# Design-for-Empowerment-for-Design: Computational Structures for Design Democratization

by

Theodora Vardouli

Diploma in Architectural Engineering
National Technical University of Athens, Greece, 2008
Post-Graduate Diploma in Architectural Design - Space - Culture
National Technical University of Athens, Greece, 2010

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN ARCHITECTURE STUDIES
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JUNE 2012



Signature of Author:________________________________________

Theodora Vardouli
Department of Architecture
May 22, 2012

Certified by:________________________________________

George Stiny
Professor of Design and Computation
Thesis Advisor

Accepted by:________________________________________

Takehiko Nagakura
Associate Professor of Design and Computation
Chair of the Department Committee on Graduate Students

Terry Knight
Professor of Design and Computation
Thesis Reader

Arindam Dutta
Associate Professor of the History of Architecture
Thesis Reader

# Design-for-Empowerment-for-Design: Computational Structures for Design Democratization

by

Theodora Vardouli

Submitted to the Department of Architecture
on May 22, 2012 in Partial Fulfillment of the
Requirements for the Degree of Master of Science in
Architecture Studies

ABSTRACT

The vision to engage non-architects in the design of their habitat through the mediation of computer aids, dates back to the early computational era (1960s-1970s) and is currently being recast under cyber-cultural and technological influences. The computational tools enabling this architectural do-it-yourself-ism have been traditionally conceptualized as mediating "infrastructures:" neutral and non-defining control systems, which ensure the validity of the designs produced by the non-expert users without distorting their personal hypotheses. Through a critical comparative analysis of two basal computational systems for design "democratization," as discussed in Yona Friedman's and Nicholas Negroponte's early 1970s writings, this thesis illustrates that the "infrastructure" metaphor was engendered and still resides in a positivist paradigm of design, allowing for little freedom or intuition on behalf of the user. Rather than denouncing the internal contradictions of the "structure for freedom" model, this thesis inquires into the computational structures of Friedman's and Negroponte's proto-computational proposals in order to identify and critique the assumptions which underpin their optimism about the non-paternalistic character of their control systems. By exposing the discursive role of the internal workings of the two systems in their authors' arguments, along with their cultural and historical biases, this research aims to problematize inherited approaches to computational tools for user empowerment in design which persist until the present, and to hint to new programmatic agendas.

Thesis Advisor: George Stiny
Title: Professor of Design and Computation

# Acknowledgements

George Stiny for the unique intellectual stimulation, ideas and provocations throughout this research. I feel deeply indebted to him for his confidence in my work and for his active involvement in my explorations. His new ways to look at things have decisively shaped my approach to Design and Computation and inspired future trajectories of research.

Terry Knight for her insightful guidance, close collaboration and valuable advice, which have been key in forming the foundations of my inquiry into Design and Computation. Her comprehensive feedback has been a constant motivation for improvement in this thesis and throughout my studies in SMArchS.

Arindam Dutta, for his astute critique and for providing me with an armature of tools and methods to pursue this research. His questions and arguments have been key in problematizing the "humanizing" and "democratizing" claims of technology.

Patrick Winston, for his invaluable academic and personal support, which defined my experience at MIT. The breadth and depth of his visions and questions regarding the infinitely interpretable idea of "intelligence," has been a continuous source of inspiration for inquiry into cognition, perception and computation. I am grateful for his trust in selecting me as his teaching assistant and for making my interview with Yona Friedman possible.

Leah Buechley for immersing me into the questions of user empowerment in design since my first days at MIT and for guiding my investigations in the "open source everything" trends. She has been a valuable collaborator, co-author and co-traveler throughout my graduate studies. I am thankful to her for preparing the ground for my encounter with Nicholas Negroponte.

Yona Friedman for accepting me in his home in Paris and gratuitously sharing with me stories, anecdotes and contemplations on his life's work. His visionary books and projects have formed the landscape of my research since my studies in Athens, allowing me to dream of Architectures of another world.

Nicholas Negroponte for twice fitting me in his busy schedule and for transferring me back to his early explorations with the Architecture Machine Group. His input was crucial in weaving a network of people and ideas who played a leading role in shifting of the computational metaphor toward visions of humanism and creativity.

Guy Weinzapfel for offering me details and trivia about his collaboration with Nicholas Negroponte and Yona Friedman at the Architecture-by-Yourself project at MIT. His comprehensive descriptions were valuable historical material for this research allowing for new connections and associations between its protagonists.

The Fulbright Foundation in Greece, the Alexander S. Onassis Public Benefit Foundation, the Leventis Foundation and the MIT Department of Architecture, for financially supporting my studies at MIT.

Everyone in the Design and Computation Group, in the SMArchS and PhD Program, for creating the rich intellectual climate which fostered this research.

My dear friends and colleagues from the 2012 Class of the Design and Computation Group, for the wonderful discussions and exchanges which made every day of these past two years count. Thank you Carolina, Katia, Sarah, Carl, Will, Moritz, Josh, Alan and Masoud, for your continuous support during these two years.

All the members of the 2012 Read DCG for the generous sharing of their thoughts and ideas which helped shape new pathways in this thesis. Special thanks to Daniel, Onur, Asli and Moa for their friendship and insight on my research.

My sister Rodanthi for always impressing me with her sharp comments. This thesis would not have been the same without our endless conversations.

My parents, Dimitris and Fani, for their love and support and for making everything that I do now possible.

This thesis is dedicated to my family.

# *Design-for-Empowerment-for-Design: Computational Structures for Design Democratization*

# Table of Contents

# *01. Introduction*

## 1.1. Hypothesis

The cyber-cultural rhetoric of "democratization"[1] is stimulating architectural speculation. The climate of collaboration and creative individualism cultivated by the Free/Libre Open Source (FLOSS) movement,[2] has been offering a fertile ground for the emergence of new processes of design, where users also become the producers of the artifacts they use. The new diagrams of production, distribution and use of knowledge and artifacts which are being engendered in this process do not cease in software, but are currently expanding to all the domains of design.

Within this climate, online connectivity, increasing technological literacy, and advancements in design and fabrication technologies, have made possible to imagine a process where groups and individuals acquire direct access to the shaping of their environments. Current technological possibilities, from responsive environments to design tools for non-experts, seem capable of accommodating the emerging demand for user-centric processes of architectural design.

These cultural shifts and technological potentials coalesce with a growing skepticism of the relevance of the professional architect's role to pressing problems of the built environment, such as mobility, urbanization or sustainability.[3] At the same time, the inert and inflexible housing industry proves incapable to respond to the accelerating rhythms of change in housing needs and the increasing demand for personalization of habitats. The idea of an Architecture which can accommodate the needs and values of its users emerges as the antidote to the discontents caused by the social, cultural and environmental unresponsiveness of the built environment.

The expanding culture of do-it-yourself-ism, the growing accessibility and potency of computational tools, and the demand for a user-responsive Architecture as a viable alternative to the stagnant building industry, have brought the discussion of the user-as-designer to the forefront of architectural discourses. Research projects, professional practices and independent initiatives have started identifying with the vision of an inclusive, user-centric approach to Architecture, supported by a resilient infrastructure of design, fabrication and communication technologies. The examples of this tendency are numerous: they range from design engines for the configuration of one's living space (e.g. Open Source Building Alliance[4], Blu Homes[5], Wikihouse project[6] etc.) to "intelligent" urban and domestic environments which respond to user activity.

Besides the diversity of their intentions and implementations, these projects share the common vision to employ computation and information technology as a means to empower non-expert users to shape their environments, with little or no mediation from the

1. "Democratization" refers to the process of making something "democratic," by removing barriers of access and allowing "everyone" to participate in decision making. The term, with as many interpretations as its uses, can refer to information, technology, design and production of personal and collective artifacts etc.

2. Free/Libre and open source software: Survey and study. 2005 [cited May/04 2012]. Available from http://www.flossproject.org/.

3. Kaspori, Dennis. 2003. A communism of ideas: Towards an architectural open source practice. *Archis 3* : 13-7.

4. Larson, Kent, Stephen Intille, Timothy Mcleish, Jennifer Beaudin, and Reid Williams. 2004. Open source building: Reinventing places of living. *BT Technology Journal 22* (4) (October 2004): 187-200.

5. Blu homes. [cited May/04 2012]. Available from http://www.bluhomes.com/.

6. WikiHouse / open source construction set. [cited May/04 2012]. Available from http://www.wikihouse.cc/.

7. "Access to tools" was the subtitle of the *Whole Earth Catalog*, a widely circulated and highly influential countercultural periodical circulating in the years 1968-1971. In the Catalog the term "tools" contains "anything useful as a tool, relevant to independent education, high quality or low cost, easily available by mail."
Portola Institute. 1968. *Whole Earth Catalog*. CA : Menlo Park, 2.

architect. This discourse is underpinned by the assumption that "access to tools"[7] can make everyone his/her own designer, thus promoting intuitive, creative and sustainable solutions.

In these re-emerging technological evangelisms, issues of "access" are widely discussed, from the licensing and distribution of technological tools, to their social and cultural inclusivity. However, there is little or no reference to the aspect of the design of the "tools" themselves. This "black box"[8] attitude is pervasive in the way computational systems are approached: their internal workings are frequently overlooked as technicalities, thus limiting their critical assessment to the benevolent (or not) intentions of their authors. This excludes questions pertaining to the computational structures of the tools, which are nonetheless crucial for the critical evaluation of their liberating and democratizing promises.

A computational tool for user empowerment in design is itself designed. It therefore encodes the toolmaker's (designer's) assumptions about what design is, and about how it can be made accessible to the non-expert user. At the same time, it establishes a set of affordances and constraints which set the boundaries of the user's operation.[9] If this is the case, does the designer, self-exiled from the design process, still exert authorial control on the future user under the disguise of an allegedly neutral computational tool? How do we design-for-empowerment-for-design avoiding the conflict between democratizing intentions and highly controlling implementations?

In order to address these questions, which are of increasing cultural and technological relevance, inquiry into the computational structures of the tools for user empowerment in design is essential. In this thesis, the term "computational structure" is used to refer to the internal mathematical representations of a computational tool, as well as to its interaction protocols with the user.

