexagons made sense in the local region around a center, and that triangulation is best at the largest scales. This combination of orthogonal grid and triangular net can be seen in all his schemes. But the parallel research by other architects had moved triangulation into individual buildings. The 1952–58 project for Tomorrow's Town Hall by Kahn and Tyng was particularly influential in this. Well known since its publication in *Perspecta* in 1953 and *L'architecture d'aujourd'hui* in 1954, the building was conceived as a series of triangulated structural systems operating at different scales. Appearing from a distance, in Kahn's words, as "a lacey network of metal,"[71] it even stood in the center of a plaza marked with a triangulated networked pattern. Another

Clockwise from top left:
Louis Kahn and Ann Tyng. Tomorrow's Town Hall project, 1952–8.

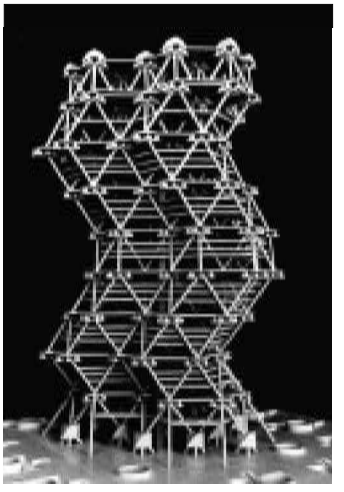
Buckminster Fuller. Octet Truss, MoMA, 1958.

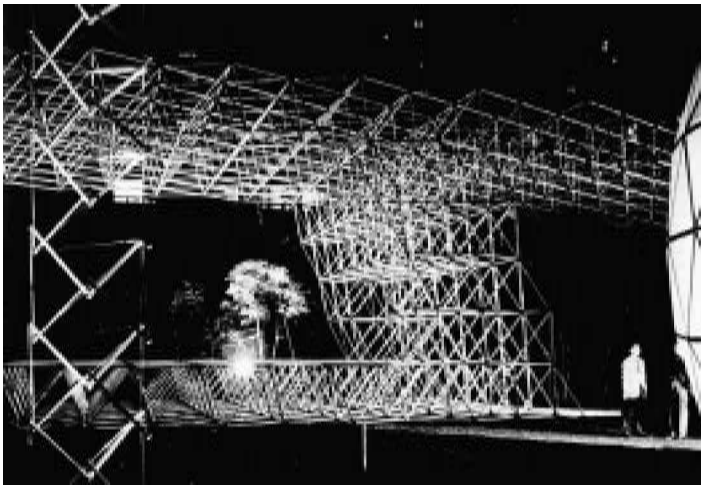
Konrad Wachsmann. Airline Hanger project, 1954.

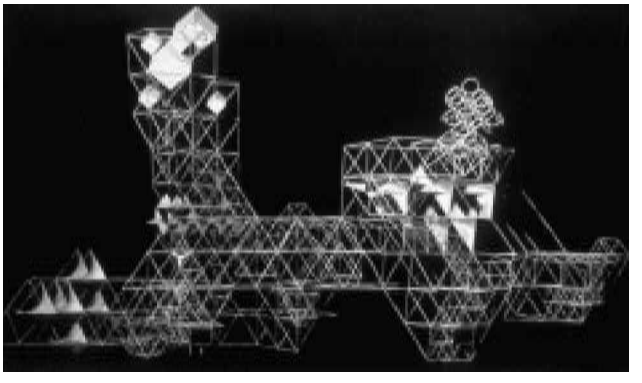
Eckhard Schultze-Fielitz. Space City project, 1960.

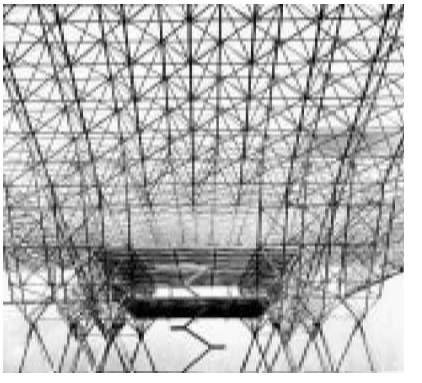
key source of inspiration was A. and J. Pollack and A. Waterkeyn's 1958 Atomium for the Brussels World Fair, which appeared in *Archigram 4* alongside the City Interchange. The Atomium, in which people move up inside the diagonal links to occupy the spherical nodes, has exactly the shape of Doxiadis's drawing of the basic principle of networks. Triangulation is at once identified with the micro scale of atoms and the supermacro scale of transplanetary connections.

The application of a physical image of a global network at all scales became polemically clear in the schemes and systems in which there is no difference between building and extended web, notably in a series of projects published at the end of the fifties: Fuller's demonstration of an Octet-truss at MoMA; Constant Nieuwenhuys's "wide world web" New Babylon; and Eckhard Schultze-Fielitz's Space City. Each of these was influenced by Konrad Wachsmann's enormous Airline Hanger for the U.S. Air Force that was first published in 1954 (and immediately made its way into a section on space frames in Giedion's *A Decade of New Architecture* that was edited by Tyrwhitt in the same year).[72] It became a major influence on the Japanese architects, as all the young architects who would later form the Metabolist group attended Wachsmann's lecture on the project in Japan in 1955, a lecture organized by Tange. Yet all these practical schemes by an international community of architects, including Wachsmann's, can be seen as a compromise of the more radical web that Wachsmann had developed in 1953 with students at Chicago. It envisions a structural system that



