

Hertzian Space

The rapid expansion of knowledge and technical development has swept us into a world beyond our grasp; the face of nature is alien once again. Like the forest and the mountains of medieval times, our new environment harbours strange menacing beasts, invisible viruses, atoms, mesons, protons, cosmic rays, supersonic waves.

—GYORGY KEPES

It might seem strange to write about radio,¹ a long-established medium, when discussion today centers on cyberspace, virtual reality, networks, smart materials and other electronic technologies. But radio, meaning part of the electromagnetic spectrum (figure 6.1), is fundamental to electronics. Objects not only “dematerialize” into software in response to miniaturization and replacement by services, but literally dematerialize into radiation. All electronic products are hybrids of radiation and matter. This chapter does not discuss making the invisible visible, or visualizing radio, but explores the links between the material and immaterial that lead to new aesthetic possibilities for life in an electromagnetic environment. Whereas cyberspace is a metaphor that spatializes what happens in computers distributed around the world, radio space is actual and physical, even though our senses detect only a tiny part of it.

It is just over one hundred years since electricity generation started, seventy since radio transmissions began, and fifty since radar and telecommunications entered our environment. The twentieth century has seen space evolve into a complex soup of electromagnetic radiation. The extrasensory parts of the electromagnetic spectrum form more and more of our artifactual environment, yet

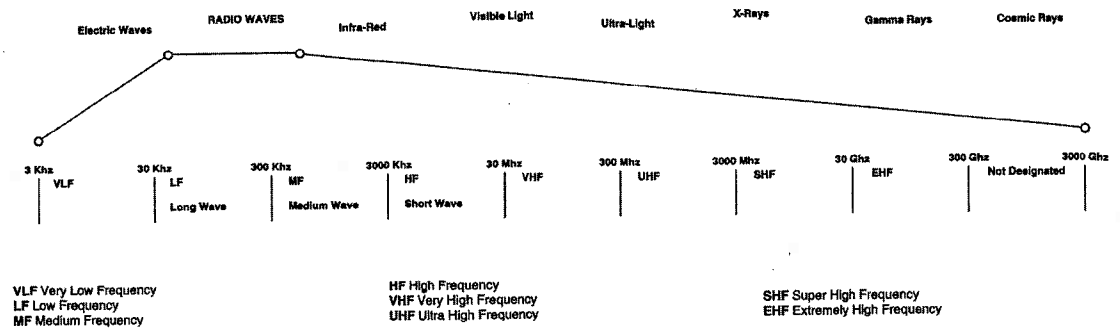


Figure 6.1 Electromagnetic Spectrum showing the Radio Frequency Spectrum.

designers direct little attention toward the possible sensual and poetic experience of this industrially produced new materiality.² In design, immateriality is often referred to through visual motifs, usually in relation to product semantics and representation, but it is rarely dealt with directly as a physical phenomenon.

Tuneable Reality

The extrasensory nature of electromagnetic radiation often leads to its treatment as something conceptual—which easily becomes confused with the notional, although of course it is physical and exists in space. The conflict between the conceptual and the perceptual aspects of hertzian space is an appropriate vehicle for investigating the boundaries between the imaginary and the actual.

Ray Lee and Harry Dawes exploit this ambiguity in *In the Ether*, a combination of film, theremin music, and performance, which takes the audience into a nostalgic and surreal realm between fiction and actuality: “They like it up high, radio waves. If you attach a long piece of wire to a long pole and put it up high you can hear them. I imagine that they spend all their time racing each other around and around the earth. I don’t expect they come down very often. Except if they are curious” (Lee and Dawes 1996). Their film, made with Frances Boyle, taps into vaguely paranormal myths of radio folklore concerned with the mysteries of magnetism, and offers what can be described as a “psycho-hertzian” reading of everyday life.

Aerial Paris and *Aero-Living Laboratories* by Lebbeus Woods, a re-siting of architecture in electromagnetism, exploit this ambiguity less successfully. Electromagnetism becomes a field that “binds building to the sky instead of the earth.”³ Although one of the few architectural propositions centred on the electromag-

netic aspects of space, this "architecture suspended in an invisible matrix of air and charge" is a form of science fiction. Its grand speculations and escapist logic cannot match the gently provocative poetry of Lee and Dawes. It is difficult to see exactly what Woods's two projects gain through their association with electromagnetism in terms of architecture or new models of living

Another architect, Laura Kurgan, responds more directly to inhabiting a ubiquitous electrosphere projected onto earth by a network of satellites.⁴ Using what Virilio calls "the little everyday object [that] probably constitutes the event of the decade as far as globalisation of location goes," the GPS (Global Positioning System) navigator, she rigorously maps her explorations of this space. The GPS, which uses military satellites to plot the position of a sensor anywhere on the planet, is currently not very accurate, partly because for security reasons the military does not want civilians to have access to such accuracy and partly because the signal is distorted through reflections near the sensor (e.g., by buildings). Kurgan uses the GPS to map a space somewhere among the physical, digital, and conceptual. She stands in a gallery stationary for ten minutes recording 311 position records, plots the results on a map of the gallery and its surroundings and compares them with a more accurate computer corrected version.⁵

The artist Ingo Günther's site casting describes a situation where the television signal does not travel to where you are; the reverse happens. You have to go where it is; you have to hunt for it. He imagines a city of tiny television transmitters broadcasting the forgotten pasts of buildings, places, and streets. The city becomes a tuneable urban environment. Different time periods could be arranged as different channels into which the participant could tune. To do this it is necessary to design aerials more directional than usual, allowing different signals to be spatially separate in one location. The resultant antennas resemble the sculptures of Klaus vom Bruch who as early as 1984 exhibited constructivist-inspired aerials for broadcasting video signals between elements of his installations. For Günther's video installation, *Exhibition on Air*, the visitor enters the P3 art and environment gallery in Tokyo and wanders about holding a combination of aerial and LCD television, receiving broadcasts from other antennas sited around the building.