The design of tools for user empowerment in design is a hard conceptual problem. It implies the design of a computational system which can resolve the unpredictable subjectivities of its users into built form without distorting them with external assumptions, and can negotiate potential conflicts between the individual and the collective. A careful scrutiny into past and present endeavors in tools for architectural do-it-yourself-ism, reveals the persistence of models of computer-aided design participation, which emerged in the early computational era and have been naturalized in current approaches. The most salient conceptual model is this of the "infrastructure:" designers transpose their control mechanisms to allegedly neutral control frameworks, on which users are invited to plug-in personal meanings and intuitions.

As the question of tools for the user-as-designer is gaining momentum in current discourses, it is essential to critically evaluate

8. The term "black box" refers to the description of a computational system in terms of input, output and transfer, overlooking its internal workings.

9. Diana Forsythe's ethnographic studies on knowledge elicitation processes for the design of expert Artificial Intelligence systems, meticulously illustrate the cultural biases which are infused in the systems by the knowledge engineers who construct their internal representations. Besides the engineers' positivist beliefs about the "conceptually straightforward" nature of their task, Forsythe's studies illustrate that the internal representations of these systems are highly influenced by the assumptions of their authors. Forsythe, Diana. Engineering knowledge: The construction of knowledge in artificial intelligence. *Social Studies of Science.* 23 (3). 445-77

the ambivalent assumptions which underpin the optimism around the pervasive computational metaphor of the "infrastructure," and to question its conceptual adequacy for the enterprise of design "democratization." The argument of this thesis is that, besides the liberating proclamations which accompany it, the "infrastructure" allegory of control resides in a positivist paradigm of design, allowing for little freedom or intuition on behalf of the user. This hypothesis will be supported by a critical comparative analysis of two basal discourses of design democratization, which will problematize the cultural and historical biases of the "infrastructure" model, and identify the ambivalence between its liberating promises and its positivist operations.

## 1.2. Method

Besides its recent appearance in the architectural actuality, the optimism of a do-it-yourself Architecture, where professional intermediaries are removed from the process of design, presents a rich historical precedence. Its roots can be traced in the mid 1960s - mid 1970s international vogue of participatory design, a term with as many interpretations as its advocates. The concept of a technologically enhanced architectural do-it-yourself-ism[10] emerged as a radical version of participatory design, in a context reminiscent of current phenomena: a cultural climate promoting individualism and personalization, new technological possibilities ranging from novel structural systems to the emergence of the computer, and a demand for personally responsive, socially and ecologically "sustainable" environments.

Within this context, the question of how to design computational systems which can allow users to spatialize their needs and desires without translations or distortions, was systematically articulated by a plethora of researchers in the United States and in Europe. The more than twenty renowned participants of the 1971 Conference on *Design Participation*, organized by the Design Research Society in Manchester, are only part of a larger scene which adopted an anti-professional discourse. Individuals like the French architect Yona Friedman, the American architecture critic Reyner Banham, Nicholas Negroponte and Bill Mitchel from the Massachusetts Institute of Technology, and Nigel Cross from the Open University, all participants of the *Design Participation* Conference, shared similar concerns with Christopher Alexander in the United States, John Habraken from the Netherlands and many others.

The proposal of this thesis to revisit the basal discourses of design democratization is not a symptom of nostalgic retro-futurism, nor does it imply undisturbed continuities between the early computational era and today. The hypothesis is that research

10. The term is used by Reyner Banham in the Design Participation Conference of the Design Research Society's in Manchester in 1971. Nicholas Negroponte also uses this term in *Soft Architecture Machines* to describe Yona Friedman's model of design participation. Banham, Reyner. 1972. Alternative networks for the alternative culture. In *Design participation.*, ed. Nigel Cross. Academy Editions ed., 15-19, and Negroponte, Nicholas. 1975. Computer-Aided participatory design. In *Soft architecture machines.*, 92-129. Cambridge, Mass., and London, England: MIT Press, 101.

11. Friedman, Yona. 1975. *Toward a scientific architecture.* Trans. Cynthia Lang. Cambridge, Mass.: MIT Press.

12. Negroponte Nicholas, and Leon Groisser. 1971. *Computer aids to participatory architecture.* [Principal Investigators: Leon Groisser and Nicholas Negroponte]. Cambridge, Mass: Massachusetts Institute of Technology.

13. Negroponte, *Nicholas. 1975.* Computer-aided participatory design. In *Soft architecture machines*. 92-129. Cambridge, Massachusetts, and London, England: MIT Press.

into this transitional stage, when the concepts of computation, "democratization" and Architecture are first brought together, can problematize the boundaries between these terms, thus reviving questions which have been effaced because of their long coexistence.

**Figure 1.** A copy of the French edition of *Toward a Scientific Architecture* in Yona Friedman's library in Paris [photo: Theodora Vardouli]

**Figure 2.** A copy of the NSF proposal *Computer Aids to Participatory Architecture* from Nicholas Negroponte's Archive [photo: Theodora Vardouli]

This thesis presents a critical comparative analysis of two early proposals for design "democratization" as they are described in Yona Friedman's book *Toward a Scientific Architecture*[11] and the Architecture Machine Group's National Science Foundation (NSF) Proposal *Computer Aids to Participatory Architecture*.[12] The latter proposal was then condensed in the third chapter of Nicholas Negroponte's book *Soft Architecture Machines* entitled *Computer-Aided Participatory Design*.[13] The productivity of a "dialogue" between these two seminal figures is supported by their importance in the construction of the concept of design "democratization," by the different cultural contexts that they represent, and by their collaboration in the 1973-1975 *Architecture-by-Yourself* Program at the MIT Architecture Machine Group.[14]

Both Friedman and Negroponte proposed architecture "machines" in order to empower future users to create their own designs without the architect-as-middleman, with the motto "every man his own architect."[15] This invites a question which is crucial in the evangelisms of design democratization: When the architect is replaced by a machine, is the architect's paternalism also replaced by a machine paternalism? Or conversely: how do the two authors argue that they have devised a "non-paternalistic"[16] computational system, which allows the future users to express their own hypotheses into the production of a design, without distortions or external interpretations?

This thesis addresses the computational structures of the "machine" as "machine intentionalities." This perspective offers both a tool for analysis of the arguments of authority and democracy in Friedman's and Negroponte's proposals, and a tool for critique of the democratizing proclamations of the two proposals through the identification of tensions between intentions and implementations; what the authors say and what the "machines" do.

The analytical axis of this thesis is centered around the question: What role do specific computational representations play in the two authors' arguments about the "non-paternalism" of their systems? Where does the optimism around the "neutrality" of these computational representations stem from? The critical axis of this thesis revolves around the problematization of this optimism, the questioning of the "neutrality" or "naturality" of these representations.

The persistence of these structures in the current conceptions of design-for-empowerment-for-design, makes these questions relevant to current discourses. Inquiry into the first encounters of

14. Weinzapfel, Guy, and Nicholas Negroponte. 1976. Architecture-by-yourself: An experiment with computer graphics for house design. Paper presented at *Proceedings of the 3rd annual conference on Computer graphics and interactive techniques*, Philadelphia, Pennsylvania.

15. Negroponte, *Soft architecture machines*, 100.

16. Ibid., 102.

computation and design participation is therefore proposed as a way to develop critical frameworks of re-emerging computational evangelisms, and to devise new programmatic agendas and computational methods promoting user empowerment and design "democratization."

## 1.3. Steps

The main body of this thesis is developed in five steps: Problem Statement; Method; History; Description; Analysis and Reflections. Chapter 2, *Problem Statement*, expands on the introductory observations on the cultural and technological context in which the vision of user empowerment in design is being re-activated. The discussion is initiated with a reference to broader cyber-cultural trends which are promoting a rhetoric of "democratization." The FLOSS movement is presented as producing a metaphor for a new user-centric approach to design with impact beyond the software. The chapter continues with specific examples of the appropriation of the Open Source metaphor in architectural discourses, followed by technological speculations on tools for user empowerment in design, in order to identify their challenges and pitfalls. These discussions lead to the question: How does one design-for-empowerment-for-design?

Chapter 3, *Method*, discusses the way that this thesis proposes to address this question. The term "digital liminal"[17] is proposed to denote the importance of inquiry into the basal discourses of design "democratization" in order to inform current questions. This chapter also discusses the limits and motivations of this method, and analyzes some reasons that Yona Friedman and Nicholas Negroponte have been selected as the protagonists of this inquiry.

Chapter 4, *History*, presents a historical narrative on how Yona Friedman and Nicholas Negroponte developed the vision of a technologically enhanced architectural do-it-yourself-ism. The goal of this chapter is to trace the cultural and historical contexts in which the authors operated, the influences they accepted, and the potent impact of their work, which establishes them as foundational actors in the field of computational tools for user empowerment in design. This historical account is intensified around the time when the two authors produce *Toward a Scientific Architecture* and the two connected proposals on computer-aided participatory design, respectively. For this historical account invaluable material is drawn from personal interviews with Yona Friedman, Nicholas Negroponte and Guy Weinzapfel (project manager of the *Architecture-by-Yourself* Program at the MIT Architecture Machine Group).

Chapter 5, *Description*, focuses on Yona Friedman's *Toward a Scientific Architecture* and Nicholas Negroponte's texts on

17. Inspiration for this name is drawn from the concept of "liminality," as it was articulated by the British cultural anthropologist Victor Turner.
See: Turner, Victor Witter. 1967. Betwixt and between: The liminal period in rites de passage. In *The Forest of symbols*. Ithaca, N.Y.: Cornell University Press.

18. Levi-Strauss, Claude. 1954. The mathematics of man. *International Social Science Bulletin* 6 (4): 581-90.

computer-aided participatory design. The outline of the authors' arguments is followed by an abstraction of the basic operational diagrams of the proposed computational systems for the "democratization" of Architecture. This chapter illustrates that besides significant differences in their theoretical approaches to the interaction of the non-expert user with the machine, the two authors adopt similar mathematical representations in order to resolve the user's intentions into built form.

This observation leads to chapter 6, *Analysis,* where the two proposals are compared and contrasted, in an abstracted, diagrammatic form. The analysis focuses on the way that the two authors articulate their promises of "non-paternalism" with respect to the computational structures of their systems. The purpose is to expose the assumptions which allow the authors to reconcile a desire for positivist control with their emancipatory and democratizing proclamations, drawing references from broader epistemological and philosophical debates of the time. This chapter illustrates the two authors' structuralist approach of design, where the mathematical representation of the graph, as a new kind of "qualitative mathematics,"[18] operates as the symbol of both scientific objectivity (Friedman) and intuitive subjectivity (Negroponte).