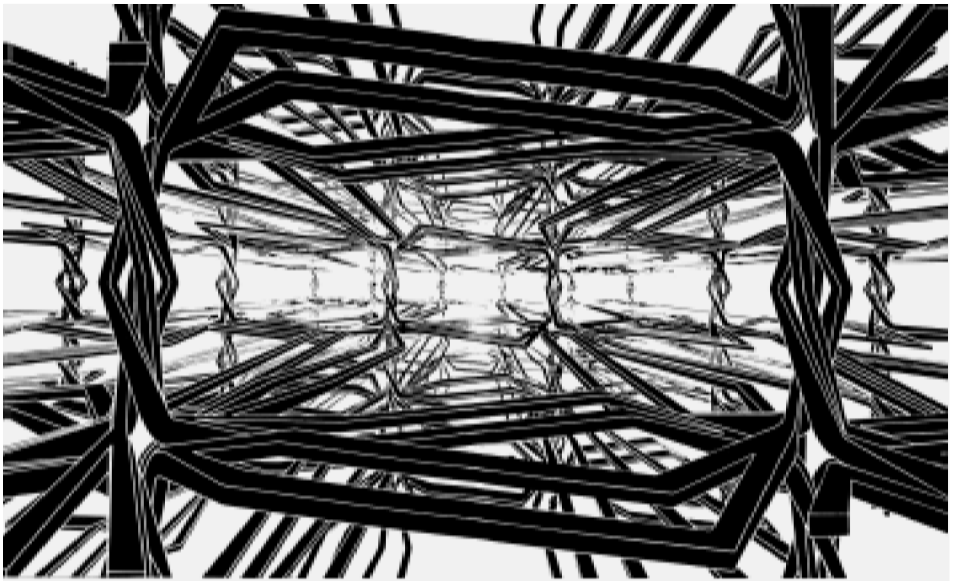


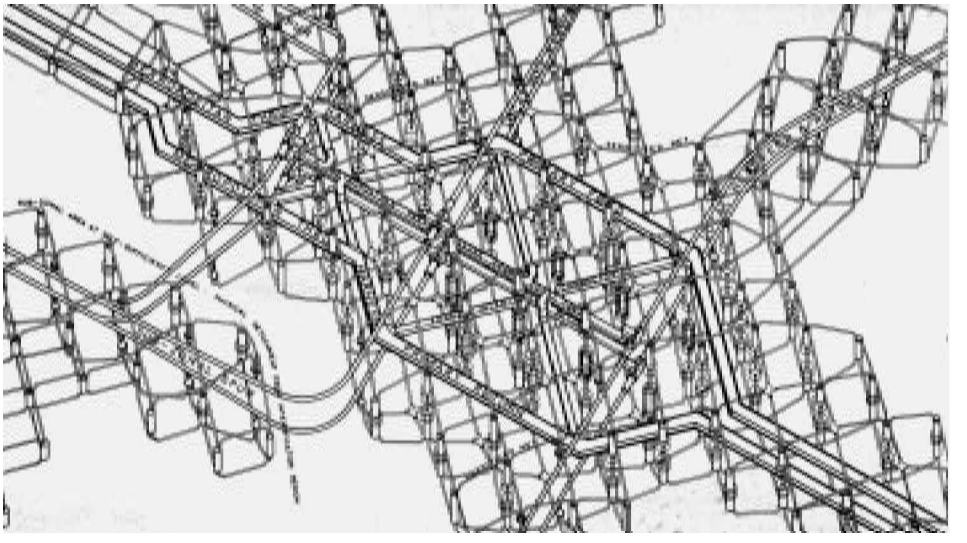




refuses any difference between the horizontal and vertical strands of the web and the intersections between them. Structural threads are simply twisted together in an endless fabric.

It is symptomatic that information flow is crucial for all these web designers. Wachsmann and Fuller speak of the way communications can activate any point in their systems. Constant and Schultze-Fielitz argue that electronics will change the shape of their spaces, with computers continuously rearranging the forms on the basis of constant feedback from the occupants, an idea that Archigram's Dennis Crompton would take to the extreme with his Computer City project of 1964, in which the city itself is nothing more than a computer, a hardwired "sensitized net" with "local net feedback." When it was published a year later in the November 1965 *Ekistics,* the short explanatory text asserted, "The activities of an organized society occur within a balanced network of forces which naturally interact to form a continuous chain of change."[73] The mesh of links activated or modified by electronics has





turned into an endless mesh of self-adjusting information channels.

Indeed, it can be argued that the whole obsession with triangulated space frames in the sixties, and even the concern with building systems as such, was just an attempt to make poetic images of the invisible communication infrastructure whose influence had grown throughout the century—a visible aesthetics for the invisible net. In 1966, Tange, who would polemically have himself photographed against a dense weave of triangulated scaffolding to open his monograph, said exactly that: "Creating an architecture and a city may be called a process of making the communication network visible in a space."[74]

It was not by chance, then, that the first triangulated space frame was actually produced in 1902 by the same person who invented the telephone: Alexander Graham Bell.[75] Fuller's more famous webbed space frames, hovering as light as they could be, as little in the world as possible, likewise came after his fascination with nonphysical technologies of communication. Already in his first book of 1938, Fuller, who would eventually be given Bell's original tetrahedral models by his great-grandchildren, was using the "inter-communicating web" of the telephone as a model for housing and was describing the house as an apparatus for receiving and broadcasting. Fuller always referred to his structural systems as "nets," understood not as systems of physical interconnections but as networks of energy flow, information systems—an association between visible and invisible net that would finally become literal in his dome for Expo '67, the first computer-controlled structure, with each metal link in the net carrying the wiring for a continuous adjustment of the color, opacity, and porousness of the building's surface.

All the webs that proliferated in the sixties, including Doxiadis's City of the Future, were likewise an attempt to establish a physical image of the invisible space of electronics, even if electronics itself is not discussed. All the projects by Tange, the Metabolists, Team X, Archigram, Constant, and others were practical and even took their character from their engagement with the pragmatics of construction, but they were first and foremost polemical images—and were presented as such. It matters little that virtually nothing from all those experiments was built. Or, to be more precise, what was carefully built was a set of images that remain polemical today, a commentary on the networks we already inhabit rather than a dream of a future world.

