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Cybernetification II: Toward a sixth ecology

Liss C. Werner, a book chapter for Man-Machine Technologies (Arie Graafland and Dulimini Parera, eds.)

Abstract

Digital infrastructure and learning algorithms, digital industry and automated services, digital society, humanities, and health converge with the Anthropocene. This mix has given birth to extraordinary challenges; for architecture as discipline, in its role as cultural heritage and as materialized co-evolution of man and machine. Despite of re-modelling and re-designing work-flows to integrate data necessary to arrive at a structurally and energetically 'good' piece of architecture, or rethinking an IoT (Internet of Things) supply chain management from planning via production to construction of a building or city and its performance monitoring, the digital has impacted our 20th century our long-standing relationship to architecture, technology and nature. This chapter suggests first ideas of a sixth ecology – influenced by Felix Guattari's "The Three Ecologies"[1,2], Reyner Banham's "Theory and Design in the First Machine Age"[3] and Benjamin Bratton's "The Stack"[4]. The *Sixth Ecology* describes one of and for a dynamic relationality across systems; multi-parametric, functionally adaptable, morphologically changing, cybernetic. One, where man, machine, technology and 'nature' merge – or speaking for architecture: designer and computer, builder and robot, planner and construction factory, construction site and biologically grown habitats. In 1958 Gilbert Simondon states that "culture has become a system of defence designed to safeguard man from technics. This is the result of the assumption that technical objects contain no human reality."[5, 6, 7] Vaucason's 18th century automaton the *defecating duck*[8, 9] describes a cornerstone for the beginnings of *humanification* of mechanical technical objects. The rise of digital technical objects since the 1980s and the disappearance of their atomic materiality in a wireless world describes a step further. *Humanification of technology* crosses the border of co-evolution and co-existence towards coalescence. My research on the 'sixth ecology' and concepts such as 'netgraft' and 'neurotecture' has been influences by the work conceived computational architecture studio *Codes in the Clouds* which I ran between 2009 and 2016 at DIA, Dessau International Graduate School of Architecture.

Keywords: computational architecture, ecology, cybernetics, technology, Reyner Banham, Felix Guattari, digital turn

[1] Félix Guattari, *The Three Ecologies*, trans. I. Pindar, Sutton, P. (London: The Athlone Press, 2000).
[2] Félix Guattari's theory of *The Three Ecologies* finds its foundations in Gregory Bateson's *Steps to an Ecology of Mind* (1972) "Ecology in the widest sense turns out to be the study of the interaction and survival of ideas and programs (i.e. differences, complexes of differences) in circuits." Gregory Bateson, ed. *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology* (Chicago: University Of Chicago Press, 1972). p.491
[3] Reyner Banham, *Theory and Design in the First Machine Age*, 2nd ed. (New York: Praeger Publishers, 1970).
[4] Benjamin Bratton, *The Stack* (Cambridge: The MIT Press, 2016).
[5] Gilbert Simondon, *On the Mode of Existence of Technical Objects*, trans. Ninian Mellamphy (Paris: Aubier, Edition Montaigne, 1980).
[6] Translated from the French to the English language by Nimian Mellamphy, University of Western Ontario, June 1980
[7] The term 'reality' may be defined as a phenomenon entailing human characteristics such as emotions or the driving will to live – not the prove of physical existence of mankind. 'Technics' and 'technical objects' may be defined as a purely utilitarian, and not as result of evolution.
[8] Jessica Riskin, "The Defacating Duck, or, the Ambiguous Origins of Artificial Life," *Critical Inquiry* 29, no. 4 (2003).
[9] The French engineer Jacques Vaucanson created the *Defecating Duck* and other kinetic automata that mimicked nature around the year 1730. The duck seemed to be able to digest food in a chemical stomach. The reality however was, the stomach was pre-filled with digested kernels to be released on demand. See. Wood, Gaby, *Edison's Eve: A Magical History of the Quest for Mechanical Life*, 2003.

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A glimpse into a temperamental Environment 1964-2010: an architectural ecology on the move

Subjects related to the digital and computational in architecture have been developed since the early 1960s – possibly earlier - through projects such as the IBM Pavilion at the 1964 at the New York World's Fair designed by Charles and Ray Eames or Ivan Sutherland's Sketchpad (1963) developed at MIT; the latter entails a sketching software, an 'automated' drafting tool, a graphics tool, a communication system between human and the machine in order to create shapes and drawings. The software functioned on a set of algorithms, a cathode ray pen, a human and a screen, describing the interface between the two 'alien' species, the Human-Computer-Interface (HCI). The *Colloquy of Mobiles,* an interactive (possibly even user centred) structure developed by the British cybernetician Gordon Pask followed suit in 1968[10]. It was exhibited at *Cybernetic Serendipity* at the Institute of Contemporary Arts (ICA) in London. The exhibition was curated by Jasia Reichardt and featured the use of computers in art, music - and the phenomenon of feedback. The same era brought out Nicholas Negroponte's *Architecture Machine Group* (1967–1985, MIT) developing 'Architecture Machines' that would see, learn, forget and assist the architect. Negroponte based the research of the Architecture Machine Group on the concept that "If a machine can be a self-improving evolutionary specie, it sports better chance of making its computational and informal abilities relevant."[11] He states that "Most computer-aided design studies are irrelevant inasmuch as they only present more cooperation with the machines that have been thought to be inhuman devices – devices that can intelligently respond to the tiny, individual, constantly changing bits of information that reflect the identity of each urbanite as well as the coherence of the city. If this is true, then the first issue is: Can a machine deduce responses from a host of environmental data?"[12] Negroponte actively combined architecture, urban design, computer sciences and biological principles culminating in the emergence of projects presenting self-organization and generative/iterative evolution rather than designing projects of finite geometry or function. In architectural theory and practice the search for new typologies and interdisciplinary approaches was tested on a number of levels, ranging from 'utopian' mega-cities and urban-scapes including projects by Archizoom via the Japanese Metabolism with projects, buit and unbuilt, by e.g., Kenzo Tange, Kisho Kurakawa and Yona Friedman with 'Spatial Cities'. The idea of endless growing architecture (*Il Monumento Cintiunuo* by Superstudio, 1969) modular buildings (*Interaction Centre* by Cedric Price, 1972), self-organizing public spaces (*Fun Palace* by Cedric Price and Gordon Pask), cities conceived through industrial automated production and rule-based compositions (houses I to X by Peter Eisenman, 1967- 1975) have triggered a change of mind-set from object-focused design strategies to relation-focused ecological environments – slow but steady. Christopher Alexander's books "Notes on the Synthesis of Form"[13,14] and "Pattern Language"[15] have supported this development until today. Architects started defragmenting their building designs, to reconstruct them differently, sometimes with underlying rules sometimes based on individual preference of composition. In either case the long-established typologies of building components got distorted and questioned; new spatial qualities emerged. Architectural theory and societal critic kept driving experimental projects in form and expression also in the 1980s (Dame Zaha Hadid *The World (89 Degrees)*, 1983, or Bernard Tschumi's *Parc de la Villette,* 1982-