A different kind of narrative space is explored by Scanner, who uses a wide-band radio scanner to tune into cellular telephone conversations, combining them on CDs to create ambient and often poignant sound images of the psychological and social poetry of everyday radio space.

These urban analyses of the militarization of the spectrum, tuneable urban narratives, and audio snapshots of telephone "normality" contrast with the New

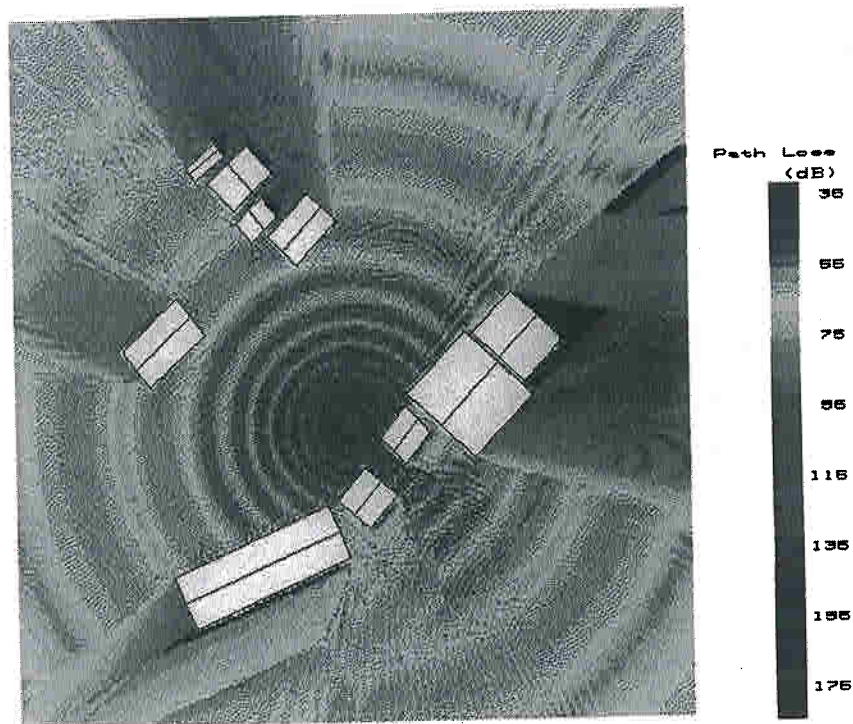
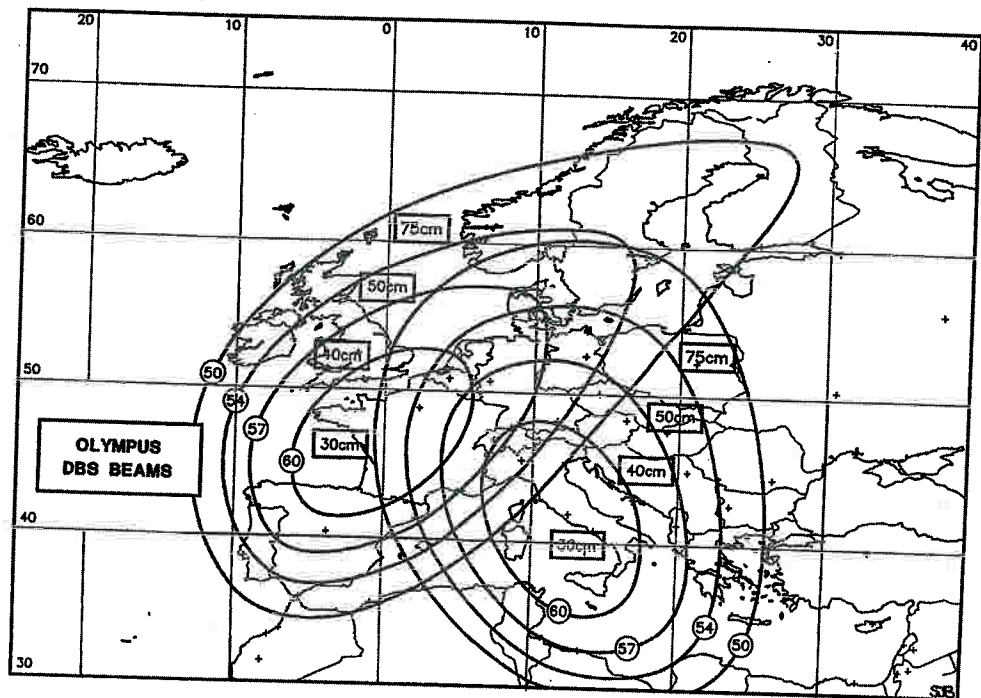


Figure 6.2 (see opposite)

Age mysticism of sculptor Michael Heivly who, like Woods, seems to encourage an escape into the fantastic rather than a confrontation with and possible transformation of existing reality. Heivly writes about how microwave form, detectable yet unavailable to the senses,⁶ represents simultaneously the idea of the real and the imagined. His work translates landscapes into musical sound compositions transmitted as microwaves into deep space. The microwave energy becomes a cone-shaped sculptural form that moves through space at the speed of light and retains its form for millennia. All his work aims to create an environment that confronts participants with the known and the unknown, and requires them to use their imaginations to construct the piece in deep space.