It took decades to forget such experiments so that a new generation could present itself as the first to engage seriously with the architecture of electronics. Much of what we hear today is an echo—but so delayed that it sounds fresh. It is as if the discourse forgets its own history precisely because it is too afraid to leave those earlier positions behind. Supposedly avant-garde visions manifest the discipline's greatest fears.

Top: Konrad Wachsmann.
Experimental structural web, 1953.

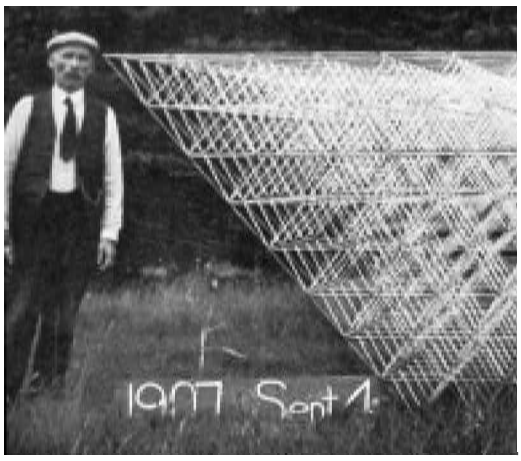
Bottom: Dennis Crompton.
Computer City project, 1964.

Unsettlement

The point here is that McLuhan's influential discourse about networks during the sixties was exactly paralleled by that of experimental architects during the same years. And the architects did not simply follow the communication expert. Rather, they all followed an even earlier generation of designers. Indeed, McLuhan's work begins as a kind of rethinking of architecture. It was his close alliance with Giedion and Tyrwhitt that opened up a new way of reading the space of technology, one that leaned heavily on Fuller.

As the key link between the twenties and the Internet, Fuller played a crucial role. His work was first monitored by *Ekistics* in 1957, but his Dymaxion Map showing the planet as a single network was on every cover from the beginning until mid-1959 and occasionally reappeared. Fuller was president of the World Society for Ekistics and, remarkably, was the only person other than Tyrwhitt to attend all the Delos conferences. Not by chance did another version of his map return for the cover of the issue of the Delos on "Networks" in 1970. Delos was now positioned at the center of the triangulated map, and radiating lines show where all the participants had come from. It is as if Ekistics occupied Fuller's world. His vision of a fundamental continuity between visible and invisible architecture had always lurked in the background and slowly took over. Making the same argument from the side of communication, McLuhan was a crucial ally. The two hovered over the discourse in the same way that they hovered over all the experimental architects obsessing about networks in the sixties.

Yet Fuller and McLuhan pursued such a radical line that even those deeply infected by network fever could not handle it. Already by the fifth morning of the first Delos, Fuller was saying that the idea of permanent settlements and neighborhoods is obsolete in the contemporary hypermobile age. The very idea of settlement so treasured by Ekistics is challenged in a time characterized by "stirring up rather than settling down."[76] McLuhan was quick to agree and even suggested that the whole framework had to change: "Are we selecting as key problems things that are possibly about to disappear with the rise of information levels, such as congestion and confusion?"[77] Fuller both mentored the group and criticized it. In 1966, he wrote "the longest letter I have ever written" to Doxiadis outlining his "general strategy." Published in 1969 as "Letter



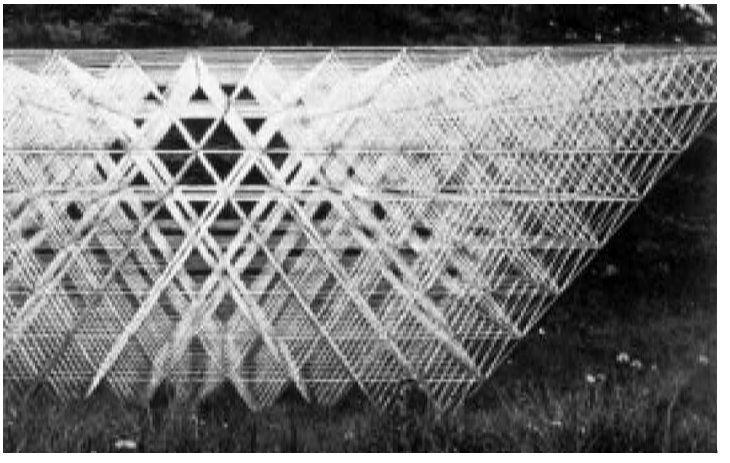
Left: Kenzo Tange, 1966.

Right: Alexander Graham Bell. Tetrahedral space frame, 1907.

to Doxiadis," it repeats his prosthetic account of architecture and insists that electronics will lead the way. The latest computer techniques will render conventional architecture and planning obsolete, substituting static urban planning with "Instant city!" New world networks foster a hypermobility of bodies and spaces—technologically upgraded and endlessly circulating bodies being the new spaces.[78] The new biology of technology doesn't leave the kind of fixed trace Doxiadis tried to establish.

After all, there had always been a fundamental conflict between Fuller's original call in the late twenties for a physical disconnection from infrastructural networks and the Ekistics obsession with establishing vast physical nets. Fuller shares the commitment to a single world city. After all, his very first project in 1927 was for a "one world town," but everything in it is mobile and physically disconnected. Buildings are dropped by airplane, have autonomous service systems of plumbing and electricity, and are only interconnected by invisible air and radio links. Fuller rejected physical infrastructure, no matter how flexible, preferring atomized nomadic systems. For him, the capacity to disconnect from a system was as important as the capacity to connect. He was fatally attracted to Ekistics, attending every event and publishing articles like "Why I Am Interested in Ekistics,"[79] but ultimately he had to go beyond it.