[10] Gordon Pask, "A Comment, a Case History and a Plan," *Cybernetics, Art, and Ideas* (1971).
[11] Nicholas Negroponte, "Toward a Theory of Architecure Machines," *Journal of Architectural Education* 23, no. 2 (1969).
[12] Ibid.
[13] Christopher Alexander, *Notes on the Synthesis of Form* (Cambridge. Massachusetts: Harvard University Press, 1971).
[14] originally published 1964
[15] Christopher et al. Alexander, *A Pattern Language: Towns, Buildings and Construction* (New York: Oxford University Press, 1977).

1998).[16] an evolution that, between the mid 1960s and late 1980s, underpinned an understanding of a building or a city as system, as organism. Each element would be connected one or more others; some relations stronger, some loser, some evolving independently and some influenced in their morphology by environmental changes and impact. Deconstructivism – to complete the short overview - played a crucial role in the trans-formation of architecture. It brought to being architecture that lived of incoherence, defragmentation and contradiction; disharmonious and without underlying logic in order to arrive at a visually pleasing architectural composition. In this context, I may want to suggest deconstructivism as an era that bridges between postmodernism (approx. 1960s-1990s) and the digital. Between 1990s and approx. 2005 deconstrucivism ran in parallel with the first digital turn, accompanying projects such as Frank Gehry's *Guggenheim Museum* in Bilbao (1992-1997). Late Deconstructivism was the birth child of more than two decades overwhelming architectural theory. Gottfried Wilhelm Leibniz (and the baroque) was rediscovered, Gilles Deleuze and Félix Guattari, Kenneth Frampton, Peter Eisenman, Anthony Vidler, Rem Koolhaas, Kurt W. Foster, Guiseppe Terragni, Diana Agrest and a number of highly influential architects and theoreticians created the *Oppositions* readers (1973-1984); even Hans Reichenbach's idea of the manifold became part of the debate. Architecture became truly com-plex and com-plicated through new mind-sets that discussed architecture beyond buildings, technology and construction but as politics, as capitalism, as economics, utopia and society – and they discussed the role of the architect as an organiser of cities, and designer of statements. A progressive group of architects that accepted, embraced and celebrated non-linearity, networks, causality and multiplicity in opposite to the linearity and clarity that was assumed to be 'the true characteristic' of architecture, initiated and carried through a radical change. Architecture transformed and steered towards a becoming a new kind of animal; one that would soon underlie rule-based principles and play with becoming digital, with being governed by the topological logic of NURBs[17], tessellation and what we used to call 'pulling vertices';[18] "Hybrid Spaces"[19] happening in cyberspace[20,21], slowly turning, unfolding and finally releasing the first digital turn[22] – a new age (1992-2010)[23]. "Architecture in the Digital Age – Design and Manufacturing", a compilation conceived through a conference held at University of Pennsylvania in 2002 and edited by Branko Kolarevic mirrors the new Zeitgeist towards the fluid and relational that started entering its adolescence. In the introduction Kolarevic refers to Greg Lynn and states "In his essay on "Architectural Curvilinearity"[24] published in 1993, Greg Lynn offers examples of new approaches to design that move away from the deconstructivism's "logic of conflict and contradiction" to develop a "more fluid logic of connectivity." This new fluidity of connectivity is manifested through "folding," a design strategy that departs from Euclidean geometry of discrete volumes represented in Cartesian space, and employs topological conception of form and the "rubber-sheet" geometry of continuous curves and surfaces as its ultimate expression."[25] The new species of digital architecture developed in the 1970s supported by CAAD (Computer Aided Architectural Design) in the 1990s has created the path towards an architecture produced by computer and

[16] These are two selected projects of a large range of experimental work and have been chosen due to author's preference.
[17] non-uniform rational basis spline
[18] We are writing the years around 2000
[19] Peter Zellner, *Hybrid Spaces* (London: Thames & Hudson, 1999).
[20] Michael Benedikt, "Cyberspace: Some Proposals," in *Cyberspace: First Steps*, ed. Michael Benedikt (Massachusetts: MIT Press, 1991).
[21] The term 'Cyberspace' stems from the Science Fiction writer William Gibson (1984), see Benedikt, Michael 'Cyberspace: First Steps', MIT Press, 1991
[22] Mario Carpo, ed. *The Digital Turn in Architecture 1992 - 2012* (London: Wiley, 2012).
[23] See Carpo, Mario, *The Digital Turn in Architecture 1992-2012*, AD Reader, 2012.
[24] Greg Lynn, "Architectural Curvilinearity: The Fold, the Pliant and the Supple," in *Ad Profile: Folding in Architecture*, ed. Greg Lynn (London: Academy Editions, 1993).
[25] Branko Kolarevic, ed. *Architecture in the Digital Age: Design and Manufacturing* (London: Taylor & Francis, 2003).:3