Electroclimates

Computer models showing radio propagation in relation to urban environments (figure 6.2), and maps showing the field strength and "footprint" of television and radio transmissions in relation to the surface of the earth (figure 6.3), reveal that hertzian space is not isotropic but has an "electroclimate" defined by wave-



Figures 6.2-6.3 Computer-generated models showing radio propagation in relation to urban environments, and maps showing the field strength and "footprint" of television and radio transmissions in relation to the surface of the earth, reveal that hertzian space is not isotropic but has an "electroclimate" defined by wavelength, frequency, and field strength arising from interaction with the natural and artificial landscape.

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The extent of the electrosphere is reflected in the difficulty of finding electromagnetically unpolluted parts of the globe as sites for intelligence gathering, "antenna farms," the use of faraday cages to create "empty" zero-field spaces for isolating sensitive equipment, and the realization that a modern war is won by the side that best exploits the electromagnetic spectrum by denying the enemy its effective use and protecting friendly electromagnetic systems against electronic attack:

Before we bipedal apes invented radio receivers, before we even exchanged our gills for lungs, there was radio. It was in lightning, in hydrogen atoms, in the big bang that

propelled our universe into existence. But as soon as we invented technology that enabled us to listen to the transmissions of our planet, we saturated the airwaves with our own sounds—garage door openers, cordless phones, baby monitors, police dispatchers, pagers, and wireless microphones—jamming the oldest radio station around. (Strauss 1993, 336)

“Whistler hunters,” natural radio enthusiasts who search out radio transmissions created by atmospheric events, map the interface between atmospheric and electromagnetic climates. They search out natural radio signals, VLF (very low frequency) radio waves or “sferics” (short for atmospheric: natural radio-frequency emissions in the ionosphere, caused by electromagnetic energy radiated from lightning). These signals—resonant clicks and pops called “tweaks” and “bonks” by scientists—occur in the audible range and may be picked up by antennas and amplified for listening. They are best received at night, far from power lines. Occasionally sferics get caught on, and travel long distances along, the magnetic flux lines around the earth, producing “whistlers,” downward-gliding signals that may last up to three seconds. Whistler hunters travel far from power lines and electromagnetic pollution, sometimes camping out for days, listening for the elusive sounds of natural radio.

Between 1967 and 1975, the composer Alvin Lucier became interested in these sounds and made performances using prerecorded whistlers. In 1981 he recorded whistlers and spliced together short samples in chronological order for *Sferics* (1988). Other variations were produced for performances during the early 1980s, one of which involved setting up a small array of antennas at a campsite for the public to listen to in real time through battery-powered tape recorders and headsets. But it is doubtful that such artificial events capture the poetry of the whistler hunters’ activities. Although the sounds are fleetingly beautiful, out of context they lose much; their beauty is entwined with the effort endured and the symbolic significance of receiving them, which for some is quasi-mystical, for others a defiant gesture against people’s careless attitude toward nature.

More successful if less romantic celebrations of the electroclimate of artificial radio have been achieved through radios used as performing instruments by other composers. This began with Cage’s “Imaginary Landscape No. 4 for 12” receiving sets: the arbitrary nature of broadcast material must have appealed to the composer of the “Music of Changes” and “4’33.” Later, in “Kurzwellen (Shortwaves),” Stockhausen used radio sounds to open himself to a “music of the whole earth”:

What can be more world-wide . . . more ego-transcending, more all embracing, more universal and more momentous than the broadcasts which in Kurzwellen take on the guise of musical material? . . . What happens consists only of what the world is broadcasting now; it issues from the human spirit, is further moulded and continually transformed by the mutual interference to which all emissions are subject; and finally it is brought to a higher unity by our musicians in their performance." (Griffiths 1986, 165–166)

Whereas these composers celebrated the ubiquity of hertzian space, for Architekturbüro Bolles + Wilson the electronic glare of an invisible ephemeral city of ubiquitous impulses is something to be sheltered from, where comfort is to negate for a moment this network to create a zone of electronic shadows. Their proposal is less about the poetics of revealing the world as it is, and more about charging architectural space with psychological dimensions derived from acknowledging hertzian space.

Immaterial Sensuality

We are experiencing a new kind of connection to our artifactual environment. The electronic object is spread over many frequencies of the electromagnetic spectrum, partly visible, partly not. Sense organs function as transducers, converting environmental energy into neural signals. Our sense organs cannot transduce radio waves or other wavelengths outside the narrow bandwidth of visible light (and infrared energy through the skin as warmth). Electronic objects are disembodied machines with extended invisible skins everywhere. They couple and decouple with our bodies without us knowing. Working on microscopic scales, often pathogenic, many electromagnetic fields interfere with the cellular structure of the body. Paranoia accompanies dealings with such hertzian machines. How do they touch us? Do they merely reflect off our skin, or the surface of our internal organs? In other words, do they merely "see" us, or can they "read" us too, extracting personal information about our identity, status, and health?

An operating manual for X-ray machines contains images of radiographic actors and props (figure 6.4) that view the body as a radio medium. The machines establish views, and support a sort of radio perspective, revealing, concealing, and exposing hidden organs and views, and creating a "radio theater" of the hidden body. In configuring the body according to an unusual conception of space, these images of people and X-ray machines illustrate an expanded view of space as an electromagnetic medium.