At the tenth Delos in 1972, Fuller pointed out that the group was not yet ready to deal with the fact that the boat in which they were talking was actually filled with the signals of over a million radio stations.[80] At the same meeting, McLuhan also acted as the dissident by presenting James Joyce's *Ulysses* as "the greatest piece of city planning and building in this century" and rock music as "an enormous world-wide network of culture which directly relates to the health of human settlements" since it processes the sounds of the city.[81] He insisted that books and music fossilize buildings. Cities should be designed less for occupancy than for performance, a "global theatre" built out of the hidden electronic networks. Tyrwhitt kept her distance from her old teammate, publishing his intervention in a section entitled "Communication via Humor." The earnest reconfiguration of the global city as a physical image of an invisible order was not to be held up by the thought that physical configurations were already redundant. In letters to friends, McLuhan concluded that the other Delos participants were "earnest men, rather all 19th-century types, still preoccupied with bricks and mortar" and that people already existed electronically in "a new kind of world city far outside the keen of Doxiadis."[82]



Fuller had meanwhile become excited by the idea of strategic unsettlement and

had elaborated an even more radical defense of it at a conference in the Bahamas organized by McLuhan.[83] The odd couple was once again in the sun, entertaining each other by taking every argument to the next level. Ekistics was losing its appeal. At the beginning of the last Delos in 1975, Fuller mourned the death of Doxiadis just two weeks earlier. When the meeting was finished, he went dancing with "young" people in his dome at Jacky Tyrwhitt's house for the last time.[84] A year later, he did attend a United Nations conference on habitat as the representative of Ekistics, but he published his contribution under the title "Accommodating Human Unsettlement," arguing that it is precisely the stability of unseen infrastructural networks that makes global physical instability possible and desirable.[85] The global village supports a hypermobility of people and architecture. Designers are to aim for "formless" systems of unsettlement rather than overcome them.

Such thoughts rarely appear in the otherwise faithful but unwitting echo of the sixties that occupies so much architectural discourse today. As the computer is rediscovered on saliva-drenched glossy pages featuring the excited commentary of breathless critics, networks are portrayed as playgrounds of the future. Young designers are persuaded that they are pioneer explorers, shockingly oblivious of how well traveled are their paths and how many architects went so much farther. In the face of destabilizing forces, the romantic figure of the architect as stabilizer is reasserted. Now digital architects have moved into housing, with competitions on the virtual house, house forms inspired by information flows, mass-production techniques for infinite variations of housing forms within generic parameters, and so on. Electronic space is being settled. The architect is yet again a figure of order, of pattern within chaos, of comfort. The architectural species has survived by ignoring a century of intense discourse about networks. In a kind of Warholian dream, every echo has become an original artwork.

McLuhan and Fuller in the Bahamas, 1970.

Notes

This essay is part of a research project on the prehistory of virtual space, which has been supported by the Graham Foundation. It was first presented as the Myriam Bellazoug Memorial Lecture at Yale University, February 12, 2000.

1. The proliferation of electronic forms of public space has been matched by the proliferation of highly restricted private networks. New forms of inaccessibility breed under the cover of our utopian image of infinite mobility. Half aware of this, since by definition one cannot be fully aware of the spaces one cannot enter, we all too eagerly celebrate the new forms of connection.

2. "On a certain day, Bucky gave an afternoon presentation. [Norman] Cousins says: 'Then they adjourned for dinner, but Bucky kept right on talking, not eating himself, and resumed in the saloon after dinner. Then he walked with the individual participants to their cabins. Finally he ended up with Doxiadis and Jim Perkins in the former's cabin long after midnight. . . . Perkins and Doxiadis, totally exhausted, looked at this man, who by now had been on this talking marathon for nine hours. You can picture it—Doxiadis getting undressed, Jim Perkins slumped down in a chair, and Bucky sounding off his thoughts, exhilarated, fresh, energetic. And there was no doubt in either Doxiadis's or Perkins's minds that he could have kept on through the entire night, and he would still be fresh.'" Albert Hatch, *Buckminster Fuller: At Home in the Universe* (New York: Crown, 1974), 234.

3. Letter from Buckminster Fuller to E. J. Applewhite, July 10, 1973, in *Synergetics Dictionary: The Mind of Buckminster Fuller,* ed. E. J. Applewhite (New York: Garland, 1986), 592.

4. "I realize of course that this is a rather belated time to invite someone on such short notice but I want to say frankly that I have just finished reading your wonderful book 'Gutenberg Galaxy,' in which I found so many of the things that we also believe in and so many of the ideas which I think are relevant and essential to human settlements and their problems." Letter from Constantinos Doxiadis to Marshall McLuhan, May 20, 1973, cited in letter from Marshall McLuhan to Stewart Bates, June 17, 1973, in Matie Molinaro et al., eds., *Letters of Marshall McLuhan* (Toronto: Oxford University Press, 1987), 289.

5. McLuhan to Bates, June 17, 1973.

6. McLuhan noted that, "The electronic age with its tremendous speedup of communications has created a situation of 'implosion' rather than explosion. The technological age extended man's physical senses enormously, the electronic age is now extending the nervous system. Technology separated our different functions and distributed them widely in space; electronics fuses them together and overlays them. We have all become totally involved and—in terms of communication—the whole globe has been compressed to the dimensions of a village. This global extension of the human brain is as involuntary as seeing when one's eyes are open. It represents a new kind of continuous learning and an enormous upgrading of man. The task of the planner is to prepare the environment for the exploitation of this new tremendous opportunity." Notes from the second meeting, July 8, 1963, "Delos Documents," Avery Classics Collection, Columbia University. McLuhan's statement was reproduced, without identifying the date of the meeting, in "The Delos Symposium," *Ekistics* 16 (October 1963): 206. McLuhan continued in a similar vein: "Electronic technology has extended the brain to embrace the globe; previous technology had only extended the bodily servants of the brain. The result now is a speedup of information that reduces the planet to the scale of a village—a global consciousness thus

becomes the new human scale." "The Delos Symposium," 257.