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architect in mutual relationship.[26] The evolution of architecture since the 1970s - as in parts outlined above - had finally led to the beginning of the first digital turn between in the 1990s, and subsequently to the emergence of new typologies of buildings, architects and design tools - atom-based, bit-based, and cyber-physical - a combination of both.[27] [28]

Ecology - … and the Anthropocene

Etymologically 'ecology' stands for the study (-logy) of habitation (eco), *eco* stems from the greek οἶκος (*oikos)*, for house; to be extended to a quarter, or a section in the city. The notion of ecology seems to be one of the constants of interest in architecture. 'Ecology' as a science was established in the late 19th century as branch of biology through Alexander von Humboldt (1769-1859) and later Hermann von Helmholtz (1821-1894), Ernst Haeckel (1834-1919) – who coined the term 'ecology'[29] and Jakob von Uexküll (1864-1944)[30] but to mention a few.[31] The understanding of ecology for architecture and urban design was limited to the 'natural' in our habitat; the ecological balance of greenery, water, biodiversity, air pollution and sealed surfaces had been the focus. The online dictionary *Merriam Webster* defines ecology as a) "a branch of science concerned with the interrelationship of **organisms and their environments**", b) "the totality or pattern of relations between organisms and their environment".[32] The etymological dictionary e*tymonline* understands ecology slightly differently by referring to "relationship of **living things to their environments**" rather than 'interrelationships' and '**organisms**'.[33] Here the debate could arise if all living things are organisms or if all organisms are living things. Culture for instance, can be seen as a living thing, but perhaps not like an organism. One could look the situation from a different perspective and argue that all organisms are living things, but not all living things are organisms, since an organism is goal driven. Organizations may or may not be. Once an organization becomes an ecology it provides the system, the environment, for the organisms to inhabit the system and to thrive – an ecology emerges. The discussion about what an ecology does require a clear definition and understanding of the terms *organization, system, living thing* and *organism*. In this chapter I would like to include all interrelationships and all organisms/living things (natural and artificial)[34] in their environments, including the micro-organism of economy, politics or the multitude of dynamic domains and subdomains residing in the Internet and outside of it. As hinted at in an earlier part of the chapter the topic to discuss is our (human) relationship to technology and technical objects. In fact, I would like to go a step further and suggest that the human condition **is** the relationship to technology and technical object. A shift in the balance of the whole made

[26] I may want to add that the complexity of architecture as understood here is not reduced to the design tool and the designer, but ought to take into consideration all environmental factors, as well as material qualities and behavior of materials used in a project.
[27] At this stage I could have chosen the terms ‚material' or ‚real' and ‚virtual'; I refrained from doing so, since, and I would like to quote John Frazer: "virtual worlds should not be seen as an alternative to the real world or a substitute, but as an extra dimension which allows us a new freedom of movement in the natural world.". John Frazer, "The Architectural Relevance of Cybernspace in Architectural Design (1995)," in *The Digital Turn in Architecture 1992-2012*, ed. Mario Carpo (London: Wiley, 2013). pp.48-56
[28] cyber-physical systems here refer to 'objects' such as drones, robots, street lights, etc., that are integrated parts of the 'Internet of Things'; and not to humanoid robots, which may become integrated and active parts of society.
[29] etymonline, "Ecology," https://www.etymonline.com/word/ecology.
[30] The selection of scientists stands as exemplary and certainly only shows a fragment of the scientists and also sociologists in the 20th century who actively developed the notion of ecology.
[31] Ecology as such existed long before without being a science or specific field
[32] Merriam Webster, "Definition of Ecology," https://www.merriam-webster.com/dictionary/ecology.
[33] Etymonline, "Ecology," https://www.etymonline.com/word/ecology. Accessed 2017/11/08
[34] including culture as man-made and nature as made by a higher force, e.g., evolution or 'God'

of parts towards a whole made of relationships is taking place. The difference from one to another can be seen in a comparison between models and means of information exchange, including top down regulation, back-and-forth-conversation and feedback mechanisms, as well as their implications for evolution; and even more relevant in the 21st century – mutation and fundamental structural change.

In his critic to capitalism "The Three Ecologies"[35, 36] Félix Guattari presents the combination of a social ecology, a mental ecology and an environmental ecology. Among other observations he describes a shift in society, politics and the human condition through

a) the increasing power of the individual[37 38],

b) the irreversibility of the man-nature-convergence - more precisely, he states that "return to the past to reconstruct former ways of living. After the data-processing and robotics revolutions, the rapid development of genetic engineering and the globalization of markets, neither human labour nor the natural habitat will ever be what they once were, even just a few decades ago."[39]

c) the impossibility of separating man from nature.[40]

According to Guattari, *social ecology* aims at reconstructing the social, due to deterritorialized capitalist power; *mental ecology* relates to what Gregory Bateson calls the 'ecology of ideas', the study of how ideas interact[41] ; *environmental ecology* is based on the principle "that anything is possible". Guattari also refers to the *environmental ecology* as 'machinic' ecology, that deals with the increasing influence of humans on the environment[42]. He states that "in order to comprehend the interaction between ecosystems, the mechanosphere and the social and individual Universes of reference, we must learn to think 'transversally'".[43] Guattari further refers to the challenges we are facing due to increasing world populations and climate change. At this stage I would like to argue a direct link to the Anthropocene, the 'epoch of human impact'. Our interest considering this chapter lies in what Guattari calls *machinic ecology*.