Finally, chapter 7, *Reflections*, presents a critical analysis of the signification of these computational representations, and proposes a way to use this critique to reflect on current proposals in the field of design-for-empowerment-for-design. This last chapter of the thesis main body ends with hints towards an alternative computational analogy for the vision of design "democratization."

## 1.4. Intended contributions

This thesis aims to engage three different kinds of readers. For the skeptics of the democratizing evangelisms of computation and information technology, this thesis intends to offer additional ways to problematize the enterprise of tools for the user-as-designer through inquiry into the cultural and historical context in which it was engendered. For the technological optimists, this thesis aims to provide a clearer characterization of the problem of design-for-empowerment-for-design, and identify open questions allowing for its re-conception. For the "toolmakers," this thesis aims to problematize the debates around the "openness," "neutrality" and "naturality" of computational models thus perhaps offering points of departure to reflect on alternative models of computation for the participatory enterprise.

# *02.Problem Statement:*
## *Cyber-cultural trends and design democratization*

*Foreword for Chapter 2*

This chapter frames the cultural and technological relevance of the question of the user-as-designer and reviews tools which are currently being developed to address it. The chapter is initiated with a broad discussion on how the Open Source metaphor activates visions of "democratization" in fields beyond software. These general observations are illustrated through examples of appropriations of the Open Source rhetoric in architectural discourses, which provide an idea of the tone, scope and content of contemplations on how and why processes of design should be remodeled. These examples indicate how an extra-disciplinary vision (Open Source) reinvigorates a latent disciplinary question in Architecture (user participation in design), bringing to the surface a re-emerging technological optimism. Following the outline of the promises of this emerging cultural trend, the inquiry proceeds into a series of technological platforms which are developed to fulfill them. A review of the methodologies of these tools, however, indicates a shortage of ideas and a reductive approach to design, calling for new conceptual and computational agendas.

## 2.1. Some observations on Open Source culture

In 2004 David Bell compiled an alphabetical list of key concepts in order to provide an extensive definition of the complex and fast-changing term "cyber-culture."[19] The list included terms such as "access," "digital commons," "free software" and "open source." These terms are all contained or related with another prevalent metaphor of the network paradigm, which was absent from this cataloguing: the concept of "democratization."

"Democratization" generally refers to programs and processes which allow for an opening of fields traditionally dominated by the "select few" (professionals, proprietors etc.) to "the people." This process involves an active re-diagramming of the modes of production, distribution and use of knowledge and artifacts within these fields, supported by a technical infrastructure of tools and communication technologies.

An indicative example of this tendency is the FLOSS movement. Utilizing online connectivity and the transferability of code, FLOSS advocates for a model where individuals and collectivities can access, study and modify the technologies (software) they use. Apart from a software development methodology, Open Source serves as a potent metaphor for online collaboration and creative individualism.

19. Bell, David. 2004. *Cyberculture: The key concepts*. New York: Routledge.

Following the prophetic statement “Information wants to be free” made in the first Hacker’s Conference in 1984 by the prominent countercultural icon Stewart Brand[20], the Open Source metaphor has spread to multiple domains of the immaterial production,[21] creating a paradigm of free sharing of code, knowledge, ideas or cultural works, within networks of collaborating peers.

As per the astute observation that “human activities become increasingly data-centric,”[22] or to use Eric von Hippel’s words, “as hardware becomes more like software,”[23] the Open Source metaphor gradually migrates to the material world. This invites speculation on new methodologies for the design and fabrication of hardware, consumer electronics, product design and recently, Architecture. Such is the potency of the Open Source metaphor, that the alleged Linus Torvalds quote “the future is Open Source everything”[24] becomes a common prospective project transcending domains and disciplines.

The figure of the “user” plays a protagonistic role in this broad rhetoric of “democratization.” From the consumer of mass produced artifacts, the user is now portrayed as an “innovator,” a “maker,” a “prod-user.” In the discourses of “democratization,” an armature of digital tools empowers users to access, study and modify the products that they use, the information that they take and perhaps, the environments that they inhabit.

This zeitgeist impacts architectural discourses and gives rise to a new wave of architectural speculation. The term “Open Source Architecture,”[25] implies a remodeled architectural process, where individuals and collectivities are able to design and modify the spaces that they inhabit. The space of architectural speculations and practices which adopt the Open Source metaphor is highly non-homogenous, containing discourses which range from a new kind of technological vernacular revisiting Alexander’s “Patterns” (P2P Urbanism)[26] to hacktivism (Hackitectura)[27]; and from discussions of efficiency and mass customization (House_n, Blu Homes) to the vision of urban and domestic “intelligent” environments, where the users operate as actuators. Besides their divergent origins and methodologies these proposals converge in their common portrayal of users-as-designers, granted direct access to the shaping of their environments through an infrastructure of design and fabrication technologies.

## 2.2. Influences and metaphors: Open Source (in) Architecture

This section presents two indicative examples of how the Open Source metaphor is appropriated in Architecture, coupled with discussions of anti-professionalism and the demand for a user-

20. Brand, Stewart. 1988. *The media lab : Inventing the future at MIT.* New York, N.Y., U.S.A.: Penguin Books. 201.

21. Lazzarato, Maurizio. 1996. Immaterial labour. In *Radical thought in Italy.*, eds. Paolo Virno, Michael Hardt, 132-146. Minneapolis: University of Minnesota Press.

22. Shirky, Clay. 2007. *Generalizing peer production into the physical world. Decentralization: Implications of the end-to-end principle.* http://finance.groups.yahoo.com/group/decentralization/message/6972

23. Thompson, Clive. 2008. Build it. share it. profit. can open source hardware work? *Wired Magazine*, http://www.wired.com/techbiz/startups/magazine/16-11/ff_openmanufacturing.

24. The quote “the future is open source everything” can be found in online sources as attributed to Linus Torvalds, the inventor of Linux, however its originality remains unconfirmed.

25. The first attempt to define the term *Open Source Architecture* can be found in Ratti, Carlo et al. 2011. Open source architecture (OSArc). *Domus* (948).

26. Peer to peer urbanism. 2011 [cited May/05 2012]. Available from http://p2purbanism.blogspot.com/.

27. Hackitectura.net. [cited May/04 2012]. Available from http://hackitectura.net/blog/.

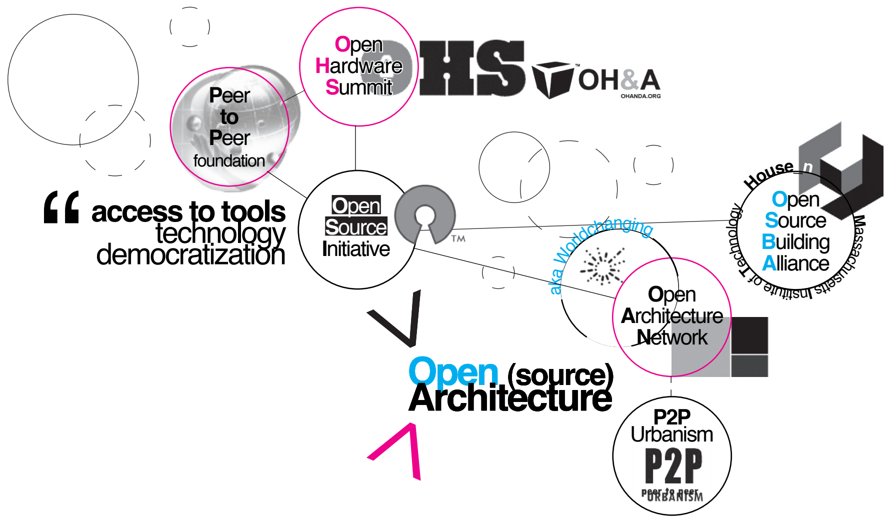



**Figure 3.** Translations of Open Source in Architecture.

centric approach to design. The texts which are employed for this purpose, are the Dutch architect Dennis Kaspori’s 2003 article *A Communism of Ideas: Towards an Open Source Architectural Practice*,[28] which was amongst the first to articulate the implications of Open Source in Architecture, and a 2010 collaborative op-ed initiated by Carlo Ratti, Director of the MIT Senseable City Lab, which is feautured as the current Wikipedia definition for the term “Opensource Architecture.”[29]

### 2.2.1. Dennis Kaspori: The developer-as-user in Architecture

Dennis Kaspori’s article entitled *A Communism of Ideas: Towards an Open Source Architectural Practice*, which appeared in Archis Magazine[30] in 2003, inaugurated the circle of speculations on the way that the ideas of Open Source can be employed to radically alter the way that Architecture is produced and used. Kaspori’s polemic starts with rejection of the architect- “visagiste” and a call for a reorientation of architectural energy to the solution of the urgent problems of the housing industry. [31] The translation of the general principles of Open Source in the field of Architecture, are discussed as presenting the opportunity for the conception of an alternative organizational model of architectural practice, which can increase the relevance of the discipline to social, political and ecological issues.

This argument builds on the idea that Open Source offers a vocabulary of concepts, which are generic enough to transcend the boundaries of software, and to migrate other fields of human activity.[32] Amongst the Open Source concepts that Kaspori isolates as radiating beyond the boundaries of code, is the shift from ownership to use value; the collapse of the divide between the “developer” and the “user.”

28. Kaspori, A communism of ideas. op.cit.

29. Ratti, Carlo et al. Opensource architecture (OSA). 2012 [cited May/04 2012]. Available from http://en.wikipedia.org/wiki/Open_Source_Architecture.

30. Archis is the predecessor of Volume, a quarterly magazine which started in 2005 as a collaboration with the C-Lab in Columbia University and OMA-AMO, headed by the renown Architect Rem Koolhaas.

31. Kaspori. A communism of ideas, 13.

32. See: Weber, Stephen. 2000. *The political economy of open source software.* Berkeley Roundtable on the International Economy. Berkeley, CA: University of California, Berkeley.

