COMPUTER OF A THOUSAND FACES: ANTHROPOMORPHIZATIONS OF THE COMPUTER IN DESIGN (1965-1975)

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PROLOGUE

"Computational Design" is a term in wide currency. Followed by the hype often associated with digital technologies, the phrase is invoked to describe a vast spectrum of design practices which employ computational media as an integral part of their conception, representation or realization processes. The ubiquity of computational tools, the hastiness for the development of faster and more efficient computer applications, and the excitement associated with the label "computational," prime a pragmatic approach to the term "computational design," leaving little space for contemplation on its conceptual premises.

Within this context, the sparse efforts to define the term usually take the form of a comprehensive listing of the design and fabrication technologies at hand, as well as the methods through which these are utilized. However, this extensive definition, where "computational design" is equated to the sum of the available computer tools and use processes, fails to capture the term's essential meaning, implications and potentials. Does the adjective "computational" describe a special subsection in the well-defined disciplinary category of Design, or does the concatenation of "computational" and "design" engender a third entity, a new field of knowledge, with its proper inquests and ways of pursuing them?

Setting aside the controversial question of whether Design and Computation can in fact be considered a new discipline, it can be argued with certainty that the coupling of the terms "computational" and "design" carries crucial epistemological implications: it suggests the utilization of an informational machine, the computer, in the creative process of design, which still escapes definition besides the numerous attempts to formalize it. Besides its current naturalization/neutralization, the phrase "computational design" contains an irresolvable tension between the systematic, linguistic and combinatorial space of the machine and the fluid, perceptual, continuous space of the designer.

This negotiation between two different, and at times antithetical, worlds legitimates the existence of a field of knowledge which inquires into the conditions of their coexistence. Does "computational design" exist as a synthesis of oppositions, merging the world of design and the world of computation, or does one of the two fields impose its operational modes upon the other, making

design more computational or computation more designerly? Untangling the difficult conceptual problem is essential in order to critically position ourselves as designers and researchers in the vast pluralism of practices which invoke the term "computational design" and to orient our creative efforts toward the inception of new computational agendas, conscious of their stakes and challenges.

Currently, the questions pertaining to the intensive relationship between the constituent parts of the phrase "computational design" tend to be obscured by its ubiquitous and opportunistic use. However, looking back to the first encounters of computers and design, one discovers a rich legacy of speculation on the implications of this merging. Inquiry into the early computational era (1965-1975) can therefore expose (part of) the cultural and historical origins of the popular but loosely defined term "computational design." Furthermore, an exploration of the computational transition in design can problematize the boundaries between the domain of computers and this of designers and bring forth ideas and questions which surpass the actualities of digital tools and methods.

The intense impulse to situate the new entity of the computer in the traditional, empirical processes of design lead to assignments of anthropomorphic roles to the machine, such as the"clerk," the "partner," the "accountant," and others. These different "occupations" were eloquent metaphors denoting different approaches to the ways that the innate characteristics of the computer could be reconciled with the elusive characteristics of design, as well as to the new relationship of the machine as a design actor with the designer-author. The main body of this paper places these metaphors in conversation, thus revealing different models of computation, as well as different processes of design. The purpose of this short survey is to bring forth computational "role models" which survive until today, assert them as historical and cultural artifacts, and present their conceptual counterpoints, re-opening them for discussion.

COMPUTER OF A THOUSAND FACES

The first Computer Aided Design (CAD) system, SKETCHPAD, made its appearance in 1963, as the result of Ivan Sutherland's PhD thesis in the Massachusetts Institute of Technology. The introduction of Sutherland's program in the design world initiated controversial debates on the role of computer aids to Design and Architecture. Sutherland's writings about SKETCHPAD explicitly reveal his approach computer graphics applications as something more than drafting aids. More than half a century before the popularization of Building Information Modeling (BIM), Sutherland was discussing the machine's ability to organize and process information. This, he argued, offered the prospect of structured representations containing explicitly stated topological information about a drawing and therefore enabling the designer to embed constraints, perform easy modifications and even compute difficult problems emerging during the design process. In the abstract of his doctoral thesis entitled *SKETCHPAD, A Man Machine Graphical Communication System*,[1] Sutherland wrote:

> It is easy to add entirely new types of conditions to Sketchpad's vocabulary. Since the conditions can involve anything computable, Sketchpad can be used for a very wide range of problems. For example, Sketchpad has been used to find the distribution of forces in the members of truss bridges drawn with it.