The architectural theoretician Reyner Banham, in the 1960s/70s observes the subject of architectural ecology from a 'technical' and domestic / social point of view. His emphasis is on the building as techné relevant to **construct the relationship between human and building and between human and** technology on one hand, and **the impact of 'modern' technology "in form of small machines** – shavers, clippers and hair-dryers" p.9 on the domestic revolution on the other. The building and its design act as interfaces for both, since it may require further electrical circuits for the operation of electrical machines or air condition for a good climate once for instance large panes of glass are installed instead of thick brick walls. "Theory and Design in the First Machine Age"[44] and "The Architecture of the Well-tempered Environment"[45] present two books relevant for the

[35] Guattari.
[36] Guattari's book follows / is related to *"Steps to an Ecology of Mind"* by the English anthropologist and cybernetician Gregory Bateson Bateson.
[37] Guattari. :41
[38] "the question of subjective enunciation will pose itself ever more forcefully as machines producing signs, images, syntax and artificial intelligence continue to develop." Felix Guattari, *The Three Ecologies*, trans. Ian Pindar and Paul Sutton (London and New Brunswick, NJ: The Athlone Press, 2000).p.41
[39] Guattari. :42
[40] Ibid.
[41] Bateson.
[42] "Natural equilibriums will be increasingly reliant upon human intervention, and a time will come when vast programmes will need to be set up in order to regulate the relationship between oxygen, ozone and carbon dioxide in the Earth's atmosphere." Guattari. p.66
[43] Guattari. :43
[44] Banham., originally published 1960
[45] *The Architecture of the Well-Tempered Environment* (London: The Architectural Press, 1969).

architect to engage with the actual building as system made of relationships, ducts that would feed the building with air, pipes that would feed the building with water, cables that would give comfort to the inhabitant of the first electrical age and a heating system that would grant the necessary warmth needed in the coder seasons. Banham presents detailed examination of a large variety of buildings, one of which is the Frederic C. Robie House, Woodlawn Avenue in Chicago, built in 1910.[46] He describes the house as integrated system of technology and architectural aesthetics. Light-sources are designed into the custom-made furniture and "hot pipes at the backs of the built-in cupboards in the bay windows at the ends of the room, which slots in the skirting and the cupboard tops to permit the warmed air to circulate."[47] Banham refers to environment, environmental ingenuity and pioneering environmentalists for example in relation Sir Joseph Paxton, the architect of the Crystal Palace (1851) or Gustave Eiffel, civil engineer and architect of the Tour Eiffel (1887-89). The term 'environment' overrides that of 'building', and the building departs from its existence as discrete object and becomes accepted as an environment. "

The list covers:

- Las Vegas; environment defined in light without visible structure of any consequence.
- Drive-in movie House; rally of mobile environmental structures in a space defined by light and sound.
- AEC mobile theatre; space enclosed by membrane supported on a cushion of air.
- Space capsule; rigid structure containing entirely and continuously manufactured life-support environment.
- St. Georges School; massive structure conserving environmental output of the contained activities now has taken on a life on their own."[48]

Our current times, in which the Anthropocene and digitization describe prominent parameters, Architects, theorists and practitioners from many disciplines respond to the demand for re-thinking what Reyner Banhan called *The Well-tempered Environment*. The Anthropocene marks a geological state of the global impact on the Earth's ecosystem through human activity, "in which humans become a global geological force".[49] The term *Anthropocene* was coined by the ecologist Eugene F. Stormer in the 1980s. The Dutch nobel prize winner Paul Crutzen has extensively researched and written about the beginnings, development and arrival of the Anthropocene. Crutzen dates the first stage of the Anthropocene back to "around 1800 with the onset of industrialization, the central feature of which was the enormous expansion in the use of fossil fuels."[50] Since then the Anthropocene went through a number of stages. Now, in the late 2010s the Anthropocene coincides with social and technical phenomena. Man has finally influenced all 'natural' spots on earth, humans have almost departed from their 'natural', 'god-given' goal of reproduction, nature and culture merge and artificial and human intelligence interact on a regular basis regulated through invisible economic and political forces.

The definition of 'ecology' concerning the relational of, in and for all 'things' seems applicable. Erich Hörl's recent publication "General Ecology: The New Ecological Paradigm"[51, 52] investigates ecology as a state,

[46] *The Architecture of the Well-Tempered Environment* (London: The Architectural Press, 1969). :115-19
[47] *The Architecture of the Well-Tempered Environment* (London: The Architectural Press, 1969). :117
[48] Ibid. :285
[49] W. Steffen, Crutzen, P. J., McNeill, J. R. , "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?," *Ambio* 36, no. 8 (2007).
[50] Ibid. :614
[51] Erich Hörl, "Introduction," in *General Ecology*, ed. Erich Hörl (London: Bloomsbury, 2017).
[52] Erich Hörl's '*General Ecology: The New Ecological Paradigm'* is an anthology combining essays from the field of cultural history, theory and sciences, sociology, literature, media culture, communication sciences.

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in which everything is connected to everything. Hörl in the introduction to the book refers to Barry Commoner's *'The closing Circle: Nature, Man and Technology"*[53, 54] The idea of an era of ecology or an ecological age is not a novel one. However, since the networks between human, non-human and humanoid agents become denser and increasingly differentiated, ecology deserves to be seen in a broader scale. The individual disappears in the background structure appears in the foreground. Figure 1 shows a selection of 2-dimensional network studies to investigate hierarchical growth through DLA (diffused limited aggregation) (left), centralized static structures (centre) and evolutionary re-clustering through movement from one place to another (top-right). The work started a debate on network versus cluster and the possibility of multiple layered relationships – and ecologies existing at simultaneously.