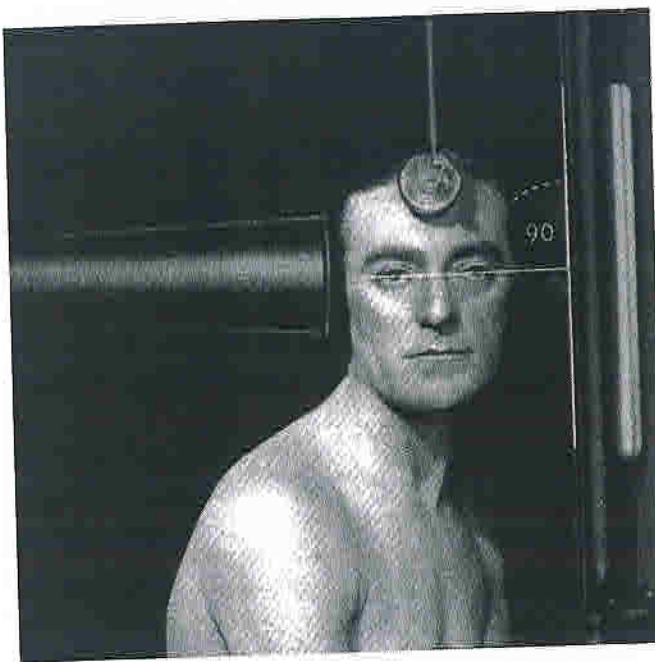


Figure 6.4 An Ilford manual for X-ray machines contains images of radiographic actors and props that illustrate the use of the body as a radio medium.

The artist Arthur Elsenaar, inspired by photographs of experiments by gentleman scholars in the 1850s, taps into our strong feelings about electricity, its danger and mystery, and its measurability. He uses the microwave field of a radar sensor to create “an aura, or an extension of my skin into spaces, into which people can walk,” which causes a 24-volt pulsed DC current to deliver a variable charge of up to three milliamps to two electrodes attached above the jaw and two to the “hunch” muscles in the shoulders. He is developing a digital system that will support a wider range of inputs and outputs—for example, different responses for people retreating and approaching, and head turns and nods.

Elsenaar’s poetic use of fields, a pathological exploration of personal space, is very different from research carried out at MIT into technically interesting but aesthetically mundane applications of electrical fields to interpersonal information exchange. The body is treated literally as a circuit board and the commercial ambitions of the project have eradicated any possibility for poetry although the “electrical whispers of fish” are one inspiration for the project.⁷ The potential of the technology is reduced to the most basic level of utility and conceived as a replacement for physical connections between personal databases.

Making Visible the Invisible

Long before radio energy was used to carry an acoustic signal, many ingenious devices were invented to detect radio energy⁸—for example, Lefeuve's "physiological" receiver (figure 6.5) that uses the electrical sensitivity of the frog's leg. These objects resemble the early meteorological equipment used to make visible atmospheric phenomena otherwise too subtle for our bodies to sense. Just as the barometer tells us how heavy the sky is, these early radio detectors embody a more poetic understanding of hertzian space by revealing the extent of its presence.

Today a typical urban radio frequency environment is dominated by radio and television broadcast transmissions. Other forms of radiation such as microwave relay links, radio telephones, CB, speed-detecting radar, satellite communications systems, military tracking radar, civilian air traffic control, air route surveillance, and weather radar all combine into what Ito has called "Active Air."⁹

Several of Ito's works evoke this implied sensuality. In his *Tower of Winds* (figure 6.6)—realized in 1986 in the middle of a neon downtown, in front of Yokohama station—he wanted the air itself to be converted into light. The tower appears to dematerialize at a particular moment, reappearing in response to ambient noise levels. His *Dreams Room* (figure 6.7), installed at the Victoria and Albert Museum in London in 1991–1992, tries to evoke the immaterial sensuality of the new information environment by combining an information-saturated environment of projected imagery with specially commissioned interface objects,¹⁰ intended to reinforce at an intimate scale what the environment communicates at the scale of architecture.

Although at first sight *Signals* by Takis looks like antennas responding to the contents of the air, low-tech precursors of Ito's *Tower of Winds*, they are in fact nonworking symbolic evocations. His work is important not only because it dealt with the poetry of electromagnetism in the 1950s long before others, but also because he developed a language that referred indirectly to the mysterious and metaphysical aspects of electricity and magnetism, in contrast to the more exuberant responses to technology of many of his contemporaries.

Ito's and Takis's pieces visually imply they are translating the invisible into the visible. Another piece of architecture, *House under High Voltage Lines* (figure 6.8) by Kazuo Shinohara, at the other end of the technological scale from Ito, provides an equally beautiful but more restrained response to the new technological situation brought about by electromagnetic space. The site is beneath high-voltage power lines. Strict regulations determine the safe distance from these lines, and the roof of the house defines this zone for two cables, creating an interface between a possibly pathogenic electromagnetic field and a sculpted

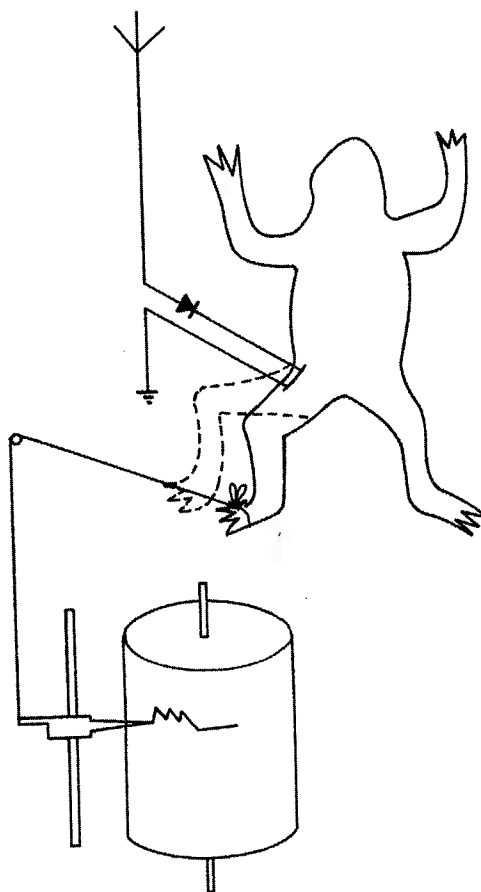


Figure 6.5 Long before radio energy was used to carry an acoustic signal, many ingenious devices were invented to detect radio energy. Lefeuve's "physiological" receiver, for instance, uses the electrical sensitivity of a frog's leg.

interior space. It evokes more disturbing and powerful notions of radio space than the work of either Ito or Takis because it exposes the possible harmfulness of these fields and their existence in everyday life.