Figure-1: *Ivan Sutherland's SKETCHPAD. The user "sketches" on a 7 by 7 inch scope device with a 1024 by 1024 raster using a light pen and presses command buttons with the second hand*

Source: *"Vision and Reality of Hypertext and GUIs: 3.1.2. Sketchpad - mprove.de" Available at: http://www.mprove.de/diplom/text/3.1.2_sketchpad.html.*

THE CLERK

A widely shared rhetoric in the first years of CAD, was the claim that the computer would liberate the designers from the tedious, quantitative tasks involved in design, thus allowing them to channel their energy towards the truly creative parts of the design process. An indicative example of this approach was Walter Gropius' intervention in the 1964 conference *Architecture and the Computer*.[2] As denoted by its title, the conference sought to map the implications of this powerful new machinery in the discipline of Architectural Design. One year after SKETCHPAD, Gropius, founder of the Bauhaus school and of the renowned Cambridge-based architectural firm *The Architect's Collaborative* (TAC), would advocate for the imperative to make an intelligent use of computational tools "as means of superior mechanical control," offering "ever-greater freedom for the creative process of design."[3] The conceptual basis of this optimistic claim was a partitioning of the design process into a set of "objective," quantitative tasks on the one hand, and intuitive, qualitative creative processes on the other. In this fundamental divide, the computer would play the role of a sedulous slave in the service of the designer, performing measurements and calculations, faster and more efficiently than its human master.

As soon as the computer entered the ecosystem of the architectural firm, this division was transformed from a source of optimism to the cause for a widespread disillusionment, questioning the relevance of the machine to the important questions of the discipline. Before forming a boisterous critique, shared amongst designers, this concern had been prophetically framed by the American architect Christopher Alexander. In *Architecture and the Computer* Alexander had observed that in order for the computer to be truly useful for design, the important design problems should be formalized in a way that they could be input and processed by the machine. Until then, the "army of clerks,"[4] as Alexander characterized computer aids, would be of little assistance to designers.

The criticism that designers needed something more than unimaginative clerks, soon became widely shared amongst designers. One decade after the first encounters of architecture and the computer, there was already an atmosphere of a pre-mature end. The 1975 collection *Computer Aids to Design and Architecture*,[5] edited by Nicholas Negroponte, under the intention to serve as a reflective retrospective of the first decade of CAD, is infused with a climate of disillusionment, stemming both from the world of research and practice in the United States. Articles such as this of the UC Berkeley Professor Vladimir Bazjanac, with the

Figure-2: *The computer in the architectural office. The Applicon 800 System.*

Source: *Teague, Lavette. A Decade of Discovery and Development. in Reflections on Computer Aids to Design and Architecture. 1975. , ed. Nicholas Negroponte. Petrocelli/Charter.*

telling title *The promises and the disappointments of computer-aided design,*[6] narrate the transition from an enthusiastic belief to the revolutionary potentialities of the machine to the disappointment about its poor performance in the world's "messy realism." The early optimism about the wonders of CAD gave its place to skepticism and restraint about the imposition of the machine's operational modes to the designer. As is revealed by the discussions of Patrick Purcell, research fellow in the Department of Design Research at the Royal College of Art in London, or Murray Milne, at the time Associate Dean of the UCLA School of Architecture and Urban Planning, it soon became evident that in order to understand the role of computational systems in design, one should first better understand the design process itself.[7]