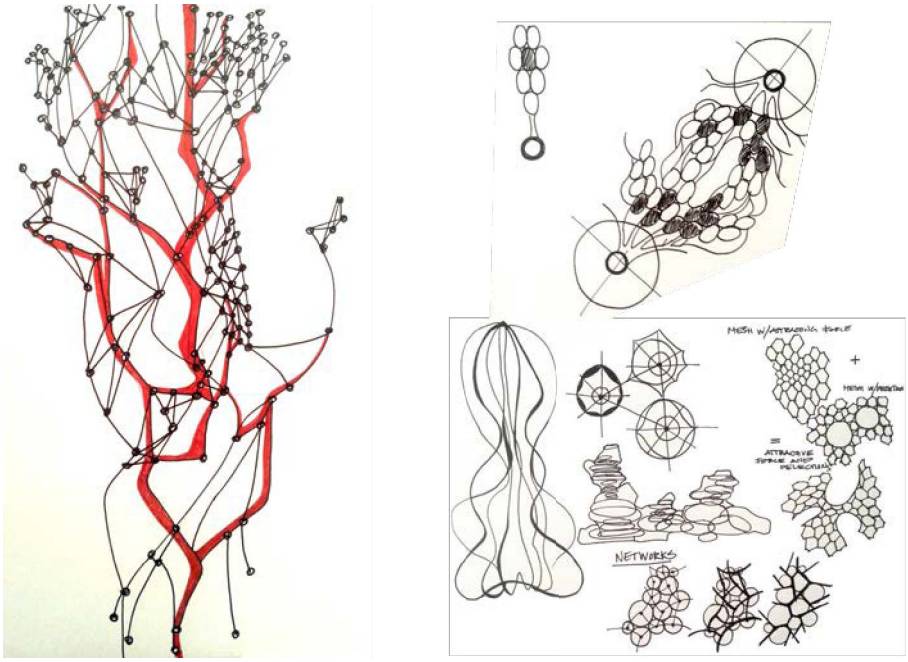

Fig. 1. Cerebellum Network Studies, Natalie Belous and Kamel Lokman, 2014

The Anthropocene in the 21st century allows us to redefine the natural as a state, rather than a representation of something organically grown without human influence. The natural is something that we, as humans, take for natural, such as a chair, or a wall, a knife, or a cell-phone. Objects, formerly technologically state of the art, rare and alien to our 'human' world. The systems approach of ecology paired with the Anthropocene helps us to depart from pre-determined ideas about architecture and its production. It offers us to embrace technology and AI to assist us in designing – maybe.

Toward a Sixth Ecology – post-anthropocene

The production of architecture is directly influences by this development of the ecological age. A pool of parameters - some clearly defined (climate, budget, material behaviour), others acting in the background (politics, culture, economics, software development) - author the design of digital tools, prototypes, processes

[53] Barry Commoner, *The Closing Circle: Nature, Man, Technology* (New York: Knopf, 1971).
[54] Hörl. 1-45

and finally buildings and cities.[55] The concept of ecology adopts cybernetic principles of feedback, conversation and learning. It also feeds principles developed by the Austrian biologist Ludwig von Bertalanffy's "General Systems Theory"[56], originally published in 1949. Those include but are not limited to systems dynamics and the focus on a system's structure rather than a system's function. The mission for how to continue the new architectural paradigm seems clear: digital infrastructure, methods and algorithms, industry, services and digital production, the growth of a digital society, a changing understanding of the humanities and digital health are desiring to be filled with life. They also demand an architectural response, in which the extreme digital and the extreme analogue and natural can co-exist and create a fruitful ecology. An increasing variety of sub-ecologies or micro-ecologies (biological, artificial, human, non-human) triggers an increase of ideas and concepts. It also increases the variety of possible habitats, possible cultures and ways of communication. Each entity, agent and cluster brings its own understanding (its own culture) into the equation of the sixth ecology. They inhabit their semiotic niches[57] - a term coined by Yuri Lotman. Semiotic niches are part of the interaction of all connected entities in the network as well as part of the environment in which they exist and act. The semiotician Yuri Lotman specifically refers to linguistics and signs, which for the sixth ecology is abstracted to code, syntax and taxonomy of environments (Umwelten)[58] (fig. 2).

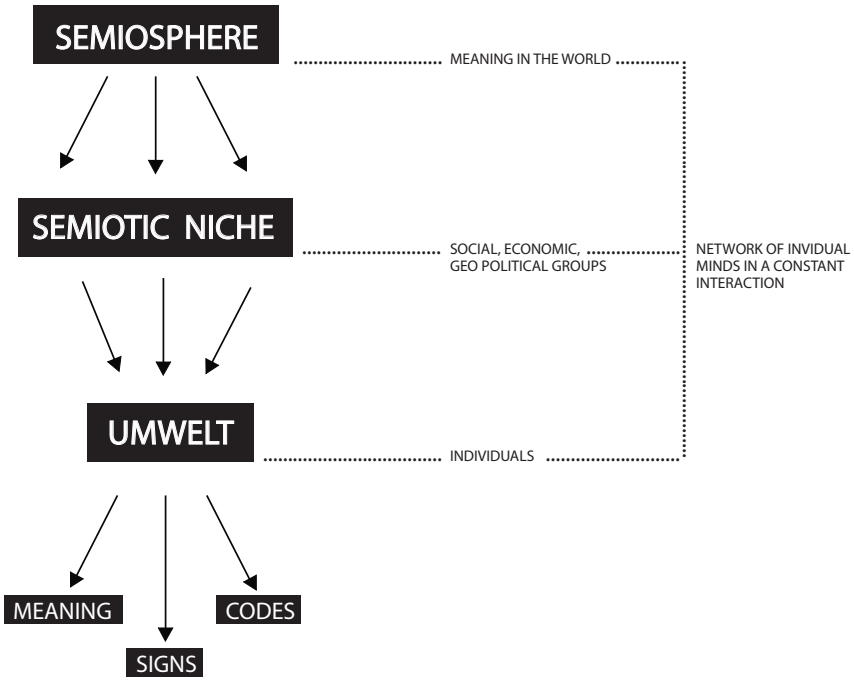

Fig. 2. Cerebellum Semiosphere[59], Natalie Belous and Kamel Lokman, Codes in The Clouds VII 'Topology Frequencies', 2014

[55] At this stage we could suggest that architecture enters an age of post-architecture, in a way that humans have (according to Katherine Hayles) become post-human; N. Katherine Hayles, *How We Became Post-Human* (Chicago: University of Chicago Press, 1999). I would refrain from such an alien extreme, and propose that 'post-architecture' and 'post-human' are states of the natural development of our society and culture.
[56] Ludwig v. Bertalanffy, *General System Theory: Foundations, Development, Applications* (New York: George Braziller, 1968).
[57] The term *semiotic niche* was developed by the Estonian semiotician Yuri Lotman in his concept of the semiosphere in 1982
[58] for contextual understanding see Jakob von Uexküll, *Umwelt Und Innenwelt Der Tiere* (Berlin: J. Springer, 1909).
[59] Juri Lotman, "On the Semiosphere," *Sign Systems Studies* 33, no. 1 (1984).