7. Letter from Fuller to Applewhite, July 10, 1973. The prosthetic argument also appears in *No More Second Hand God,* as when Fuller refers to "irreversible physical evolution technologically extrapolated as extra-corporeal simplex or complex of tooled man-process extension and augmentation." Buckminster Fuller, *No More Second Hand God and Other Writings* (Carbondale: Southern Illinois University Press, 1963), 77.

8. "Have you encountered the work of Ed. T. Hall? He says he got the idea of our technologies as outerings of sense and function from Buckminster Fuller. I got it from nobody." Marshall McLuhan, *Sheet* (privately circulated newsletter), February 27, 1962, in Molinaro et al., eds., *Letters of Marshall McLuhan,* 287.

9. "McLuhan has never made any bones about his indebtedness to me as the original source of most of his ideas. The 'Global Village' indeed was my concept. I don't think he has an original idea. Not one. McLuhan says so himself. He's really a very great enthusiast, a marvelous populariser and teacher. He has an irrepressible sense of the histrionic, like no one I've known other than Frank Lloyd Wright. . . . My concept of the 'Mechanical extensions of man' is the basis for his talk of the 'Electrical Extensions' of man. . . . McLuhan has always been the first to say 'Bucky is my master. I am only his disciple.'" Letter from Fuller to Applewhite, July 10, 1973. "Regarding McLuhan, I have known him for five years. He acknowledges use of my concept and phrasing of the 'Mechanical' and other 'Extensions of Man' which was first published in the 'predictions' in my preface to the *Nine Chains to the Moon,* Lippincott 1938, and also in my charts in 1938 and republished in my book *The Epic of Industrialization,* written in 1940. I speak about such phenomena as a scientist, McLuhan speaks as a Professor of Literature. He is well read and has good insights . . . [and] he is skilled in verbal dueling. . . . I greatly enjoy his foot and rapier work. I have been present when hostile audiences thought they had him on the run only to discover themselves chasing themselves up dead-end alleys as he himself reappeared far down another highway. I like him, personally, respect him and appreciate the respect and friendliness he shows toward my own work." Letter from Buckminster Fuller to John Ragsdale, editor of the *Biophilist,* November 7, 1966, in Molinaro et al., eds., *Letters of Marshall McLuhan,* 308.

10. The map appears on the cover of *Ekistics* 12 (July 1961). By 1956, Doxiadis had five hundred colleagues working in six countries and two continents. By 1961, the branches of his office were working in every continent. By 1966, "our responsibilities, commissions and colleagues had increased even more, to the point that growth had to be controlled in order to avoid creating a mammoth organization." C. A. Doxiadis, "Fifteen Years of Life," *DA Review: House Organ of Doxiadis Associates, Consultants on Development and Ekistics* 3 (January 1, 1967): 1.

11. C. A. Doxiadis, *Ecumenopolis: Towards a Universal Settlement,* Document R-GA 305 (Athens: Athens Technological Institute, June 1963), 116.

12. "When the group visited ruins of the ancient cities of Miletus and Priene, in Ionia, they were reminded that they were in the birth place of western philosophy, the place 'where the first rational myth was born, the myth which gave wings to man's mind and power to his hands to conquer and transform the world.'" E. Papanoutsos, *Ekistics* 16 (October 1963): 205.

13. "For the period of our cruise we shall be to some extent cut off from the outside world. Cables can be received and sent at rates available from the Information Desk, but there are no telephone connections from the boat. We shall not receive newspaper or mail on board, but letters for mail-

ing can be handed in at the Information Desk and will be stamped and sent off at the next convenient port." Delos Symposion Document 9, "General Information, July 1, 1963," 2.

14. C. A. Doxiadis, "Comment on the Delos Symposium," *Ekistics* 16 (October 1963): 204.

15. All participants were sent a copy of the package of information about the meeting that was sent to "the most important national and international technical and scientific journals of all fields represented in the Symposion," along with a list of journals that "we thought might be of special interest to you, just in case you wish to provide them with additional information." Delos Symposion Document 17, "Delos Documents," Avery Classics Collection, Columbia University.

16. "We are citizens of a worldwide city, threatened by its own torrential expansion and . . . at this level our concern and commitment is for man himself." "Delos Declaration," foldout insert, *Ekistics* 16 (October 1963).

17. Buckminster Fuller, cited in "The Delos Symposium," *Ekistics* 16 (October 1963): 205.

18. The introduction of the Delos Declaration into the *Congressional Record,* for example, is reported in *DA Newsletter* 4 (January 1964): 2. Press clippings on the Delos meetings appear in *DA Newsletter* 4 (January 1964): 2–3.

19. "When I recall the congress at which we wrote the Charte d'Athens I can only think that Greece has done it again! There must be something in the air to induce a peaceful working together and loosen normally constrained behavior." Sigfried Giedion, quoted in "Ninth Meeting—July 12, 1963. The Declaration of Delos: Statements and Comments," *Ekistics* 16 (October 1963): 254.

20. Doxiadis was so committed to the idea of the boat that when a meeting of the Delians was held in Washington in May 1968, the so-called Delos 5 1/2, it took place on a barge for an excursion and a picnic lunch. The event was reported in "Delians Stage Special USA Meeting," *DA Magazine,* July 1968, 15.

21. "Points Made in Discussions," *Ekistics* 30 (October 1970): 261.

22. C. A. Doxiadis, "The Networks We Build and the Networks We Need to Build," *Ekistics* 30 (October 1970): 263; and C. A. Doxiadis, "A Methodological Approach to Networks," *Ekistics* 30 (October 1970): 331.