The architects Herzog & De Meuron respond to an electromagnetic context in their design for a signal box (figure 6.9). The building houses sensitive electronic equipment and needs to be protected from sudden bursts of electromagnetic radiation. It is not clear if this proposal is an alternative or an augmentation of the usual techniques of shielding, but it has resulted in a powerful image of architecture situated within hertzian space. Although relatively low-tech and programmatically mundane, this is another example of how sensual material responses to immaterial electromagnetic fields can lead to new aesthetic possibilities for architecture. It contrasts with more self-conscious rhetorical expressions of electronic culture by architects such as Jean Nouvel, Rem Koolhaas, and Bernard Tschumi.

The Radiogenic Object

Objects designed to straddle both material and immaterial domains arouse curiosity about the fit between these worlds. Many military aircraft are now "teledynamic," designed to fly undetected through fields of radar-frequency radiation. But teledynamic forms are not aerodynamic and to remain airborne their outline needs to be constantly adjusted by a computer. These aircraft fly through fusions of abstract digital, hertzian, and atmospheric spaces. If this awareness of hertzian space is to form the basis of an approach to everyday objects, it is not enough simply to present the technical facts. They must be grounded in rich cultural contexts if they are to be more than mere illustrations.

Objects that I call "radiogenic" function as unwitting interfaces between the abstract space of electromagnetism and the material cultures of everyday life, revealing unexpected points of contact between them. Many of these objects centre on the aerial, a device that links the perceptible material world to the extrasensory world of radiation and energy.

"Aerialness" is a quality of an object considered in relation to the electromagnetic environment. Even the human body is a crude monopole aerial. Although in theory precise laws govern the geometry of aerials, in reality it is a black art, a fusion of the macro world of perception and the imperceptible world of micro-electronics. Embodying the contradictions and limits of scientific thought, an aerial's behaviour can be described but not easily understood because it depends on the dual concept of electromagnetic radiation as wave and



particle. As the aerial allows this invisible world to be understood and modeled in terms of material reality, it provides a starting point for a design approach that links the immaterial and the material so as to open up new aesthetic and conceptual possibilities.

Although few artists have explored radiogenic objects, several objects have been created by radio amateurs by enhancing radiogenic qualities in existing environments and artifacts, resulting in objects that provide new perceptions of our hertzian environment. These objects hint at the fertile territory beyond the designer's concern with the semiotics of radio interfaces and the engineer's narrow conception of functionality.

Do-it-yourself (DIY) books on antenna theory and practice offer many examples that generate the kind of pleasure that Wentworth shows in *Making Do and Getting By* and people's natural ability to subvert object types and act in new



Figure 6.6 Several of Ito's works attempt to evoke an implied sensuality. In his *Tower of Winds* (1986)—realized in the middle of a neon downtown, in front of Yokohama station—he wanted the “air itself to be converted into light.”

ways on the environment. It is a pleasure derived from invention as poetry, loosening the connection between language and things, and challenging the tyranny of language over artifacts. For instance, the use of a specific size of domestic shelving as a core antenna (figure 6.10) or a milk bottle and tin foil for another (figure 6.11) reveal unexpected functional connections between physical objects and hertzian space that offer an alternative to representation.

Another example is the bobbin cane (figure 6.12), conceived and made by Georges Droz-Georget for listening to the forbidden French transmitter on the Eiffel Tower during World War I. A hook passing through the hole of the ferule was attached to a low overhead telephone line connected to a shooting

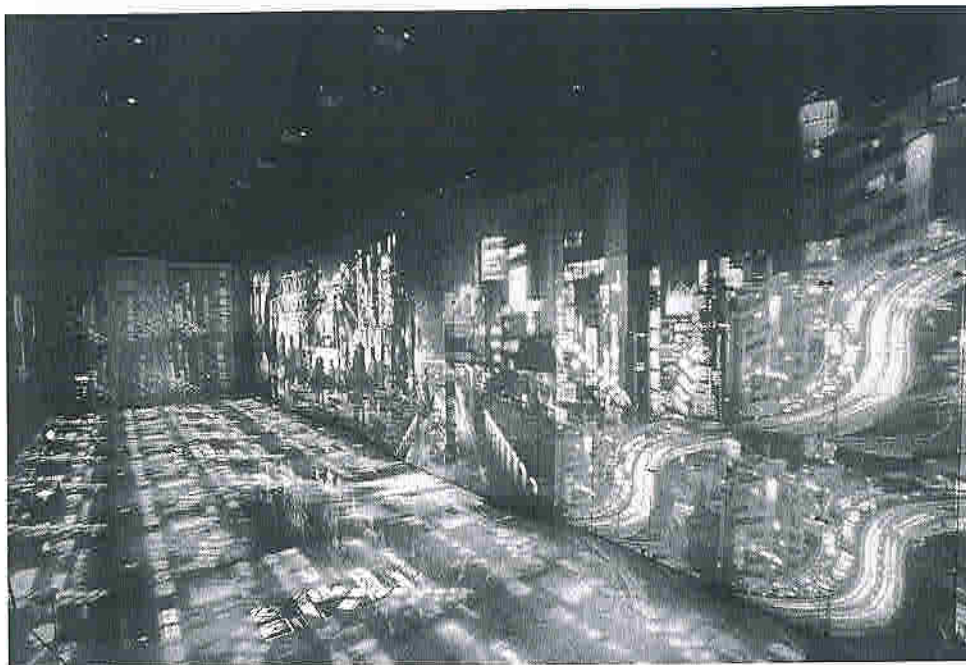


Figure 6.7 Toyo Ito's *Dreams Room* (1991–1992) for the Visions of Japan exhibition at the Victoria and Albert Museum in London evokes the immaterial sensuality of the new information environment.