This description refers to a model where users identify their needs and accommodate them in an unmediated manner by repurposing or redesigning existing products. Kaspori claims that this process allow for the immediate satisfaction of a need once this is realized by a group of people, while it also creates a framework for innovation, through the creative recycling and recombination of ideas to produce novel and original solutions. Within this context which challenges the social and economic interpretation of the concept of innovation, artifacts are seen not as final objects but as snapshots of processes, as "toolboxes" for new production, modifiable virtually by anybody.[33]

The appropriation of this vocabulary in architectural discourse points to a remodeled spatial practice, where Architecture is not any more the exclusive principle of professionals but also "opens" to hobbyists and amateurs who engage in a creative network of collaborating peers. However Kaspori does not stop by proposing an opening of design processes to volunteers and amateurs. Open Source Architecture in his definition, has an even broader cycle of engagement:

> *And then there are the "end users" (the occupants) of Architecture. They too could have a role in the process. The fact is that the open-source process can also be an important stimulus for greater participation by residents in the spatial planning process.*[34]

The article proceeds, characteristically, to a reference to consumer-led housing, where users produce their own designs based on sets of modular standards. This model is discussed as performing a social mission, by offering the largest part of the population who cannot afford an architect the rights to "good" and personally responsive Architecture.

Kaspori's reference to the future occupant comes almost as a "natural" consequence of his speculation on a more "open" and inclusive architectural process. However, this is a significant shift from the traditional conception of Open Source, where although the process of "design" (e.g. of software) is open to the public domain, only users with some level of expertise (e.g. in coding) can actually participate. In translating Open Source to Architecture, Kaspori broadens the boundaries of the term to also include the concept of user empowerment.

Dennis Kaspori's article presents three salient ideas, pertinent to the questions of this thesis: first, an attack on architectural professionalism for making Architecture irrelevant to the pressing problems of the built environment, second, the use of the Open Source metaphor as a way to rethink Architecture as an inclusive and collaborative practice, and third, a speculation on the role of the non-expert user in this process. Kaspori's proposals regarding the

33. Kaspori, A communism of ideas, 15.

34. Ibid., 16.

question of user empowerment in design are rather unambitious: they are limited either to unpolished ideas expressed by future occupants, or to menu picking activities from libraries of housing components, which can hardly be called “design.” However, the article is indicative of the activation of an imperative for user participation through the cultural influences of Open Source.

The decade following this article was marked by a popularization of the Open Source culture and the mobilization of numerous communities who sought to define the term in fields and disciplines beyond software. The *Open Source Hardware Definition*[35] and more recently, *Open Design*[36] are examples of this tendency. This climate significantly impacted architectural discourses, resulting in numerous initiatives centered around the translation of Open Source to Architecture.

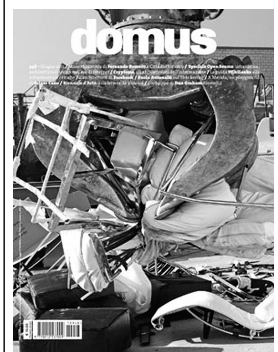




**Figure 4**. *Archis* # 3.
**Figure 5**. *Domus* 948.

### 2.2.2. A techno-utopian *Open Source Architecture* becomes “Wikipedia knowledge”

Although the Open Source metaphor had already penetrated architectural discourses, it was not until May 2011 that the speculations on *Open Source Architecture* became, what one would colloquially refer to as, “Wikipedia knowledge.” The Wikipedia entry on *Open Source Architecture* (*OSArc* and recently *OSA*)[37] was initiated by Carlo Ratti, director of the MIT Senseable City Lab, after receiving a request to write an article about this controversial term for the special issue of the italo-american magazine Domus on *Open Design*.[38] The Wiki-page was based on the idea that the definition of Open Source Architecture would have to follow the form of an Open Source document, written collaboratively and left open to future alterations and extensions.[39]

The initial contributors who were invited to produce what Ratti characterized as “a 21st century manifesto of sorts”[40] included, amongst others, names renowned for their previous engagement with issues of design participation, such as John Habraken and Nicholas Negroponte; advocates of user empowerment and technological literacy, such as Casey Reas or John Maeda; and Open Source icons, such as the science fiction author Bruce Sterling.

The origins of the invited collaborators and the manifestolike tone of the op-ed article reveal an effort to establish *Open Source Architecture* as a new architectural paradigm, revolutionizing the way that space is produced and experienced. The vastness, lack of specificity and underlying utopianism of the article recasts a tradition of technological speculation. The following quote is indicative of this tone:

> *Drawing from references as diverse as open-source culture, avant-garde architectural theory, science fiction, language theory, and others, it describes an inclusive approach to*

35. OSH - definition of free cultural works. 2012 [cited May/04 2012]. Available from http://freedomdefined.org/OSHW.

36. Bauwens, Michel. 2009. The emergence of open design and open manufacturing. *We_Magazine Collective Action.*

37. Ratti et. al., Opensource Architecture.

38. Ratti et. al., Open Source Architecture (OSArc). op. cit.

39. Ibid.

40. Ibid.

*spatial design, a collaborative use of design software and the transparent operation throughout the course of a building and city's life cycle.* [41]

In this sprawling "definition," Open Source Architecture is proposed as a laboratory of ideas where past visions and current technological and conceptual shifts in Architecture, are brought together to rediagram the way that buildings are designed, manufactured and used.[42]

The authors attempt to define the elusive concept of Open Source Architecture through five categories: funding, engagement, standards, design, construction and occupancy. These five categories, conversely, all follow one implicit core adage: user inclusiveness and participation in design through a technological infrastructure.

When, for example, it comes to "design" mass customization is presented as the antidote against standardization and monotony. According to the authors, it is now possible to enable user decision making through a repertoire of parametric software tools which allow for visualization and exploration of multiple alternatives, thus empowering different stakeholders to evaluate alternative solutions and to actively make decisions about design. The authors also exhibit optimism around the Open Source sharing of building information, enabled through the advancements in Building Information Modeling (BIM). BIM is viewed as a path toward the establishment of collective intelligence in design and the fostering of cross-disciplinary collaboration. Another example is the "manufacturing" category, where kinetic architecture and "intelligent" environments are discussed as creating the prospect of user responsiveness in a domestic and urban level, made possible through ubiquitous sensing and actuating.

These technological possibilities culminate in the "occupancy" section of the article, where the authors explicitly refer to the figure of a personalized, responsive space, constantly evolving along with its inhabitants. the empowered "occupant." Quoting from the Wikipedia entry:

> *Today's OSArc enables inhabitants to control and shape their personal environment – "to Inhabit is to Design," as John Habraken put it [...] Personalization replaces standardisation as spaces 'intelligently' recognize and respond to individual occupants. Representations of spaces become as vital after construction as they are before; real-time monitoring, feedback and ambient display become integral elements to the ongoing life of spaces and objects.*[43]

The Wikipedia definition of *Open Source Architecture* is a clear demonstration of the hypothesis framed in the beginning of this

41. Ibid.

42. Ibid.

43. Ibid.

chapter, that the Open Source metaphor in Architecture implicitly activates the vision of user participation in design. This text vests aspects of Kaspori's discussion with a feverish technological optimism, stemming from the potential of currently available "tools" to allow users to actively shape their environments.

The following section will depart from these speculations to discuss implementations, tools, which are designed with the purpose to make the future users of Architecture become their own designers. Dennis Kaspori hinted to tools for mass customization, as offering the users the possibility to shape their habitat, while the web-encyclopedia entry on Open Source Architecture contained references to numerous candidate tools for personalization and design participation, with a bias towards responsive environments. The discussion of "design" as an actuation of an "intelligent" space, which is has at times been framed as the most radical approach to user-centric design,[44] is beyond the scope of this thesis. The focus is on computer aids which aim to empower non-expert users to spatialize their needs and preferences, and to engage in what traditionally would be called "design."

The next section dwells on the implementation of such tools designed for user empowerment in design. The discussion begins with an indicative example of a research project for personalized housing conducted at MIT. This project is centered around the idea of a "design engine,"[45] a computer design aid for the non-expert future user. This offers a point of departure for a broader inquiry into implementations of computational design platforms for non experts. An exploration into the current state-of-the-art in this field of research, exposes an asymmetry between the cultural relevance, the technological possibility and the proclaimed necessity for the design of such tools and the frequent reductivism of their implementations which do not take into consideration the particularities of arhcitectural design.

## 2.3. Implementations: Tools for the user-as-designer

The most prominent current model for the production of personalized housing is mass-customization. This refers to the use of computer-aided design and manufacturing tools in order to offer choice to the future inhabitant. The basic organizational diagram of most of these systems is a "support - infill" or "chassis - infill"[46] model. The "support" corresponds to the constraints of the building (e.g. structure, supply networks), which are designed by "experts." The "infill" is the unconstrained part of the building (e.g. plan configuration, facade, surface finishings etc.) which is designed by the future occupant.[47]

44. Negroponte, *Soft Architecture Machines*, 108.

45. Larson, Kent and Stephen Intille. 2003. MIT Open Source Building Alliance White Paper. Cambridge, Mass.: MIT House_n. 6. and Larson et. al., *Open Source Building,* 188.

46. Ibid., 1. and Larson et. al., Open Source Building, 188.

47. This scheme was articulated in the 1972 book *Supports, an Alternative to Mass Housing* by the former Head of the Architecture Department at MIT and participatory design pioneer John Habraken and was implemented in the Netherlands, Japan and Finland by (or inspired by) the 1980s *Open Building Society*, a non profit organization founded in the Netherlands and active until the year 2000. Habraken, John. 1972. *Supports, an alternative to mass housing*. London: Architectural Press.

Central to current proposals aiming at the provision of personalized housing, is the concept of a computational tool for non-architects, often referred to as a "design engine." This section employs the example of a research project initiated by the House_n Group at the MIT Department of Architecture to briefly describe how ideas and practices of Open Source are combined with the "chassis-infill" scheme, to produce an programmatic framework for personalized housing. This will allow for a transition to a broader discussion on current approaches to computer aids for user empowerment in design.