Machines of loving Grace:
I like to think (and the sooner the better!)
of a cybernetic meadow
where mammals and computers
live together in mutually programming harmony
like pure water touching clear sky.

I like to think (right now, please!)
of a cybernetic forest
filled with pines and electronics
where deer stroll peacefully
past computers
as if they were flowers
with spinning blossoms.

I like to think (it has to be!)
of a cybernetic ecology
where we are free of our labors
and joined back to nature,
returned to our mammal
brothers and sisters,
and all watched over by
machines of loving grace.[60]

In "The Stack: On Software and Sovereignity"[61] Benjamin H. Bratton describes the terrestrial and extra-terrestrial infrastructure by proposing "that these different genres of computation—smart grids, cloud platforms, mobile apps, smart cities, the Internet of Things, automation— can be seen not as so many species evolving on their own, but as forming a coherent whole: an accidental megastructure called The Stack that is both a computational apparatus and a new governing architecture. We are inside The Stack and it is inside of us."[62] The image of sitting in a computer recalls the photograph of the computer ENIAC, taken by the US Army in 1946, showing an operator within the machine, being an active part of the machine.[63] We may understand ourselves as agents within this infrastructure, this net of everything. *The Stack* is made of six layers: earth, cloud, city, address, interface and user, that are undeniable interconnected and interrelated. The architectural designer, like any other designer, operates within the stack and involuntarily gets influenced by each layer and relationship; involuntarily since he or she cannot control which information to integrate into a design process. The conversation with the worlds has become overwhelming. Bratton's 528-page critical view suggests a cybernetic relationship of everything that resolutes in a coherent whole. It spins further the wheel of cybernetics - a theory,

[60] Richard Brautigam, *All Watched over by Machines of Loving Grace* (Communication Company, 1967).
[61] Bratton.
[62] The MIT Press, "The Stack - Overview," https://mitpress.mit.edu/books/stack.
[63] see ENIAC (Electronic Numerical Integrator and Computer), one of the earliest general-purpose computers, University of Pennsylvania, February 1946. A photograph, originally by the US Army, published in the article *"Lightning Strikes Mathematics"*, published in *Popular Sciences* in April 1946 Allen Rose, "Lightning Strikes Mathematics," New York, https://books.google.de/books?id=niEDAAAAMBAJ&pg=PA83&redir_esc=y&hl=en#v=onepage&q&f=false. shows Irwin Goldstein setting switches on one of ENIAC's function tables in ENIAC - the so-called 'Giant Brain' - at the Moore School of Electrical Engineering. The operator is in the computer and the computer in him.

a science, a world view and a technique for constructing conversation between things – and for construction things – material and immaterial – critical and not always positively. Subjects, which have been globally discussed since the mid-nineties have culminated in the rise of the digital natives, and cyborgian humanoids on a socio-technical level, the rise of the bitcoin and blockchain on an economical level and the rise of emergent properties through developments in the fields of design-to-production, material intelligence, the democratization of design on an industry and services level – through real-time customer response and direct digital design of mass-customized products - and digital craftsmanship[64]. The latter relates to a rethinking of a craft of drafting on conversation, or still contradiction to the craft of coding in architecture and production of architecture. The questions are, can we master the at of coding in order to fulfil architecture's responsibility and love up to its standards? Do we actually know what the responsibilities and state of the art standards are? What is it that architecture has to deliver to respond to contemporary dramatic changes? Isn't the ease of using a computer for designing and producing architecture, for drawing and rendering the way out of the tedious process of revising designs over and over again? It is so easy to feed the machine with necessary data to spit out a 'good' piece of architecture. Surely issues in architecture are more complex, and the process of design an individual one between the designer, the tool and the to be designed[65] [66] [67] Richard Sennett refers to CAD and states "The seduction of CAD lies in its speed, the fact it never tires, and indeed in the reality that its capacities to compute are superior to those of anyone working out a drawing by hand. Yet people can pay a personal price for mechanization; misuse of CAD programming diminished the mental understanding of its users. This seems a sad story, but perhaps it can be told in a different way. Might we, in our very comparative imperfection, learn something positive about being human?"[68] Ecology, in regards to the design process in architecture and the building as manifested micro-organism within a larger system of dynamically interweaving subsystems, and overlapping layers, has changed according to the global development. The entrance into the Anthropocene – not only as a geological phenomenon but as sign, as a phenomenon for radical change – complexifies the task for the architect even further. The ‚architect' is, of course not the only one affected during the design and construction process. The role of the architect changes dramatically, and so does the role of the architectural teacher, architectural education, architecture schools developing curricula for the digital age and the students of architecture. Opinions of how to engage range widely, due to a number of reasons not always comprehensible. If we regard ecologies as the study of habitation, derived from multiple relations, one of the aspects of designing is how we design the actual design process. Students in the master studio 'Codes in the Clouds' have regularly developed series of project maps (ecologies of interconnected parts) of their projects, combining site observations with theoretical underpinnings, tools and core parameters. Figure 4 shows a project map of the project 'AllaNoo', a space for people to dwell, designed through the phenomenon noise on site. 'alla' stands for 'all', 'noo' stands for the mind. The design was conceived through the combining factors of kinetic architecture and the interfering sounds of anthrophony (noise through humans), biophony (noise through nature) and technophony (noise through technical objects) (fig. 3).