THE PARTNER

At the time that *Reflections on Computer Aids* were written, Nicholas Negroponte was already counting eight years of research in computer graphics in the

renowned MIT Architecture Machine (ArcMac) Group, which was later transformed into the Media Lab. From its first years of operation ArcMac offered a strong counter-point to the figuration of the computer as a clerk and oriented its efforts to the development of a system that could "assist architects with those activities they call "design" (as against specification writing, preparation of working drawings, accounting, etc...)."[8]

The Architecture Machine Group's first major work under this agenda was *URBAN 5*, a research project for computer-aided architecture jointly funded by the IBM Cambridge Scientific Center and MIT, which started in 1966. Besides the intention to actively involve the computer in the decision making processes of the designer, *URBAN 5*[9] did not fully escape the predispositions of the time about the tasks that a computer could efficiently perform, namely the performance of hard calculations and the checking of violations in constraints that exceeded the designer's cognitive capacity. However, Negroponte soon became self-critical of the rigidity of this approach and envisioned a "system (that) could really change itself to reflect the design attitudes of a particular designer."[10] This realization reoriented the ArcMac's efforts to an area which would later become the epitome of the Group's work: *interaction*.

The computer vision experiments which were at the time being conducted in the Artificial Intelligence Department at MIT, opened new possibilities for Computer Aids, which were explored in the first book publication of the Architecture Machine Group entitled *The Architecture Machine: Toward a More Human Environment*.[11] *The Architecture Machine* presented the vision of interconnected personal, "domesticated" machines connected to a central host, which would surpass the role of the clerk (ie. a problem solving device) to rise to the level of a problem worrying partner. Through just-in-time interventions, responsive to the designer's idioms and idiosyncrasies, the machine would allow the architects to think simultaneously of the very big (global constraints) and the very small (local needs and desires), thus leading to what Negroponte characterized as a "humanism through intelligent machines,"[12] where the machine would "exhibit alternatives, suggestions, incompatibilities and oversee the urban rights of individuals."[13]

Influenced by the techno-humanistic cybernetic visions of a harmonious synergistic relationship between men and machines, which were floating in the MIT air in the 1960s and 1970s, Negroponte proposed a model which surpassed the rigid division of labor in the design process and called for a partnership between the computer and the designer. The idea of man-computer symbiosis, borrowed by JCR Licklider's highly influential

Figure-3: *URBAN 5's overlay and the IBM 2250 model 1 cathode ray-tube used for URBAN 5.*

Source: *Negroponte, Nicholas. 1970. The Architecture Machine: Toward A More Human Environment. Cambridge, Mass.: MIT Press.*

1960 text,[14] polemically asserted the computer not as a rigid, counterintuitive machinery, but as a tool for creative amplification: a design partner. In his 1970 article entitled *The Semantics of Architecture Machines,*[15] coauthored with Leon Groisser, Negroponte noted:

> A paradox exists in all man-machine interactions and is epitomized in the interactions between the architect and the computer. The paradox is as follows: Architects are concerned with issues generally considered to be unmanageable by computers. These issues draw upon human experiences, senses, attitudes, even idiosyncrasies, none of which are enjoyed by machines at this point in time. So the standard procedure is to partition the design task: the man is given what he is good at doing (which is usually what he enjoys), and the machine is given only those tasks it can handle efficiently.[16]

Negroponte and Groisser sought a way to render the innately syntactic informational machine sensitive to the semantics of Architecture, meaning, context and missing information, thus promoting the machine from an unimaginative slave, measuring "kips, feet, decibels, acres, coulombs," to a design partner understanding "calipers of participation, contentment, responsiveness, adaptability, diversity, resilience and so on."[17]