House_n is a research group in the MIT Department of Architecture, currently headed by Kent Larson, Principal Research Scientist. The group was created in order to explore the impact of new technologies at the habitat, both from a programmatic and operational perspective. In 2003, the group launched the *Open Source Building Alliance* (OSBA) project directed by Kent Larson and Stephen Intille. The project sought to combine a network of relationships across suppliers and manufacturers, with tools enabling individuals to shape their environments. The OSBA white paper begins with what should now be a familiarly optimistic approach to the results of this enterprise:

> *A web of cross-industry relationships, and tools that allow individuals to craft their physical and digital environment – directly connecting manufacturers to customers – will lead to an explosion of creative energy and path to market for innovative products.* [48]

The main underpinning of the *Open Source Building Alliance* enterprise is the observation that a very small part of the built fabric is actually designed by architects. A significant portion of the population, unable to employ the services of an architect, is condemned to mass-standardized solutions, proposed by developers and building merchants for purposes of complexity and cost reduction.[49] [50] OSBA portrays these solutions as highly inflexible, and thus unresponsive to the accelerating rhythms of typological and programmatic changes that the concept of habitat is undergoing. [51]

An important part of the OSBA argument is that apart from the changes in the conception of the home, the inhabitants themselves also change. The "baby boomers" or "gen x," are described as "sophisticated" and "financially enabled customers" who seek the personalization of their living environments and the right to choose.[52] Within the context of the somber homogeny stemming from the unimaginative and practicality-driven solutions of the building industry, technological possibilities are vested with almost evangelistic connotations. The following statement is telling:

48. Larson and Intille, MIT OSBA white paper, 1.
49. Kovidvisith, Kalaya. 2007. Open source building alliance ecology : The internet framework for consumer driven participative design. S.M., Massachusetts Institute of Technology, Dept. of Architecture.

50. Philips, Matthew Giles. 2007. Design by searching : A system for creating and evaluating complex architectural assemblies. S.M., Massachusetts Institute of Technology, Dept. of Architecture.

51. Larson and Intille, MIT OSBA white paper, 2.

52. Ibid., 198.

*So the market is built upon our silent acceptance of mass-standardization, because through our limited choice and limited awareness of the market, we the people let it be so. In the market driven world of housing development, is there any space for the dreams of humanity in the building process? Can people engage and design on a large scale? Perhaps there is a way.* [53]

The OSBA is a multi-layered framework following the "chassis-infill" model. Expert builders and manufacturers provide an infrastructural framework, within which future inhabitants have the ability to "freely" operate, "tailoring" their environment to their personal needs and values. The system consists grossly of a business network of cooperating manufacturers and suppliers, a prefabricated infrastructure and an integrated interior infill system which is designed by the users.

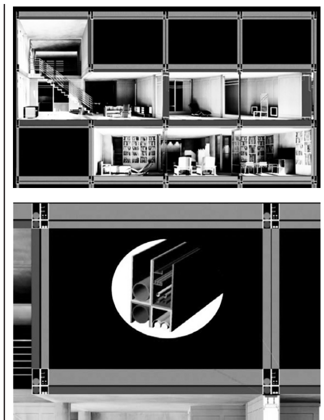


**Figure 6.** The MIT House_n *Open Source Building Alliance* "structure-infill" scheme.

In the center of this complex web is the idea of design tools for non-expert users:

*Central to Open Source Building are web-based, consumer design/configuration tools that provide individuals with the means to make informed decisions design and the products and services they incorporate into their places of living*.[54]

The role of these tools is crucial for the success of the entire enterprise; it is them that fulfill the initial promise to allow non-expert inhabitants to express their needs and values in order to "craft their physical and digital environments."[55]

The solution that OSBA proposes in order to empower users design the "infill," is the operation of a "preference engine" and a "design engine." The preference engine engages the user in what is referred to as "dialogue" in order to reveal needs and values and trace the "tradeoffs" the user is willing to make.[56] This system is conceptualized as a "good architect," conversing with the client at the beginning of the design process in order to understand their desires, needs and personal characteristics.[57]

The implementations of such "design engines" by the House_n team have so far followed a "kit-of-parts" computational approach,[58] where design solutions are produced as combinatorial assemblies of discrete elements. An indicative example is the *Home Genome Project*[59] initiated in 2010 by the MIT Media Lab Changing Places Group.[60] The project comprised an implementation of a system where the "design engine" generated "assemblies" (i.e. combinations of parts) and utilized data from what was earlier referred to as a "preference engine" to match an assembly with a specific user personal profile.[61]

53. Philips, Design by searching, 10.

54. Larson and Intille, MIT OSBA white paper, 6.

55. Ibid., 1.

56. Ibid., 12.

57. Ibid., 12.

58. Ophir, Yaniv. 2010. UDesign : Toward a user-centered architecture. S.M., Massachusetts Institute of Technology, Dept. of Electrical Engineering and Computer Science, and Massachusetts Institute of Technology, Dept. of Architecture.

59. Home genome project. [cited May/05 2012]. Available from http://livinglabs.mit.edu.libproxy.mit.edu/index.php?option=comcontent&view=article&id=47:home-genome-project&catid=37:home&Itemid=81.
Also see Joyce, John. 2006. Pandora and the music genome project. *Scientific Computing* 10 : 40-1.

60. Changing places | MIT media lab. [cited May/04 2012]. Available from http://www.media.mit.edu/research/groups/changing-places.

61. Ophir. UDesign, op. cit.

*a. Configurators*

This preference/design engine is a variation on the theme of the "Configurator," a category of tools for mass personalization which are already used by the housing industry. These tools guide the user in the configuration of a living space, through a series of choices connected in a story-like procession with some constraints in the sequencing of user actions. Such Configurators are widely used for the mass customization of design products, from clothing to cars and, more recently, houses. They fall under what Von Hippel referred to as the "toolkit" approach,[62] where users are offered the tools to experiment with tailoring a product to their needs.

*b. Design Recommendations Engines*

The highly constrained, linear and prescribed process of the commercial Configurator is the source of various discontents. The main criticisms of such tools are that they limit the user's freedom of choice to a set of combinatory possibilities between prescribed parts, and that they fail to address the fact that the users, devoid of expert knowledge in Architecture, are often unable to evaluate the decisions that they make in relation to their needs and values.[63]

The *Home Genome Project* recommendation engine proposes to resolve this problem through a model of informed configuration, where the engine "understands" the user's needs and values, through the recording of the user's previous preferences, demographic information etc., and provides a small list of recommendations. Through this process users are proclaimed to develop a better awareness of their needs and how these can be expressed in the final product (the plan).[64]

*c. Design as Search: Inquiry into Constructive Interfaces*

In the case of the recommendation engine, the involvement of the user is reduced to filling in online questionnaires and ranking images of plans. An alternative model for aiding non-expert users better comprehend their needs and values, is explored by Gilles Philips in his graduate MIT thesis *Design by searching*,[65] also under the auspices of the House_n group. In this work, the interaction with the machine is discussed as a self-reflective process, potentially enabling the users to construct a "knowledge" both as to what they are looking for (needs and values) and of how to express it in spatial terms. Opposite to linear design preference and design engines which output one final recommendation based on user profiles constructed by asking questions, users design "queries" (i.e. design problem representations) which are then employed to search for home solutions.

The intention behind this process is to allow users to incorporate metaphors and associations, as well as to link their interactions with

62. Von Hippel, Eric. 2001. User toolkits for innovation. *Journal of Product Innovation Management*.

63. Larson, Kent and Daniel Smithwick. Beyond the configurator: Collecting accurate data for an architectural design recommendation engine. *Working Paper*, 2010.

64. Ibid.

65. Philips. Design by searching, op. cit.

the machine with their own mental frameworks. Interestingly, after exploring various potential interfaces (text queries, role playing, narratives etc.), Philipps proposed that the representation that users reported as more enjoyable, intuitive and improvisational, was constructing space diagrams, where the nodes correspond to spaces and the links to connections between spaces.[66] By the end of this thesis this observation will fit in the discussion of design-for-empowerment-for-design as an interesting trivium.

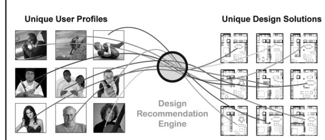



**Figure 7.** Snapshot of the Blu Homes Configurator.

**Figure 8:** Matching people profiles with apartment layouts in the MIT *Home Genome Project*.

The rhetoric and promises of personalized housing, as a path toward a creative revival of the built fabric, are contingent on the tools employed for the realization of this vision. The concept of a "design engine," a computational platform allowing users to create designs reflecting their needs and values, is central in the enterprise of habitat personalization. However, the examination of the operation of the tools which are currently being developed along these lines demonstrates a tension between this ambitious idea and rather uninspiring implementations.

The design of these tools is based on the repurposing of digital platforms from product design or the automobile industry, which were not developed in the context of architectural design and thus have little concern for the intricacies of this process. Questions such as: Is designing one's habitat the same as designing one's shirt? (in the case of the "configurator") or, can living needs and desires be modeled in the same way as music preferences? (in the case of the design recommendation engine), appear inevitable.

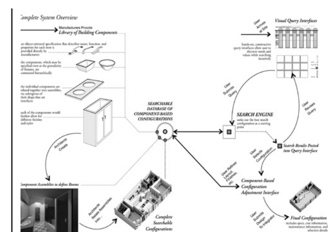


**Figure 9.** Gilles Philips' *Design by searching* diagram of search queries.

The conception of digital tools allowing non experts to spatialize their needs and desires is clearly a complex task, a design problem in its own terms. However, in this complex problem there is an asymmetry between a multitude of implementations and a shortage of reflections on the hypotheses on which these implementations are developed. The problem of design-for-empowerment-for-design is seeking to be characterized.

## *Afterword for Chapter 2*

Finishing chapter 2, it is perhaps time to go back to the introductory paragraph and unpack three key questions:

- How do we reveal the mechanisms which fuel the current technological optimism around design democratization?
- How do we conceptualize the problem of designing computational platforms of user empowerment in design?

66. Ibid., 92.

- How do we develop computational platforms in response to this problem?

The first question alludes to the latency of certain ideas (such as the user-as-designer), which are being revisited under different circumstances and at different times, but their essence remains almost unaltered. Linking such ideas with their historical doppelgangers can offer additional tools for the analysis and critique. For instance, although the discussion of Open Source (in) Architecture per se is a novel phenomenon, the rhetoric which supports it (anti-professionalism, technological optimism, architectural do-it-yourself-ism) present ample historical precedents.

The second question refers to the difficult problem of reflecting on the "design requirements" of computer aids, which are produced in order to empower non expert users to express their own hypotheses in design. This question is contingent on the characterization the problem of design-for-empowerment-for-design, and the identification of its basic constraints. It inevitably involves taking a position about the role of the user and of the computational design, as well as defining terms such as "design," "empowerment" and "democratization."