range: this became his antenna. The wavelength was selected by moving two sliding rings over the copper thread wound around the shaft, and the receiver was carried in the user's pocket. All these radiogenic objects are part of a hertzian culture that includes diagrams on the use of drain pipes as antennas, and garden layouts (figure 6.13) that integrate an antenna with vegetables and paths.

When Objects Dream . . .

Although when we look at an electronic product we only see what is radiated at the frequency of visible light, all electronic objects are a form of radio. If our eyes could see (tune into) energy of a lower frequency these objects would not only appear different but their boundaries would extend much further into space, interpenetrating other objects considered discrete at the frequency of light. Besides the obvious harmfulness of X-rays and microwaves there is a growing concern over the effect of the radiation leaked by domestic appliances. *Radio and*



Figure 6.8 Kazuo Shinohara's *House under High Voltage Lines* (1981) provides a conceptually eloquent response to the new technological situation brought about by electromagnetic space.



Figure 6.9 Herzog & De Meuron's *Signal Box #4* (1991–1994) is an example of how sensual material responses to immaterial electromagnetic fields can lead to new aesthetic possibilities for architecture situated within hertzian space.

Beans, an installation by Patrick Ready, draws attention to the possibly harmful effects of electromagnetic fields generated by domestic appliances. It consists of electrical devices suspended on wooden shelves from the gallery ceiling. Around them hang small paper bags containing fast-growing mung beans in soil, arranged at equal intervals in a three-dimensional grid and watered three times a day. It was hoped that the beans would exhibit effects from the electrical fields through irregular growth patterns. But as the experiment was not controlled and scientific but ironic, it was never clear how the beans were affected.

In this piece the artist becomes a radio biologist investigating the interaction between radiant energy and biological systems. Science and folklore meet in this strange electrical garden, reminding us of the interconnectedness of nature and technology, something that must be made more visible if we are to find more

meaningful ways of inhabiting an environment gradually becoming more radioactive.

The electronic object is often described as "smart." But using this term to describe objects with enhanced electronic functionality encourages a bland interpretation of electronic objects: "Smart, after all, is not the same as intelligent, let alone intellectual. Smartness is intelligence that is cost-efficient, planner-responsible, user-friendly, and unerringly obedient to its programmer's designs. None of the qualities, in other words, which we associate with free-thinking intellectuals" (Ross 1994, 331).

Electronic objects are not only "smart," they "dream"—in the sense that they leak radiation into the space and objects surrounding them, including our bodies. Despite the images of control and efficiency conveyed through a beige visual language of intelligibility and smartness, electronic objects, it might be imagined, are irrational—or at least allow their thoughts to wander. Thinking of them in terms of dreaminess rather than smartness opens them to more interesting interpretations.

For example, some possibilities for new relationships with these hybrids of radiation and matter are found in pathological products based on paranoia or eccentricity. Many devices designed to transform private situations into public ones depend on the "leakiness" of electronic objects, tuning into the dreams of radiant objects. The Computer Intercept System sold by the Surveillance Technology Group (n.d.) is an example: "Without entering the premises, electromagnetic radiating from unshielded computer screens and ancillary equipment can be intercepted from a remote location. The Computer Intercept System's highly sensitive receiver logs all radiating signals into its 100 channel memory. These emissions are then stabilised, processed and reassembled into clear reproduction of the intercepted data onto its built-in monitor" (27).

Many buildings are now designed as faraday cages to prevent such eavesdropping, usually invisibly by deploying electromagnetic shielding materials throughout the structure. The same technology protects sensitive equipment in a building from bursts of external radiation. Test-sites, specially designed environments, or anechoic chambers now measure an object's leakiness to predict its effect on other objects.

A more bizarre use of leakiness is seen in the Bat Band Converter (figure 6.14), a parasitical device that allows you to "use your a.m. portable radio and this novel design to tune-in to the secret world of bats." The title of the magazine that provides the plans, *Everyday Practical Electronics*, seems at odds with a world where