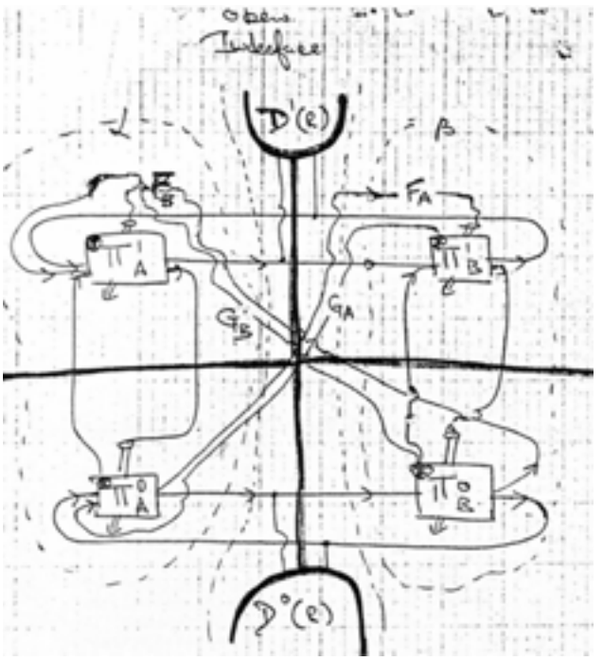

Figure-4: *Gordon Pask's sketch for Conversation Theory.*
Negroponte, Nicholas. 1975. Soft architecture machines. Cambridge, Mass.: MIT Press.

The interface became the key to surpassing the syntax-semantics dichotomy and to re-establish the lost unity of the design process. Through numerous research proposals, with the most robust being the 1976 Proposal to the National Science Foundation entitled *Graphical Conversation Theory*,[18] ArcMac outlined the maxims of a successful interaction between the designer and the computer and developed haptic and visual interfaces allowing the designer to interact as fluidly as possible with the machine, without being stifled by denatured formalizations.

> This disjunction is cumbersome but can be alleviated by the nature of the so called interface between the two protagonists. [...] They (researchers) are trying to make it approach the interface with which we are familiar in human discourse. Thus we work on interfaces, not only the interface between computer and architect, but also the interfaces between the machine and the nonprofessional.[19]

THE WIZARD

The shattering of the hierarchical, master-slave relationship between the designer and the computer, opened the door to speculation about a radical re-diagramming of the design process and the role of its actors. The abolition of the boundaries between the professional architect and the non-expert user dominated the work of the Architecture Machine Group in the first half of the 1970s. Apart from the operation of this rhetoric as a challenging motivation for taking the enterprise of creative amplification through computers to its conceptual and technical limits, this vision was heavily influenced by a zeitgeist which denounced architectural professionalism as morally suspect and envisioned the design of systems and platforms which would allow for personal liberty and creative individualism. Drawing references from sources as diverse as cybernetics, participatory design and advocacy planning, the counterculture movement in the United States and the radical megastructural fantasies in Europe and Asia, the Architecture Machine Group engaged with the agenda to empower people to shape their own environments through resilient computational infrastructures.[20]

Inspired by a rave optimism on the potential of Artificial Intelligence, ArcMac started with the ambitious vision of the Architecture Machine as a self-configuring, "intelligent" environment, able to sense and respond to the user's most intimate desires. This prospect was presented in the *Design Participation Conference*, organized in September 1971, by the Design Research Society in Manchester.[21] The Architecture Machine Group's paper entitled *Aspects of Living in the Architecture Machine* discussed the idea of a "responsive architecture" as a concept which "takes both movements (computation and participation) to their limiting cases; in some sense invalidating the corner stones of their existence."[22] The imminent, seamless spatialization of the user's design intentions, prior even to their verbalization, seemed like pure wizardry. A wizardry, however, which as Negroponte admitted in his 1975 book Soft Architecture Machines,[23] remained yet distant.

THE SURROGATE

Setting aside the vision of the "Wizard machine,"[24] Negroponte returned to the idea of a creative amplifier, this time partnering not with the professional designer, but with the non-professional user of architecture. The moral rhetoric accompanying the ArcMac's Group attack to the opportunistic interpretations and simplifications of the professional architect, imposed additional constraints to the conception of the "design amplifier." The

role of the machine was to empower non-expert users, who knew very little about design but plenty about their living preferences, to spatialize their intentions and produce their own designs. The success of the entire enterprise was therefore contingent on the non-paternalistic partnership between the non-expert user and the machine. In *Soft Architecture Machines*, Negroponte assigned to the computer the role of simultaneously a "benevolent educator" and a "thirsting student,"[25] whose goal was to establish a mutual understanding with the user by interacting with him in a visual and verbal manner. By making inferences on the user's sketches and statements the computer would ideally be able to construct a model of the user and therefore operate as his surrogate, his expert alter ego, his own native architect.[26] In the *Soft Architecture Machines* model, a fleet of interconnected design amplifiers, controlled by Architecture Machines, forms an omnipresent cybernetic system of user surrogates negotiating the user individual desires and global criteria pertaining to the sustainability of the urban whole.