The third question pertains to the development of computational processes and representations which are consistent with the definitions of "design," "empowerment" and "democratization" which are selected during the problem characterization.

The usual approach to the design of computational tools is usually the reverse: One starts by the computational methods at hand and then shoehorns the problem that the tool is designed to address, to fit these methods. This is not curious at a time when interest in applications leaves little time for reflections.  However, apart from a result of hastiness, this phenomenon is also result of assumptions about "innate" characteristics of computational processes, from their discrete and combinatorial nature, to conventions about the design of their interfaces with the user and the "world."  The purpose of the following chapters is to problematize these naturalized assumptions.

# *03. Method*

## *The "digital liminal" or, creating one's precursors*

> *The fact is that every writer creates his own precursors. His work modifies our conception of the past, as it will modify the future.*[67]

Inquiry into the basal discourses of computation and design democratization can offer valuable tools in order to rethink the enterprise of design-for-empowerment-for-design in the present. The central hypothesis of this research is that these early discourses are characterized by a productive liminality, where concepts are in a state of negotiating their boundaries without having yet been merged into a singular construct. In this stage of betwixt and between,[68] it is possible to question the legitimacy of analogies between the categories being merged: debates such as what the computer can do for designers were highly active in the early computational era (1960s-1970s) but have now been suppressed by the ubiquity of Computer-Aided Design (CAD) applications. Furthermore, the question of how a computer can be conceived as a machine for design democracy, which may be almost impossible to untangle today, was explicitly articulated at its origins. Looking back at these early discourses can help better understand the intricacies of the question and expose parts of the cultural and historical context surrounding its initial framing.

This is the overarching motivation for the placement of two early proposals of computational methods for design democratization in dialogue, as a means to address the questions framed in the first two chapters of this thesis. Before commencing this inquiry, this chapter will elaborate on the reasons for which Yona Friedman's *Toward a Scientific Architecture* and Nicholas Negroponte's research on computer aids for participatory architecture have been selected as the protagonists of this thesis.

## 3.1. Why Yona Friedman? Why Nicholas Negroponte?

The first reason is that both Friedman and Negroponte had a highly influential presence in debates of "democratization." Friedman's theories and projects radically redefined the relationship between Architecture and "the People," while Negroponte's research and activity radically redefined the relationship between the Computer and "the People."

The Hungarian born architect Yona Friedman was one of the leading figures of the radical architectural scene of the 1960s-1970s. His work is construed as being of particular relevance to the topic of this thesis, because Friedman was the intellectual father of participatory design in the form of an architectural do-it-yourself-ism, enabled by a resilient technological infrastructure. His model of a uniform space-grid system, where dwellings were inserted as ephemeral infill able to be moved and changed by their inhabitants,

67. Borges, Jorge Luis. *Kafka and his Precursors* Transl. James E. Irby

had a decisive impact in the formation of the spatial culture in France, where Friedman was mostly active,[69] as well as in the international experimental architectural scene.[70] Currently, he is widely considered as one of the most influential and innovative thinkers of his time, having established a foundation for issues that preoccupy the "forward-looking architects today."[71] He enjoys high popularity in architectural press and in cyberspace where his work is discussed as proto-ecological,[72] proto- "parametric,"[73] or as sharing conceptual links with the Open Source culture.[74]

Nicholas Negroponte, founder of the Architecture Machine Group at MIT, which later transitioned into the MIT Media Lab, lead pioneering researches in the field of human-computer interaction for design. Negroponte was amongst the first to combine computation and participatory design, and to contemplate on the characteristics of computer aids to participatory architecture. His writings and research projects at the MIT Architecture Machine Group, with the collaboration of Leon Groisser, Guy Weinzapfel and others, articulated the computer as a tool for creativity and defined fluid, intuitive and personalized interfaces as a prerequisite for creativity.

The speculative research of the Architecture Machine Group foretold ideas which are currently considered as the cutting edge of technology such as augmented reality, intelligent environments, touch displays, recommendation engines and many others. In his post-Architecture Machine Group activity, Negroponte played a key role in the establishment of the rhetoric of computers as tools for personalization and humanism. [75] [76]

### 3.2. Why Yona Friedman *and* Nicholas Negroponte?

A reason which supports the parallel reading of these two seminal figures, is the intersection and crossfertilization of their research agendas. Besides their operation in different contexts (radical Parisian architectural scene vs research in an MIT Laboratory) and seemingly different aspirations (French utopianism vs American pragmatism),[77] Yona Friedman and Nicholas Negroponte have a history of close acquaintance and productive collaboration. Their contact started in the mid 1960s and culminated in the NSF funded *Architecture-by-Yourself* of the Architecture Machine Group, in which Yona Friedman actively participated.

In personal conversation, Nicholas Negroponte characteristically identified Friedman as one of his most important influences in his transition from Architecture to computers.[78] The influences of the french architect to Nicholas Negroponte are further revealed by his extensive citations to Friedman's work in his chapter on *Computer-Aided Participatory Design* in *Soft Architecture Machines,* which bears Friedman's introduction. Conversely, Negroponte opened the

68. Turner, Betwixt and Between, op. cit.

69. Busbea, Larry. 2007. *Topologies : The urban utopia in France,* 1960-1970. Cambridge, Mass.: MIT Press. 36.

70. Rouillard, Dominique. 2004. *Superarchitecture : Le futur de l'architecture,* 1950-1970. Librairie de l'architecture et de la ville. Paris: Editions de la Villette. 93.

71. de Witt, Wim. 2009. The papers of Yona Friedman. *Getty Research Journal* 1 : 191-6.

72. Ibid., 196.

73. Indicative references viewing Yona Friedman's work as foretelling current computational trends are: Lambert, Leopold, and Martin LeBourgeois. 2011. *#Architectural theories /// pro domo by Yona Friedman.* The funambulist: Architectural narratives. Stuart-Smith, Robert, Perez, Diego and Goutsou, Yiota. Behavioral urbanism. 2008 [cited May/05 2012]. Available from http://www.kokkugia.com/research/behavioralUrbanism.xml.

74. Barry, Robert. 2012. Yona Friedman: Ludwig museum, Budapest, Hungary. *Frieze Magazine*.

75. Brand, *The Media Lab,* 262.

76. Nicholas Negroponte, "Interview by Theodora Vardouli" (Notes, Cambridge, Mass., 2011).

77. Busbea, *Topologies*, 17.

78. Nicholas Negroponte, "Interview by Theodora Vardouli" (Audio Recording, Cambridge, Massachusetts, 2012).

English translation of Yona Friedman's book *Toward a Scientific Architecture* with a Foreword narrating the origins of their close collaboration.[79]

The historical grounding of the conversation between these two actors, is rendered even more productive by the disparate motivations and contexts that they represent. The parallel analysis of *Toward a Scientific Architecture* and *Computer Aids to Participatory Architecture/Computer-Aided Participatory Design* can be seen as containing a basal debate on approaches to design-for-empowerment-for-design, whose tensions and arguments are worthy of exposure.

### 3.3. Why *just* Yona Friedman and Nicholas Negroponte?

The shifting of the computational metaphor in Architecture to connotations of personalization and responsiveness is a very intricate cultural phenomenon which does not relate back only to these two actors. If one wanted to reveal the origins of the current optimism about digital technologies leading to more personal and responsive environments, one could not possibly omit the techno-utopian architectural scene of the 1960s negotiating the relationship of the computer and the environment (e.g. Nicholas Schoffer's "Ville Cybernetique"[80] and Denis Crompton's "Computer City"),[81] concepts promoting the idea of architectural do-it-yourself-ism (e.g. Buckminster Fuller's "Comprehensive Designer"),[82] and participatory design methodologies such as these of John Habraken or Christopher Alexander.

However this study does not seek to trace lines of ancestry between current phenomena and the works of Yona Friedman and Nicholas Negroponte, or to construct comprehensive genealogies of tools for design participation. The goal is to create three systems of inquiry, which are developed to the three following chapters of the current thesis:

The first system of inquiry concerns the histories of the two authors. This narrative aims to illuminate events and influences pertinent to the development of the two actor's computational theories for user participation in design. This historical investigation can be approached as a partial sketch of the diverse cultural and historical climate in which the idea of computational tools for architectural do-it-yourself-ism was engendered.

The second system consists of the texts *Toward a Scientific Architecture* and *Computer Aids to Participatory Architecture/ Computer-Aided Participatory Design*. Focus is placed in the diagramming of the intentions and implementations of the computational systems for user empowerment in design, as they

79. Friedman, *Toward a scientific architecture*, viii.

80. Nicholas Schoffer was a french sculptor active in the 1960s in Paris. Renown for his spatiodynamic scultpures, he was a member of the Groupe International d' Architecture Prospective (GIAP), where Yona Friedman was also participating. The Cybermetic City was published in 1969 in Paris. In Schoffer's utopia, the Cybernetic City could even anticipate revolts and make spatial adjustments in order to avoid them. Schoffer, Nicholas. 1969. *La ville cybernetique.* Paris: Tschou.

81. The Computer City was drawn in 1964 by Dennis Crompton, a member of the Archigram group and used the metaphor of the computer to abstract the operation of urban networks and control mechanisms.

82. Buckminster Fuller's idea of the Comprehensive Designer is this of someone who can understand "Whole Systems" and use tools and technology to operate within them. This idea inspired Stewart Brand and the Whole Earth group and was clearly manifested in the creative do-it-yourselfism in architecture, promoted by the *Shelter and Land Use* section of the *Whole Earth Catalog*. Turner, Fred. 2006. *From counterculture to cyberculture : Stewart brand, the whole earth network, and the rise of digital utopianism.* Chicago: University of Chicago Press.

are described in the authors' texts.

The third system inquires into the computational representations of the "machines" proposed in these two texts, the FLATWRITER[83] and the Design Amplifier,[84] as allegories for the relationship between paternalism and neutrality, objectivity and intuition, control and freedom. The aim of these three interconnected readings is to weave a network of historical anecdotes, open ideas and frames of criticism to inform current discourses.