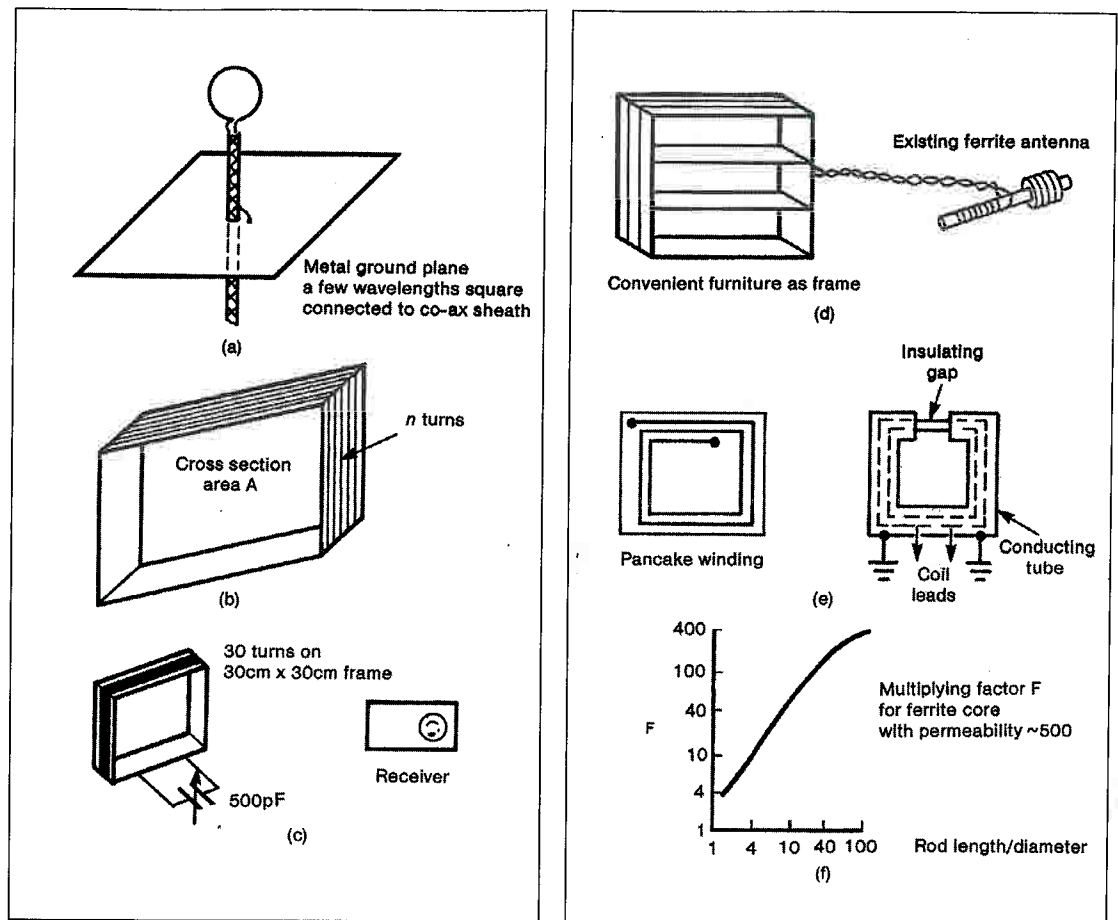
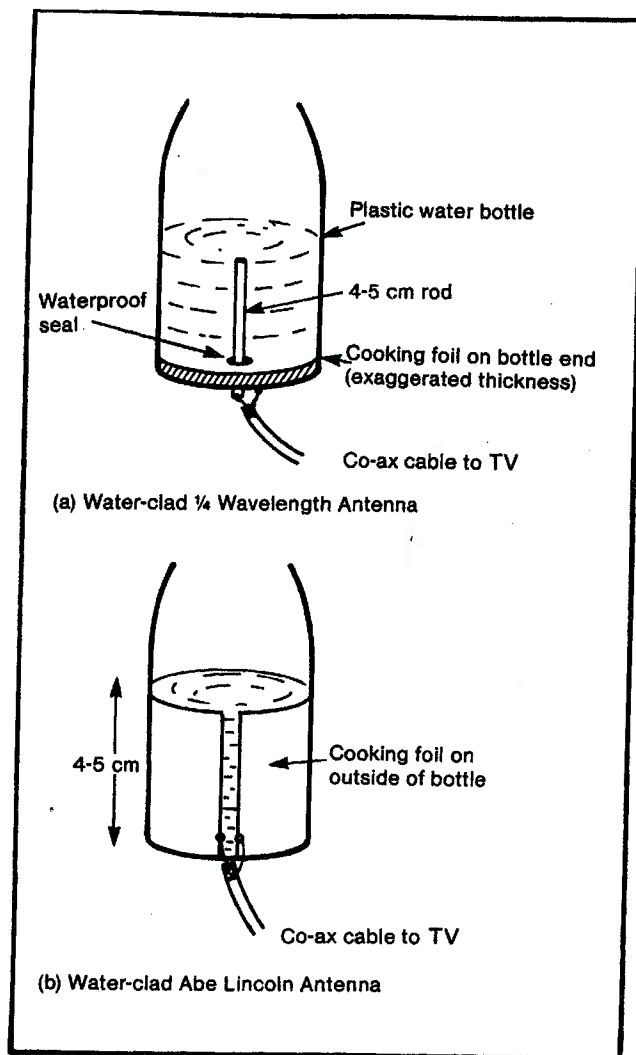


Figure 6.10 (see opposite)



Figures 6.10–6.11 The (Shelf) Loop and Frame Antenna and (Bottle) Dielectric Clad Antenna are examples from DIY books on antenna theory. They generate the kind of pleasure associated with making do and getting by and with people's ability to subvert object types and act in new ways on the environment.