[64] Digital Craftsmanship sits in relationship with the book 'The Craftsman' by Richard Sennett, originally published in 2008. Richard Sennett, *The Craftsman* (London: Penguin Books, 2010). Sennett discusses craftsmanship as a human property, which had been 'threatened' by the invention of labouring machines in the 18th century, examples are the careful carving of the Stradivari violin or the weaving of a piece of fabric (Vaucanson's loom invention following a technique he applied when designing the magic flute player – p.87).
[65] see Ranulph Glanville, "Re-Searching Design and Designing Research," *Design Issues* 15, no. 2 (1999).
[66] see Donald A. Schön, *The Reflective Practitioner : How Professionals Think in Action* (New York: Basic Books, 1983).
[67] see Leonard J. Waks, "Donald Schon's Philosophy of Design and Design Education," *International Journal of Technology and Design Education* 11 (2001).
[68] Sennett. :81

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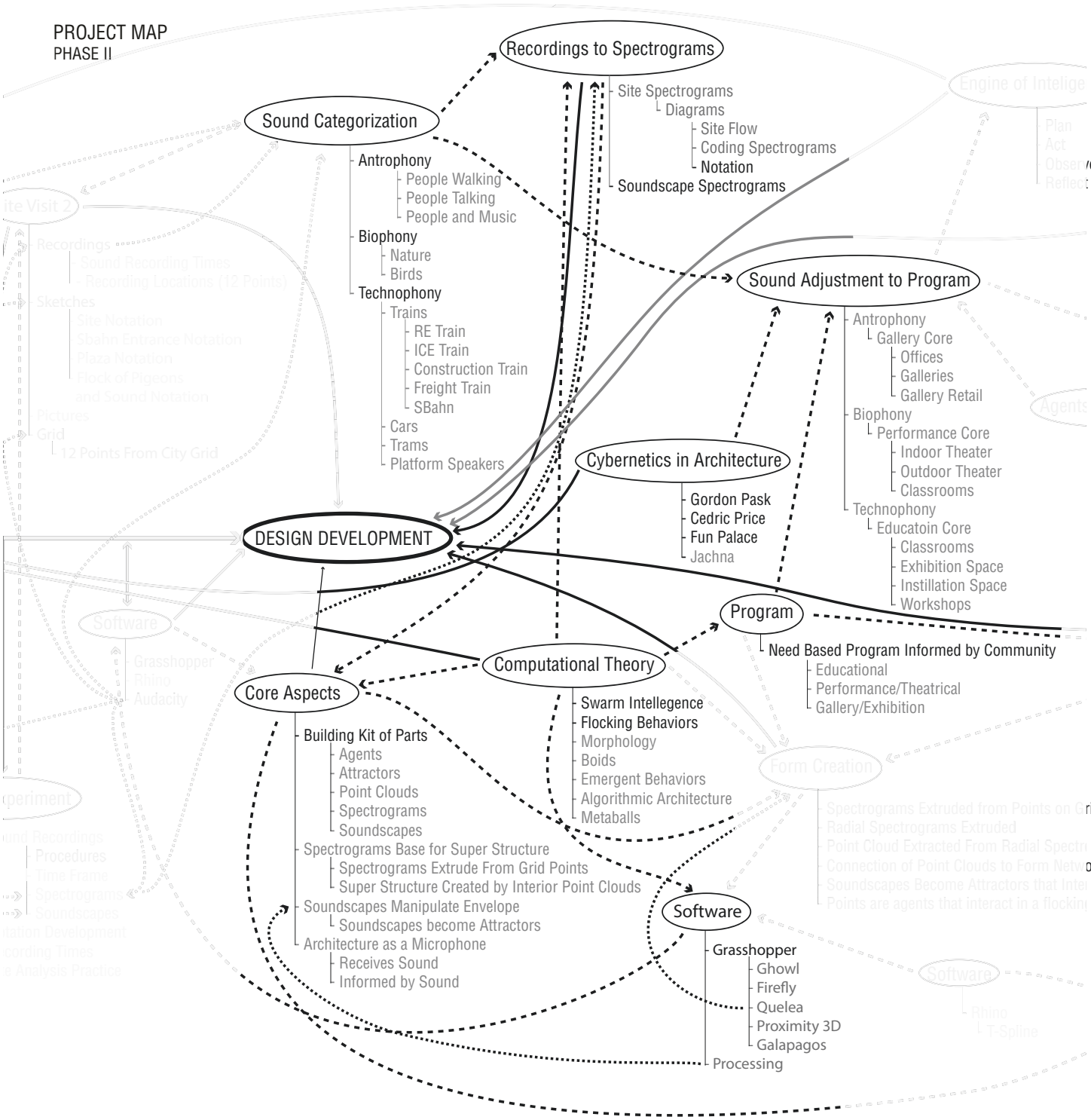

Fig. 4. AllaNoo 'Project Map 02`, Anastasija Palagina and Zachary Wilson, Codes in The Clouds X 'White Noise', 2016