83. Friedman, *Toward a scientific architecture*, 53.

84. Negroponte, *Soft architecture machines*, 108.

# *04. History*
## *Two paths to computational tools for Architecture-by-Yourself*

## *Foreword for Chapter 4*

This chapter presents a historical narrative which contextualizes Yona Friedman's *Toward a Scientific Architecture* and Nicholas Negroponte's writings on computer aids to participatory architecture. Apart from references to history books, biographical notes and encyclopedia entries, valuable material for this historical inquiry is drawn from personal conversations with the two authors.

The narrative begins with a chain of events which lead to the formulation of Yona Friedman's model of architectural do-it-yourself-ism. The scope of this exploration spans from Friedman's participation in the 1956 Tenth International Congress of Modern Architecture (CIAM X), to his book *Toward a Scientific Architecture*. In this section, inquiry into Yona Friedman's under-discussed teaching and research activity in the United States, challenges the traditional historization of the book and invites alternative interpretations. A personal anecdote of Nicholas Negroponte's first encounter with Yona Friedman, as presented in the foreword of the English translation of *Toward a Scientific Arhitecture*, provides a segway into Nicholas Negroponte's early work with the Architecture Machine Group. People, ideas and influences pertinent to this early research, are discussed as the "raw material" for Nicholas Negroponte's bricolage of Architecture, computers and participation.

## 4.1. Yona Friedman: Architecture, the "People" and (computational) systems

### 4.1.1. The establishment of the participatory techno-utopias in Architecture

*a. Beginnings: CIAM X and the crisis of International Modernism*

In the August of 1956 Yona Friedman traveled from Haifa, Israel, where he was working as an architect, to Dubrovnik, Yugoslavia in order to participate in the Tenth International Congress of Modern Architecture (CIAM X), centered around the "Habitat." The Congress, which signaled the end of International Modernism, was characterized by a generational conflict between its founding members, also referred to as the "First CIAM" and the younger CIAM participants. Most of the first generation members either absented or had already resigned[85]. Apart from the discussion of institutional changes in the Congress, the main goal of CIAM X sought to construct a "Charter of Habitat" as a continuation of the

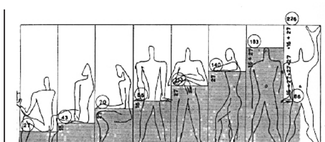


**Figure 10:** Le Corbusier's Modulor in various postures.

85. Pedret, Annie. Dubrovnik (Yugoslavia) 3-13 August 1956, CIAM X congress: Scales of association. [cited May/04 2012]. Available from http://www.team10online.org/team10/meetings/1956-dubrovnik.htm.

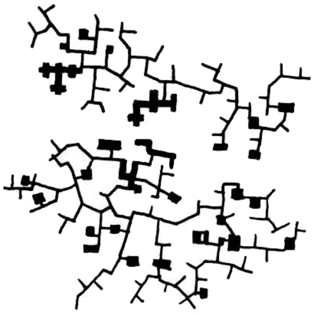


**Figure 11:** Alison and Peter Smithson's diagram for the *Golden Lane* project, 1952.

"Charter of Athens," developed in the CIAM of 1933. The "Charter of Athens" had established a quadripartite functional subdivision of the city into dwelling, working, recreation and circulation. The "Charter of Habitat" was discussed in two Commissions, which also followed a generational division between the older and the younger members of the CIAM. The goal of the second Commission was to investigate associations between the four different urban functions in the projects of the Congress. Yona Friedman participated in the "Growth and Change" subgroup, which along with "Cluster," "Mobility" and "Habitat,"[86] formed the second Commission.

At a time when the modernist functionalist rigidity was proving increasingly inadequate to account for the accelerating rhythms of the demographic, social and financial change in the post-war era,[87] the younger generation of the CIAM X participants, part of which grew later to be known as the Team X,[88] rejected the dogma of International Modernism and advocated for the introduction of human parameters in design through associative and relational concepts such as identity, association, cluster and mobility.[89] In CIAM X Yona Friedman presented his ideas on a system of modular temporary dwelling allowing for "social mobility," which he had been developing in Haifa and came in contact with the architectural actuality.[90]

Friedman's ideas, which were being overlooked by his colleagues in Israel, had been recognized and encouraged by Le Corbusier, with whom Friedman had met in 1949. However, Friedman came to soon reject the grand master's dogmas. The awe in front of Le Corbusier's Unite d' Habitation in Marseille, which he visited at the same year, was soon transformed into disillusionment: in his second visit at the Unite in 1954, Friedman became exposed to the discontents of the building's inhabitants with its unresponsiveness to their personal needs. It was at that time that Friedman claims to have realized that "Architecture cannot be simply applied geometry."[91]

### *b. Mobile Architecture: From fictive entities to "all personal hypotheses"*

After his participation in the 1956 CIAM Friedman started articulating the idea of *Mobile Architecture* as a critique to the statistical reductionism of the Modern Movement. In his *Mobile Architecture* manifesto,[92] he denounced the modernist preoccupation with the fictive entity of the "Average Man," for being far removed from the real needs of the individuals, and polemically rejected the prevalence of architectural "pseudo-theories" in education and practice, for being mere reflections of the preferences of their authors. In response, Friedman advocated for a general theory "stemming from the public domain" and encompassing "all personal hypotheses."[93]

86. Ibid.

87. Busbea, *Topologies*, 10.

88. The members of the Team X who also participated in CIAM X were Jaap Bakema, Georges Candilis, Aldo van Eyck, Rolf Gutmann, Geir Grung, Bill Howell, Reima Pietilä, Alison Smithson, Peter Smithson, Jerzy Soltan, John Voelcker and Shadrach Woods.

89. Pedret, CIAM X Congress, op. scit.

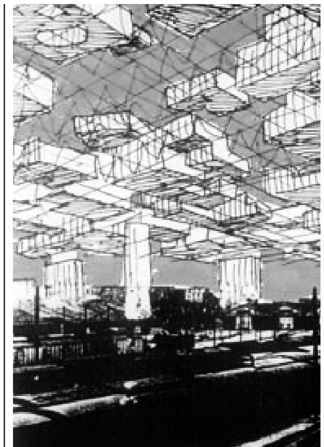
90. Rouillard, *Superarchitecture*, 87.

91. Ritoe, Rajan V. 2011. *YONA FRIEDMAN a documentary by Rajan V. Ritoe.* DVD. Nym Fix Press.

92. Friedman, Yona. 1968. L'architecture mobile. Cahiers du centre d'études architecturales; 3.1. Bruxelles: Centre d'études architecturales.

93. Ibid.

Friedman's communication with architects and engineers who had expressed interest in his ideas, such as Paul Maymont, Frei Otto, Eckhard Schultze-Fielitz, Werner Ruhnau and D. G. Emmerich, led to the formation of the avant-garde architectural group GEAM (Groupe d' Etudes d' Architecture Mobile/ Group for the Study of Mobile Architecture) in 1957.[94] The principles of the *Mobile Architecture* were the basis of Friedman's architectural proposal for the *Spatial City* (1958-59)[95]. The *Spatial City* was a space frame infrastructure on pillars, detached from the ground, with dwellings conceived as ephemeral infill. This "non-determining" and "non-determinant" structure absorbed all the necessary constraints (structural stability, water, electricity, sewage etc.) to provide a plateau for freedom and mobility. Friedman's trihedral megastructure bore significant influences from the technological advancements of structural systems in the 1960s, exemplified in the German architect Konrad Wachsmann's studies of space-frames produced by pre-fabricated elements, with which Friedman had been familiar since his time at Israel.[96]



**Figures 12 and 13:** Photomontages of Yona Friedman's *Spatial City* (1960).

*c. Imitations and misunderstandings: the impact of spatial urbanism*

The dazzling imagery of a megastructural space grid hovering over the Place de la Concorde or the Arc de Triomphe in Paris, which appeared in Friedman's 1960 collages, sparked the architectural imaginary and had major influences in "radical" architectural groups such as Archigram, in England, or the Japanese metabolists[97] [98] [99]. The international influence of Friedman's spatial urbanism to the "experimental" architectural scene of the 1960s resulted in an appreciation of mainly the visual aspects of his megastructural work; what Charles Jencks would later refer to as "the irresistible imagery."[100] However, besides the frequent analysis of the megastructure as a structural object and an emphasis on its crystalline formal characteristics and visual impact, Friedman consistently declared that his primary preoccupation in the Spatial City was not formal, but programmatic.[101]

**Figure 14:** Depictions of Friedman's *Spatial City* (1958-59). [collage of Friedman's works by Theodora Vardouli].

94. Fonds régional d'art contemporain du Centre. 2003. *Architectures expérimentales*, 1950-2000. Collection du FRAC centre. Orléans: HYX.

95. Riley, Terence, ed. 2002. *The changing of the avant-garde: Visionary architectural drawings from the Howard Gilman collection.* New York, N.Y.: The Museum of Modern Art.

96. Rouillard, *Superarchitecture*, 87.

97. Ibid., 93.

98. Gournay, Isabelle. MoMA, the collection, Yona Friedman. (french born hungary 1923). 2009 [cited May/04 2012]. Available from https://www.moma.org/collection/browse_resultsphp?criteria=O%3AAD%3AE%3A8109.

99. Ritoe,*Yona Friedman*.

100 Jencks, Charles. 1973. *Modern movements in architecture*. Garden City, N.Y: Anchor Press.

101 Friedman, *Toward a scientific architecture*, xi.

*d. A language for the democratization[102] of Architecture*

The technological framework of Friedman's megastructure was conceived as a new environment empowering its inhabitants to realize the principles of self-planning and self-construction. The megastructure was proposed as the locus of a new type of Architecture, ephemeral and user-driven, as a new kind of social organization, and as a new kind of environmental resources management, of which Friedman sought to explore the operational principles.