23. "Points Made in Discussions," 317.

24. "Report of Delos Eight," *Ekistics* 30 (October 1970): 245.

25. Doxiadis had a long-standing interest in airline systems. In a 1959 project for Pakistan, he had made a detailed study of airline and sea links. *Ekistics* had presented an analysis of global airline connections in July 1966. Again, precedent for this can be found with Le Corbusier, who, in his last book, published a global map showing an airline network linking every continent into one accessible space. "Nations, religions, principalities, powers, going to sleep, waking up, everything is different, changing, moving, flexible. A prodigious new broom has swept through the world order." Le Corbusier, *My Work* (London: Architectural Press, 1960), 152.

26. Le Corbusier, "Description of the CIAM Grid, Bergamo, 1949," appendix to J. Tyrwhitt, J. L. Sert, and E. N. Rogers, eds., *CIAM 8: The Heart of the City: Towards the Humanisation of Urban Life* (London: Lund Humphries, 1952), 171–76.

27. C. A. Doxiadis, "The Two-Headed Eagle: From the Past to the Future of Human Settlements," *Ekistics* 33 (May 1972): 406–20.

28. Doxiadis, "The Two-Headed Eagle," 418.

29. Le Corbusier, *The Athens Charter,* trans. Anthony Eardley (1943; reprint, New York: Grossman, 1973), 98.

30. As in Delos, Tyrwhitt rarely took center stage, but at CIAM 8 at Hoddeston in

1951, again organized by the MARS group (of which she had been the assistant director since 1949), she played a central role in the discussions, put together the proceedings, and edited the resulting book with José Luis Sert and Ernesto Rogers.

31. Tyrwhitt refers to Doxiadis for the first time in a February 1955 article. J. Tyrwhitt, "The Moving Eye," *Explorations,* no. 4 (February 1955): 115–19.

32. For the first issues, Tyrwhitt was assisted in the selection of material by the architecture librarian at Harvard, a role taken over the following year by the architecture librarian at MIT. The journal was distributed to a private list of people under the title *Tropical Housing and Planning Monthly Bulletin* until October 1957, when the name became *Ekistics: Housing and Planning Abstracts*. The subtitle kept evolving until the January 1975 version, *Ekistics: Problems in Human Settlements,* which has been the title ever since.

33. Giedion recommended Tyrwhitt to McLuhan in a letter thanking him for sending a copy of his first book, *The Mechanical Bride*. Tyrwhitt had arrived in Toronto in July 1951. In 1950, she had become a partner with Wells Coates (one of the original founders of the MARS group in 1933) in London and went to Toronto after a short stint at Yale at the beginning of 1951. She got together with McLuhan for the first time in November 1952.

34. Letter from Marshall McLuhan to Jacqueline Tyrwhitt, December 23, 1960, in Molinaro et al., eds., *Letters of Marshall McLuhan,* 277.

35. "This means that we are today dealing with two widely different dimensions: the eternal human scale—man with his five natural senses—our continuity with the ancient world, and the electronic scale—multi-dimensional integration—our emergence into the new world. Man of the renaissance and technological man no longer directly concern us. The human scale needs to develop the totality of the electronic scale, and the electronic scale the discipline of the human scale. Perhaps the latter can be done by maintaining the proportions of the human scale in man's electronic extensions." Edmund Bacon and Marshall McLuhan, "The Delos Symposium," *Ekistics* 16 (October 1963): 208. For Bacon, the most important thing about the conference was establishing the need for a "new science of human settlement for the purpose of comprehending city and regional growth as a total organic process within the framework of the emerging concepts of the electronic age." Edmund Bacon, cited in "Edmund N. Bacon, USA," *Ekistics* 16 (October 1963): 218.

36. "But beyond his senses, man has his 'electronic extensions.' Do these imply that, in addition to his immediate neighborhood, he can also relate to a wide variety of other centers within a single urban region or on a wider scale?" "Conclusions: Preliminary to a First Draft by Barbara Ward (Lady Jackson), Delos Meeting Document B17," July 11, 1963, "Delos Documents," Avery Classics Collection, Columbia University.

37. The editorial of the August 1959 issue describes the usefulness of analyzing the "mass" of data by punched cards, as shown in the two articles abstracted from recent issues of the English *Journal of the Town Planning Institute* and the *Journal of the American Institute of Planners*. The first article describes "a complete handling and mapping of data," and the second, on "Data Processing for City Planning," covers the role of computers, highlighting the cartographatron, an electronic device for displaying "desire lines" on the face of a cathode ray tube as the result of an analysis of over 700,000 punched cards.

38. The article by Jonathan Barrett, "Will the Computer Change the Practice of Architecture," for example, explores the new kind of shapes that could be modeled digitally and have retained the fascination of designers in recent years. *Ekistics* 19

(April 1965): 247–49.

39. The report on the "Human Community" research project says that the main emphasis in January was on computer programming, data processing, and methodology (IBM punched cards) using IBM 1620 machines. *DA Newsletter* 4 (January 1964): 41. The May 1964 issue published pictures of the new computer—organization of a new "Electronic Computer Center" in the office. *DA Newsletter* 4 (May 1964): 29. *DA Review* 7 (January 1971) shows all the punched card machines "busy around the clock." The August 1972 issue shows pictures of students with the latest computer system.

40. Diana Rowntree, "The Science of the City," *Ekistics* 22 (October 1966): 243.

41. See Beatriz Colomina, *Privacy and Publicity: Modern Architecture as Mass Media* (Cambridge: MIT Press, 1994).

42. Le Corbusier, *La Ville Radieuse* [1933], trans. Pamela Knight as *The Radiant City* (New York: Orion Press, 1967). Much of the book is devoted to the coordination of traffic networks handling different speeds.