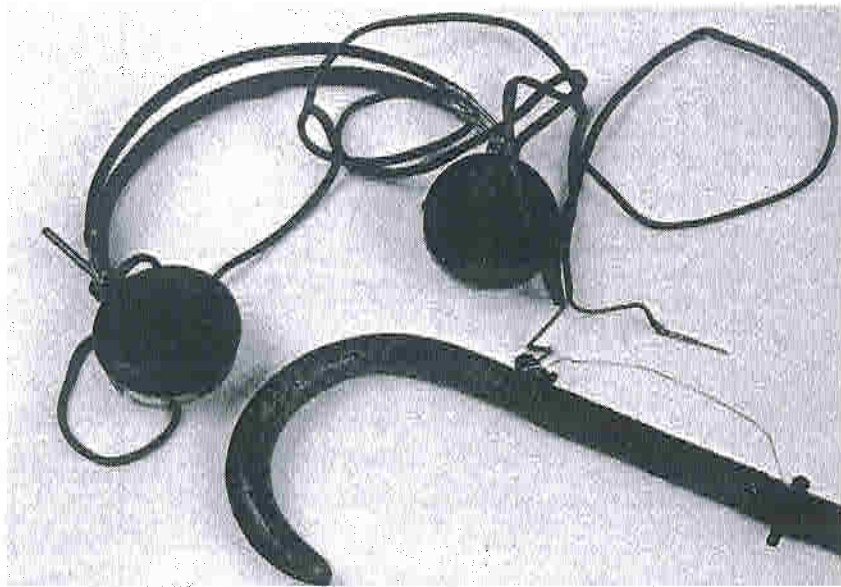


Figure 6.12 Droz-Georget's bobbin cane was made for listening to the forbidden French transmitter on the Eiffel Tower during World War I.

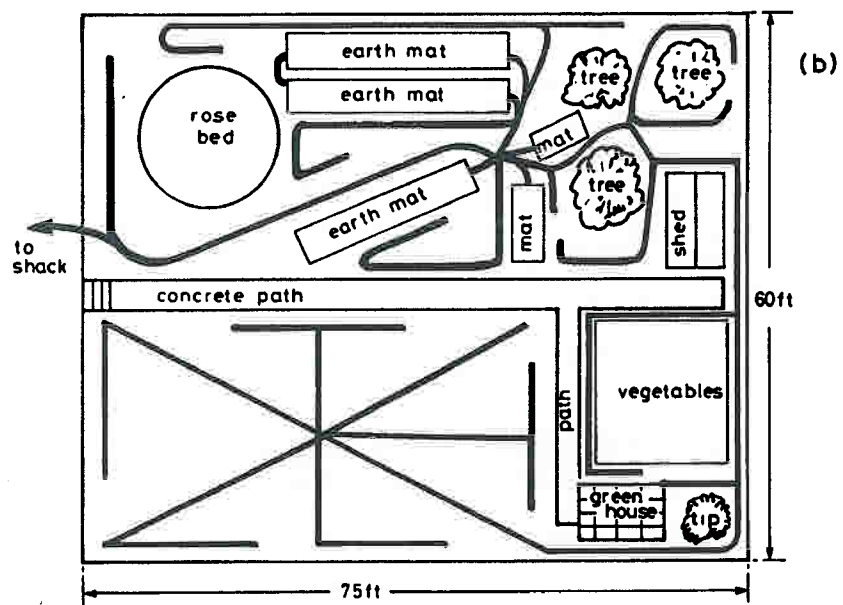


Figure 6.13 Design layout for a garden allowing for the inoffensive integration of an antenna with vegetables and paths.

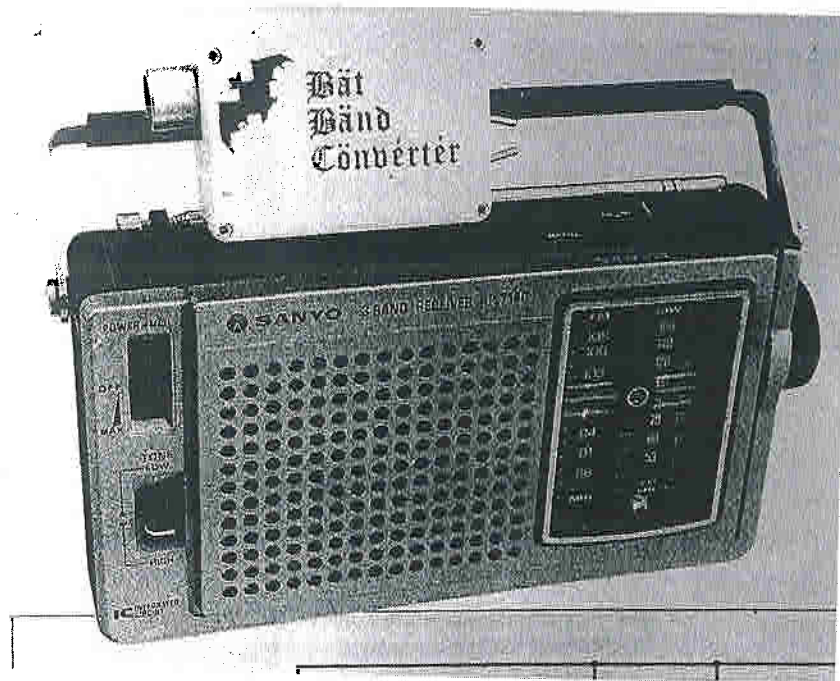


Figure 6.14 The Bat Band Converter from *Everyday Practical Electronics* is a parasitical device that allows you to “use your AM portable radio and this novel design to tune-in to the secret world of bats.”

practical skills are turned toward poetic ends, and tuning in to bats, hair, fizzy drinks, crinkly plastic bags, and dropping pins is regarded as a sane everyday activity. The device converts the non-electromagnetic ultrasonic signals of the bats into radio signals that are transmitted/leaked to the host radio.

The seemingly illicit information exchange of “dreamy objects” offers one possible interpretation of the electrosphere. It helps us think of electronic objects in “hertzian” terms, as interconnected fields rather than discrete things. It acknowledges the problematic conceptual status of electronic objects, arising from their ambiguous identity as hybrids of matter and radiation, functioning at scales and speeds well beyond the range of human perception. If the electronic object has a role in humanizing hertzian space it is not as a visualization or representation of radio but as a catalyst, encouraging the poetic and multilayered coupling of electromagnetic and material elements to produce new levels of cultural complexity.