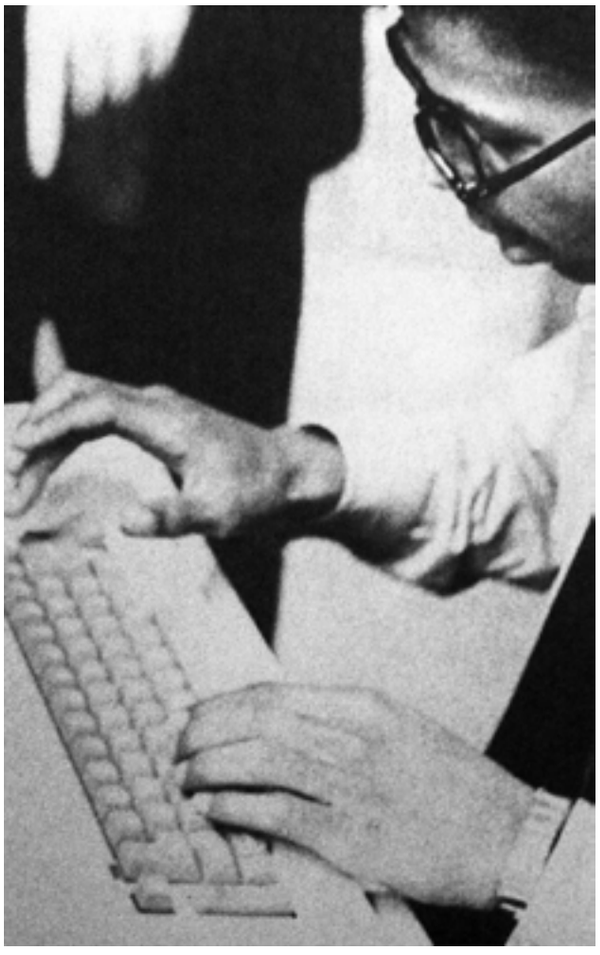

Figure-5: *Computer Aids to Participatory Architecture, by the MIT Architecture Machine Group.*

Source: *Negroponte, Nicholas and Leon Groisser. 1971. Computer Aids to Participatory Architecture. [Principal Investigators: Leon Groisser and Nicholas Negroponte]. Cambridge, Mass: Massachusetts Institute of Technology.*

THE ACCOUNTANT

Besides Negroponte's meticulous analyses in support of the non-paternalistic claims that he made for his system,[27] the dominating agency of the machine was inevitably a source of discomfort. After assassinating the professional architect, the computer came back as a bearer of good intentions, issuing promises of neutrality and objectivity. The Hungrarian-born architect Yona Friedman, one of Nicholas Negroponte's main influences in his shift toward design participation, offered a counterpoint in the figuration of the machine as a decision-making agent in design participation. In his chapter on Urban Mechanisms, in the book *Toward a Scientific Architecture*,[28] which formed the main conceptual diagram and technical basis for the "Design Amplifier prototype, Yona Friedman envisioned the machine as an "*accountant*" objectively recording personal and collective histories and feeding them back to users and communities without "agency" or "intelligence". Friedman's data-centric discourse on urban mechanisms ("accountant's point of view") which could be read as a prophetic precedent of the currently popular discussions of the "real time city." The constantly fluctuating map of the city updated in real time by the flows of the city's inhabitants on the existing physical networks and their constantly shifting preferences, could act as a "city barometer." This source of data would inform the urban inhabitants about the effect that their design decisions or even use of the fabric of the city can have to the system as a whole and allow them to trace recurring patterns and develop personal and collective anticipatory mechanisms. The accountant just kept the books; it was up to the inhabitants to own and manage the data in order to reflect on the implications of their past actions and plan their collective futures.