43. "The Delos Symposion," *Ekistics* 16 (October 1963): 205. On other connections between Waddington and other interdisciplinary communities, see Reinhold Martin, "Crystal Balls," *Any* 17 (1997): 35–39.

44. "Delos Symposion, Notes from 2nd meeting," "Delos Documents," Avery Classics Collection, Columbia University.

45. Particularly in Delos 3 of 1966, an argument repeated after a discussion of "foodwebs." See C. H. Waddington, "Biology and Human Environment," *Ekistics* 21 (February 1966): 90–94. The spider's web is a model of the resilience of biological systems to change because it is not affected by removing links.

46. "A city is a complex living system. Its anatomy and composition can be studied and analyzed like any other living system. . . . A comprehensive analysis of the interactions within an urban population could be conducted in a manner equivalent to that used by biologists in their studies of living systems were it not for the presence of shields that have been created to fend off messages. This shield is called *privacy.* The small groups clustered inside these screens for communications (homes) are known to exchange messages to which the stranger is not granted immediate or complete access." Richard Meier, *A Communication Theory of Urban Growth* (Cambridge: MIT Press, 1962), 1.

47. C. A. Doxiadis, "Ecumenopolis," *Ekistics* (January 1962): 12.

48. The charts are first described in a report on the City of the Future project in *DA Newsletter* 4 (March 1964):40. The speed drawing first appears in *DA Newsletter* 4 (April 1964): 39–41.

49. C. A. Doxiadis, *Ekistics: An Introduction to the Science of Human Settlements* (New York: Oxford University Press), 43.

50. Buckminster Fuller, "The Prospects of Humanity: 1965–1985," *Ekistics* 18 (October 1964): 232–42, special issue on Delos 2.

51. This was exemplified in the September 1965 issue, which featured Licklider's article on the "Man-Computer Partnership" and one of his drawings on the cover. J. C. R. Licklider, "Man-Computer Partnership," *Ekistics* 20 (September 1965): 165–69. The article was written when Licklider moved from the air force research laboratories to the research center of IBM. Other articles on planning buildings by computer cite his increasingly influential idea of a "symbiosis" between man and computer, and one of them argues that evolution culminates in "computer systems or automata, prostheses which will extend the brain's ability to manipulate symbols just as the bulldozer is a prosthesis for muscles and the microscope, telescope, and laser are for the eye . . . the upgrading of human capacity on a large scale. . . . Men can be upgraded. At

the strictly biological level, there is no question that the principles of genetics and selection, used widely by man in the plant and animal world, could be used to enhance desired traits in man." R. W. Gerard, "Intelligence, Information and Education," *Ekistics* 20 (September 1965): 162–64. A similar issue in 1967 begins with John McHale's speculations about the "New Symbiosis," which also cites Licklider and weaves together prosthetics, cybernetics, McLuhan, and Fuller; then a series of other articles explores the roles that computers can play in design and analysis.

52. Koichi Tonuma, "Network City," *Ekistics* 29 (June 1970): 458. This essay was first published in *Journal of High Speed Transportation* 3 (May 1969): 203–219.

53. Kenzo Tange, cited in "Kenzo Tange," *Ekistics* 22 (October 1966): 259.

54. "In the First Industrial Revolution, men learned how to extend the functions of their hands and bodies through the use of tools or machinery. The Second Industrial Revolution, which has begun only recently, is a revolution created by information theory and communications techniques, a revolution in which man is learning to extend the functions of his nervous system." Tange, "Kenzo Tange," *Ekistics* 22 (October 1966): 275.

55. Kenzo Tange, "Tokaido-Megalopolis: The Japanese Archipelago in the Future," in *Kenzo Tange: Architecture and Urban Design 1946—1969,* ed. Udo Kultermann (New York: Praeger, 1970), 150–67.

56. Kenzo Tange, "A Plan for Tokyo, 1960," *Ekistics* 12 (July 1961): 9–19.

57. Kenzo Tange, "A Building and a Project: On the Kurashiki City Hall and a Project at MIT," *Ekistics* 11 (June 1961): 469–72.

58. S. Giedion, "Density and Urbanism," *Ekistics* 20 (October 1965): 208–9.

59. Fumihiko Maki, "Linkage in Collective Form," *Ekistics* 14 (August–September 1962): 100–103. When Maki put together a more formal publication, photographs of Tange's Tokyo Bay and Boston Harbor projects were added as key examples. Fumihiko Maki, *Investigations in Collective Form* (St. Louis: Washington University, 1964).

60. Alongside an "ideogram of a net of human relations," Peter Smithson describes it as "a constellation with different values of different parts in an immensely complicated web crossing and recrossing. Brubeck! A pattern can emerge." Peter Smithson, in *Team Ten Primer,* ed., Alison Smithson (Cambridge: MIT Press, 1968), 79, caption.

61. Peter Smithson, "Recollection by Peter Smithson, September 20, 1990," *Team 10 Meetings 1953-1984,* ed. Alison Smithson (New York: Rizzoli, 1991), 60.

62. See Shadrach Woods, "Web," *Le Carrér Bleu,* no 3 (1962). The article was reported in *Ekistics* two years later. The web is "highly flexible," "non-centric," "open-ended," and "can be plugged-into at any point and can itself plug-in to greater systems at any point." See also Shadrach Woods, "Urban Environment: The Search for System," in John Donat, ed.,*World Architecture*, no. 1 (London: Studio Vista, 1964): 151–54.