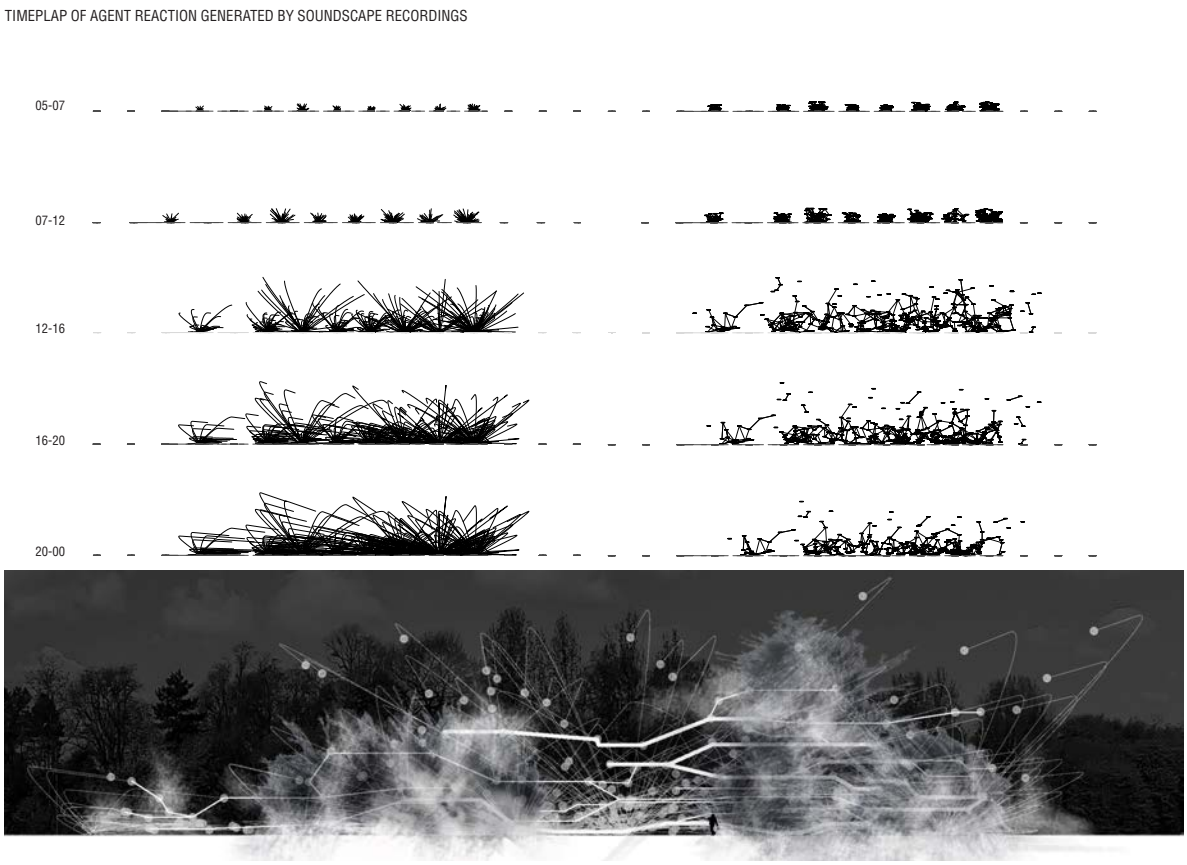

Fig. 3. AllaNoo 'Agent Reaction`, Anastasija Palagina and Zachary Wilson, Codes in The Clouds X 'White Noise', 2016

My research on the sixth ecology has developed since 2015 with the first publication on "Architectural Ecologies: Code, Culture and Technology at the Convergence", which "opened up the possibility for the conception and study of a post-digital architecture[69] (Spiller, 2009), where the computational matter becomes the catalyst of a wider understanding of architectural formations as embedded in a wider field of ecological interactions with natural, cultural and technological systemic ecologies."[70]

If we understand ecology as relational and as form of habitat ecologies cannot be reduced to known paradigms, economy or the mind. I am suggesting ecologies themselves as dynamic environments that, once parts of the ecologies are connected, interact and develop.

The first five ecologies I suggest are

1. natural ecology – meaning nature as understood in the 20th century
2. infrastructural ecology – meaning streets, water, internet, etc.
3. socio-cultural ecology – meaning the things humans do
4. artificial ecology – IoT, robots, humanoids
5. conversational ecology – meaning communication between entities, verbal and biological

[69] Neil Spiller, "Plectic Architecture: Towards a Theory of the Post-Digital in Architecture," *Technoetic Arts: A Journal of Speculative Research* 7, no. 2 (2009).
[70] L. Werner, Rossi A., PanahiKazemi, L., "Architectural Ecologies: Code, Culture and Technology at the Convergence" (paper presented at the EMCSR 2014, Vienna, 2014).

The sixth ecology describes the overwhelming network and includes unseen parameters, that do strongly affect architecture. It focuses on relations and feedback, and behaves according to principles of second order cybernetics, meaning the sixth ecology combines paradigms that have been alien to each other before the embodiment of the digital. The sixth ecology takes into consideration existing knowledge and the development (breeding) of such through interaction. At this stage I would like to call the sixth ecology, a concept in development, 'entailment' or 'entailing ecology'.[71, 72]

The term 'entailment' refers back to the cybernetician later consultant to Cedric Price's *Fun Palace* and teacher at the Architectural Association Gordon Pask, who developed the so-called 'entailment meshes' as part of his 'Conversation Theory'.[73, 74] In 1969, he states that "a building cannot be viewed simply in isolation. It is only meaningful as a human environment. It perpetually interacts with its inhabitants, on the one hand serving them and on the other hand controlling their behavior. In other words, structures make sense as parts of larger systems that include human components – and the architect is primarily concerned with these larger systems; the (not just the bricks and mortar parts) are what architects design. I shall dub this notion architectural 'mutualism'."[75] In this respect, I would like to close the chapter with a question. 'What is our post-millennial human environment how will we, as architects, respond?'

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[71] see Gordon Pask ‚entailment meshes' in Gordon Pask, *Conversaton Theory - Applications in Education and Epistomolgy* (Amsterdam: Elsevier Scientific Publishing Company, 1976).

[72] The sixth ecology as ‚entailment' is akin to the concept of the ‚Cyberneticon' developed between 2013 and 2015. "The Cyberneticon is a theoretical computing construct. A machine, a 'machinically' behaving construct that converges cybernetics, culture, technology and architecture." Liss C. Werner, "Why Gordon," (unpublished2015). p.38

[73] Pask.

[74] see Liss C. Werner, "The Origins of Design Cybernetics," in *Design Cybernetics: Navigating the New*, ed. C. M. Herr T. Fischer (Springer, forthcoming).

[75] Gordon Pask, "The Architectural Relevance of Cybernetics," *Architectural Design* (1969). :494

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