EPILOGUE

Almost forty years after the collection Reflections on Computer Aids to Design and Architecture was featuring the question: "A new concept of architecture or just a quicker working method?"[29] written in a speech bubble coming out of a dinosaur-shaped metallic skeleton, the analysis and critique of such early computational anthropomorphic

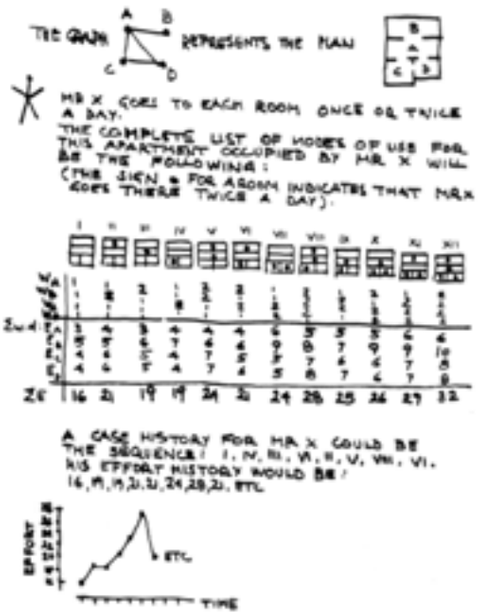

Figure 6: *Monitoring of user habits in Yona Friedman's FLATWRITER machine.*

Source: *Friedman, Yona. 1975. Toward a Scientific Architecture. Trans. Cynthia Lang. Cambridge, Mass.: MIT Press.*

metaphors can offer ways to problematize the brand "computational design" and to rethink the computer's role in the intricacies of design. The figurations of the "clerk," the "partner," the "wizard," the "surrogate" and the "accountant," engendered by the intensive encounter of the accustomed processes of design and the new entity of the machine, offer a repertoire of rich metaphors, which condense an amplitude of visions, questions and tensions worthwhile revisiting today. By looking at these proto-computational narratives one can expose the cultural and historical origins of current computational fantasies and compare them with their historical doppelgangers. The growing computational evangelisms of the potentialities of intelligent environments, smart cities, open data management, bottom up participation reflect echoes from the past, besides their appearance of unprecedented novelty, of an a-chronic here and now. At the same time, discourse around new types of computational tools, which seek to upgrade the computer from an electronic pencil to that of a design aid, offering structured, hierarchical representations, can perhaps benefit from the evolution of a history which departed from the same point more than half a century ago, to spiral back to where it started.

"Computational Design" is an intensive term, it contains an internal contradiction between two worlds -which at least in their current conceptual and practical definition- appear different in nature; one discrete, combinatorial and explicit and one continuous, fluid and unenunciated. Departing from the canonical and naturalized conceptions of the term it is time perhaps to engage in the difficult conceptual exercise of understanding this internal tension and develop platforms and ideas to negotiate it. In this quest, the thousand faces of the computer can serve as thought experiments allowing us to untangle this tension, by revisiting, recasting, reinventing them.

ENDNOTES

[1] Sutherland, Ivan. SKETCHPAD, A Man Machine Graphical Communication System. PhD Massachusetts Institute of Technology, 1963.

[2] Gropius, Walter. 1964. Computers for Architectural Design. Paper presented at Architecture and the Computer, Boston, Massachusetts.

[3] Ibid.

Figure 7: *"A new concept of architecture or just a quicker working method?"*

Source: *Weber, Jos. Denmark, Holland, Germany. in Reflections on Computer Aids to Design and Architecture. 1975. , ed. Nicholas Negroponte. Petrocelli/Charter.*

[4] Alexander stated: "A digital computer is, essentially, the same as a huge army of clerks, equipped with rule books, pencil and paper, all stupid and entirely without initiative, but able to follow exactly millions of precisely defined operations. [...] In asking how the computer might be applied to architectural design, we must, therefore, ask ourselves what problems we know of in design that could be solved by such an army of clerks [...] At the moment there are very few such problems." Alexander, Christopher. 1964. A Much Asked Question About Computers and Design. Paper presented at Architecture and the Computer, Boston, Massachusetts.