63. Alison Smithson, in *Team 10 Meetings,* ed. Alison Smithson , 9.

64. Stefan Wewerka, in Smithson, ed., *Team 10 Meetings,* 75.

65. "The capsule is cyborg architecture. Man, machine and space build a new organic body which transcends confrontation. As a human being equipped with a man-made internal organ becomes a new species which is neither machine nor human, so the capsule transcends man and equipment. . . . The capsule is a feedback mechanism in an information-oriented, a 'technetronic,' society." Kisho Kurokawa, "Capsule Declaration," *Space Design* (March 1969), reprinted in Kisho Kurokawa, *Metabolism in Architecture* (London: Studio Vista, 1977), 75–85. On the "Cybernetic Environment," see also Arata Isosaki,

"Invisible City," *Tenbou* (November 1967), trans. in *Architecture Culture, 1943–1968,* ed. Joan Ockman (New York: Rizzoli, 1993), 403–7.

66. Frequent articles appear in *Ekistics* from Alison and Peter Smithson, Jaap Bakema, Aldo Van Eyck, George Candallis and Shadrach Woods, Herman Hertzberger, Fumihiko Maki, Kisho Kurokawa, and others. Tyrwhitt's editorial for the June 1963 issue describes Team 10 as "an intelligent group of thoughtful and highly intelligent architects." In a July 1963 review of a book by Doxiadis, she compares the work of Doxiadis to that of Team 10 and the Japanese architects. Jacqueline Tyrwhitt, "Architecture in Transition, Doxiadis, C.A.: A Review," *Ekistics* 16 (July 1963): 60.

67. Jos Bosman, "CIAM after the War: A Balance of the Modern Movement," *Rassegna* 52 (December 1992): 6–21.

68. Warren Chalk and Ron Herron, "City Interchange—Project," *Living Arts* 2 (1963): 73.

69. "The foreseeable rapid rate of change in transportation method may eventually make invalid the concept of a rigid mobile communications network as the main urban structure. A whole area of study is open for experiment of expendable systems and more flexible technology in terms of communication networks. . . . Large organizations will control their own visual communications network, allowing for a city center control with satellites dispersed in constant touch with the communication center, no longer dependent on physical communication." Archigram, "Living City," *Living Arts,* no 2 (June 1963), as cited in Peter Cook, ed., *Archigram* (London: Studio Vista, 1972), 21.

70. Peter Cook and David Greene, "Metamorphosis," *Ekistics* 28 (August 1969): 104–6.

71. Louis Kahn, "Order in Architecture," *Perspecta* 4 (1957): 64.

72. Sigfried Giedion, *A Decade of New Architecture* (Zurich: Girsberger, 1954), 262. The project was the centerpiece of the special issue on structure of *L'architecture d'aujourd'hui,* no 55 (September 1954).

73. "Archigram Metropolis Issue," *Ekistics* 20 (November 1965), 282. Crompton had already elaborated the idea of the city as a self-regulating bio-technological computer a year earlier: "The city is a living organism—*pulsating*—expanding and contracting, dividing and multiplying. The complete functioning of the city is integrated by its *natural* computer mechanism. This mechanism is at once digital and biological. . . . The overall network is formed from this information and then absorbs it, processes it, and throws out the subsequent stages. . . . The network is modified and amplified and the substance of the city created. . . . The *City Scene* enveloped in a net of inter-relationships, ultimately controlled by the *Natural Computer.*" Dennis Crompton, "City Synthesis," *Living Arts* 2 (1963): 86.

74. "The other factor is the rapid advancement of organizations in modern civilized society brought about by the modern communication system, informational technology, and the sharp reflection of this phenomenon on spatial organization. In modern civilized society, space is a communication field, and it is becoming more and more organic with the development of the communication system. . . . Creating an architecture and a city may be called a process of making the communication network visible in a space. . . . We can say that the spatial organization is a network of energy and communication." Kenzo Tange, "Function, Structure and Symbol," in Kultermann, ed., *Kenzo Tange,* 240.

75. A picture of Bell's tower is featured in Wachsmann's book and Archigram's Living City of 1963.

76. "The notion of self-contained permanent settlements is obsolete. We live

under conditions of mobility which result in continual stirring up rather than settling down. It is indeed doubtful whether the notion of a neighborhood of people who fulfill the internal functions of a village community makes sense for the future." "Notes from the 5th Meeting," "Delos Documents," Avery Classics Collection, Columbia University.

77. "Notes from the 5th Meeting."

78. "In speaking of reforming the environment of man, I include a surgeon's operations on the human body, for the latter is mobile environment of the brain. . . . I define industrialization as the extra-corporeal, organic metabolic regeneration of humanity. Industrialization consists of tools. All the tools are externalizations of originally integral functions of humans." Buckminster Fuller, "Letter to Doxiadis," *Main Currents in Modern Thought* 25 (March–April 1969): 87–97.

79. Buckminster Fuller, "Why I Am Interested in Ekistics," *Ekistics* 20 (October 1965): 180–1.

80. Buckminster Fuller in the discussions about energy, *Ekistics* 34 (October 1972): 241. The point was first made in Delos 4 in 1966.

81. "Communication via Humor," *Ekistics* 34 (October 1972): 282–83.

82. Letter from Marshall McLuhan to Tom and Dorothy Easterbrook, 1 August, 1972, in Molinaro et al., eds., *Letters of Marshall McLuhan,* 454; and letter from Marshall McLuhan to Gyorgy Kepes, 1 August 1972, in Molinaro et al., eds., *Letters of Marshall McLuhan,* 453. Tom Easterbrook was one of the group of four people, including Tyrwhitt, who carried out the key research with McLuhan from 1953 to 1955.

83. "Marshall McLuhan Executive Seminar," January 7–9, 1970, Grand Bahamas Hotel and Country Club.

84. As reported by Koichi Tonuma, *Ekistics* 52 (September–October 1985): 516.

85. Buckminster Fuller, "Accommodating Human Unsettlement," *Town Planning Review* 49 (January 1978): 51–60. Report of Fuller's report to the U.N. Habitat conference, September 20, 1976.