[5] Negroponte, Nicholas (ed.). 1975. Reflections on Computer Aids to Design and Architecture. Petrocelli/Charter.

[6] Bazjanak, Vladimir, 1975. The promises and the disappointments of computer-aided design. Ibid., 17-267 Purcell, P., 1975. United Kingdom. Ibid., 207-233.

[7] Milne, M., 1975. Whatever became of design methodology. Ibid., 30-36.

[8] Negroponte, Nicholas and Leon Groisser. 1971. Computer Aids to Participatory Architecture. [Principal Investigators: Leon Groisser and Nicholas Negroponte]. Cambridge, Mass: Massachusetts Institute of Technology, 58.

[9] Negroponte, Nicholas and Leon Groisser. 1970. URBAN 5: A Machine That Discusses Urban Design. In Emerging Methods In Environmental Design And Planning., ed. Gary T. Moore. Cambridge, MA: MIT Press.

[10] Negroponte and Groisser, Computer Aids to Participatory Architecture, 59.

[11] Negroponte, Nicholas. 1970. The Architecture Machine: Toward A More Human Environment. Cambridge, Mass.: MIT Press.

[12] Ibid., 1.

[13] Ibid., 7.

[14] Licklider, J. C. R. 1960. Man-Computer Symbiosis. In IRE Transactions on Human Factors in Electronics HFE-1 4-11.

[15] Nicholas Negroponte and Leon Groisser. 1970. Sector: The Semantics of Architecture Machines. Architectural Design, XL, 466-9.ü

[16] Ibid.

[17] Ibid.

[18] Massachusetts Institute of Technology. Architecture Machine Group. 1976. Computer Mediated Inter- and Intra- personal Communication. Cambridge, Mass.: Massachusetts Institute of Technology, Dept. of Architecture, Architecture Machine Group.

[19] Negroponte and Groisser, The Semantics of Architecture Machines.

[20] Negroponte and Groisser, Computer Aids to Participatory Architecture.

[21] The Conference was organized by Nigel Cross, in collaboration with Chris Jones and Reg Talbot. Cross, Nigel (ed.) 1972. Design Participation. Academy Editions.

[22] Negroponte, Nicholas. 1972. Aspects of Living in an Architecture Machine. Ibid., 63-67.

[23] ———. 1975. Soft architecture machines. Cambridge, Mass.: MIT Press.

[24] Ibid., 108.

[25] Ibid.

[26] From 1973-1975 the Architecture Machine Group launched a computer aided participatory design research program entitled "Architecture by Yourself." The computer program that was being developed was named YONA, an acronym standing for "Your Own Native Architect" and of course referring to the intellectual father of the entire enterprise, the architect Yona Friedman, who also participated in the research program. See: Architecture Machine Group. 1978. Architecture Machinations: A Weekly Newsletter of the Architecture Machine Group. Cambridge, Mass.: MIT Department of Architecture.

[27] An analysis of the discursive role of the "design amplifier's" computational structure in Nicholas Negroponte's non-paternalistic claim can be found in my thesis for the Master of Science in Architecture Studies, Design and Computation Area at the Massachusetts Institute of Technology, advised by Professor George Stiny. The thesis is cited as follows: Vardouli, Theodora. 2012. Design-for-Empowerment-for-Design: Computational Structures for Design Democratization. S.M., Massachusetts Institute of Technology, Dept. of Architecture.

[28] Friedman, Yona. 1975. Toward a Scientific Architecture. Trans. Cynthia Lang. Cambridge, Mass.: MIT Press.

[29] Weber, Jos. Denmark, Holland, Germany. In Negroponte (ed.), Reflections on Computer Aids, 257.