**Figure 15:** Yona Friedman's pictograms.

Along the lines of his initial vision to make Architecture accessible to everyone, Friedman developed a simple language based on "pictograms." The pictograms were Friedman's first attempts to develop a language informing the user about the makings of Architecture. The intention to develop a "new information process"[103] between the users and their habitat would later find a comprehensive articulation in the book *Toward a Scientific Architecture*. Friedman's explorations on self-construction through pictograms and "simple diagrams"[104] were put to action during his 1980s invitation to India by Indira Ghandi, where he published over a hundred educational manuals on health conditions, food and living environment management in the form of pictograms. His later work involved a collaboration with UNESCO and the United Nations University in Paris, where he founded the "Communication Center for Scientific Knowledge for Self Reliance."[105]

### 4.1.2. *Toward a Scientific Architecture*

This abridged narrative of Friedman's highly influential work depicts the climate in which his ideas were first generated and describes his broad impact in the architectural discourses of his time. The subversive character of his ideas, both in a visual and programmatic level, is celebrated by historians and conveyed in all his biographical notes. Kenneth Frampton, indicatively, refers to Friedman as representing "the anarchistic architectural avant-garde of the post Second World War period."[106] The primary focus in Friedman's work is placed on his techno-utopian ideas of the *Mobile Architecture* and the *Spatial City*, while there are brief references to his 1960s-1970s studies in methods for self-planning and self-construction. This section frames the importance and relevance of these studies, and namely *Toward a Scientific Architecture,* to the discussion of computational tools for user empowerment in design.

*Toward a Scientific Architecture* was published in French in 1971 with the title *Pour Une Architecture Scientifique* and translated in English in 1975. Wim de Wit, senior curator of the Department of Architecture and Design at the Getty Research Institute, which has acquired Yona Friedman's Archive, interprets the title that Friedman chose as implying a response to Le Corbusier's 1920 book *Toward an Architecture*[107] (*Vers une Architecture*). [108]

102. This is the title of the first chapter of Friedman's *Toward a Scientific Architecture*. Friedman, *Toward a scientific architecture*, 1-14.

103. Friedman, Yona. 1972. Information processes for participatory architecture. In *Design participation.*, ed. Nigel Cross, 45-50. London: Academy Editions.

104. Gournay, MoMa, the Collection, Yona Friedman, op. cit.

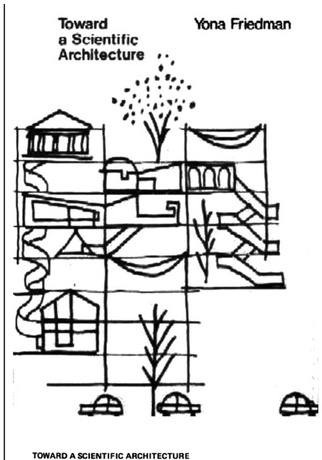
105. de Witt, The papers of Yona Friedman, 196.

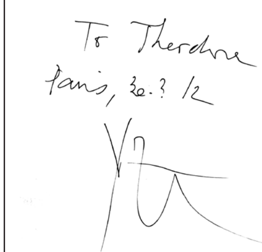
106. Frampton, Kenneth. 2007. *Modern architecture : A critical history. World of art. 4th ed. London*; New York: Thames & Hudson.

107. Le Corbusier, Jean-Louis Cohen, and John Goodman. 2007. *Toward an architecture*. Texts & documents. Los Angeles, CA.: Getty Research Institute.

108. de Witt, The papers of Yona Friedman, 192.

In *Toward a Scientific Architecture* Yona Friedman proposed a remodeled architectural process, which would empower future inhabitants to "design" their own dwelling within the infrastructure of the *Spatial City*. Friedman also described a machine, named the FLATWRITER, with which users would be able to first make choices about the configuration of their "flat," and consecutively place it in the infrastructure. The presence of a computer in Friedman's work is without doubt an anomaly, interpreted by historians either as a result of the trend of the computer, as a "generalized technology"[109] amongst the cycles of the radical architectural scene, or as a "simple computer interface," which along with Friedman's ideograms depict Friedman's taste for simple assertions and axioms. [110]



**Figures 16 and 17:** Cover and signed copy of Yona Friedman's *Toward a Scientific Architecture*.

*a. Yona Friedman in the US: An under-discussed history*

*Toward a Scientific Architecture* is often mentioned in passing in Yona Friedman's biographies, as one more of his explorations, perhaps the most systematic one, on developing a simple language accessible to the users and the builders of Architecture. The FLATWRITER is historicized as an isolated event in Friedman's work, who is known for his anti-computer attitude.[111] However, a more careful examination of the context in which the book was written reveals an alternative and compelling history.

Friedman's self-promotion agenda included extensive teaching and lecturing in universities around the world.[112] His activity throughout the 1960s and 1970s involved frequent visits in the United States, in universities and institutions such as MIT, Harvard, UCLA, Princeton, and the University of Michigan in Ann Arbor.[113] However, the influences that these interactions exerted on his work are rarely discussed. This is perhaps consistent with a line of thought which differentiates French explorations with technology, systems, structures and networks, stemming from a network of philosophical and political referents, from the technocratic pragmatism of the American research labs. Observations such as the following are telling:

> *The French engagement with these networks and systems was fundamentally different than that of the Americans, whose energies were clearly focused on economic superiority and political supremacy.*[114]

This observation is indicative of a widely accepted argument on the incommensurability of the French and the Anglo-American explorations with systems and technology. In the case of Yona Friedman, this assumption leaves out very interesting information: *Toward a Scientific Architecture,* as Friedman declared in personal conversation, was decisively influenced by his activities in the United States.[115] He revealed that the first form of *Toward a Scientific Architecture* was that of a textbook for his 1964 class in the University of Michigan. Only later was the book translated

109. Rouillard, *Superarchitecture*, 116.

110. Busbea, *Topologies*, 68.

111. Lambert, Leopold, and Martin LeBourgeois . 2010. *#Interviews/ Yona Friedman on November 14th 2007 in Paris*. The funambulist: Architectural narratives.

112. Gournay, Gournay, MoMa / the Collection / Yona Friedman, op. cit.

113. Yona friedman. 2009 [cited May/04 2012]. Available from http:// en.goldenmap.com/yona_ Friedman.

114. Busbea, *Topologies*, 17.

and published in French (1971) to be then re-published by the MIT Press in 1975.

In personal conversation, Friedman also recounted having been strongly indluenced by the renowned mathematician Frank Harary, who was at the time teaching at the University of Michigan, where Friedman had been invited. Harary was one of the founding figures of modern graph theory and is most known for extending graph theoretical applications in fields and disciplines ranging from physics to the social sciences (psychology, sociology, anthropology etc.) Friedman's contact with Harary perhaps explains the ubiquity of graphs in his mid 1960-1970 works, such as *Toward a Scientific Architecture, Realizable Utopias*[116] and others.

Interpreting Yona Friedman's diagrammatic representations as graphs and not as "simple diagrams," opens new avenues for the analysis of the conceptual underpinnings of his participatory design methodologies. The graph operates as a mathematical model of reality, allowing for the performance of calculations, the extraction of metrics, the description of rules and axioms, the examination of scenarios, which are then transposed back to reality. Furthermore, all of these calculations can be performed by an informational machine. Friedman's description of the FLATWRITER as a computer implementation of his system, as well as his persistent discussion of Architecture from the perspective of information processing,[117] sanction the characterization of his system as computational. Insofar as *Toward a Scientific Architecture* presents the "strict reasoning" which underlied the *Spatial City*,[118] its interpretation can retrospectively signify Friedman's techno-utopias as proto-computational. The systematic, yet radical, character of Yona Friedman's proposals, resonated with Nicholas Negroponte's research preoccupations, who found Friedman's model "computational enough"[119] to be implemented by an architecture machine.

## 4.2 Yona Friedman and Nicholas Negroponte: From the airport incident to the *Architecture-by-Yourself* project

Throughout the 1960s Yona Friedman visited the United States often to promote his ideas on mobile architecture and spatial urbanism.[120] This was facilitated by the abundance of grants for young researchers which gave him the liberty to frequently travel to the United States and interact with different academic environments.[121] One of these environments was the Massachusetts Institute of Technology. When Nicholas Negroponte first met Yona Friedman in 1967 he was still a student of Architecture at MIT.

115. Friedman, Yona. "Interview by Theodora Vardouli," (Video recording, Paris, 2012).

116. Friedman, Yona. 1970. *Utopies realisables*. Paris: Ed. de l' eclat.

117. Friedman, *Toward a scientific architecture*, 4.

118. Ibid., xii.

119. Negroponte, "Interview by Theodora Vardouli", 2011, op. cit.

120. Gournay, Moma / the Collection, Yona Friedman, op. cit.

121. Friedman, "Interview by Theodora Vardouli", op. cit. See Appendix A.

The anecdote of their first encounter opens Negroponte's foreword to the English translation of *Toward a Scientific Architecture*. Negroponte narrates:

> *In 1964, when I was a graduate student of Architecture, I was sent to the airport (because I spoke French) to pick up a visiting lecturer, Yona Friedman. I was turned on by a soft spoken but persuasive argument for removing the architect as middleman between a user's needs and their resolution in the built environment. Friedman's thesis rested, in part, on the matter of who bore the risk in bad design. A decade later, I find myself working with him (under National Science Foundation Support) and personally close to him and his ideologies.*[122]

The NSF-funded research, to which Negroponte alludes, refers to the 1973-1975 *Architecture-by-Yourself* project of the Architecture Machine Group. The project was managed by Guy Weinzapfel, an alumnus of the MIT Department of Architecture. Prior to joining the Architecture Machine Group Weinzapfel was a Research Assistant for the, also NSF-funded, project IMAGE, led by Tim Johnson. IMAGE was a computer program for the automation of floor plan layout production, based on architectural constraints applicable to design.[123] The idea of "constraints" had been popularized amongst the first computer graphics applications, following Ivan Sutherland's first computer graphics program, SKETCHPAD.[124][125]

The *Architecture-by-Yourself* project lasted approximately for two years and was conducted under the supervision of Yona Friedman. *Architecture Machinations*, the weekly Architecture Machine Group newsletters, contain interesting trivia on Yona Friedman's interactions with the Group, from work schedules to unsuccesful meetings.[126] The deliverable of the *Architecture-by-Yourself* project, was to produce a computer program which would apply Friedman's graph theoretical method of design, articulated in *Toward a Scientific Architecture,* to enable non-expert users to create the layouts of their homes by-themselves. As a tribute to its intellectual father, the computer program was named YONA, standing for *Your Own Native Architect*.[127]

## 4.3 Nicholas Negroponte: Computers, the "People" and Architecture

### 4.3.1. Computer aids to design and Architecture

*a. Architecture Machine Group*

After the completion of his studies at the MIT Department of Architecture, Negroponte was offered a position as an adjunct

**Figures 18:** Yona Friedman.

**Figures 19:** Nicholas Negroponte.

122. Friedman, *Toward a scientific architecture*, ix.

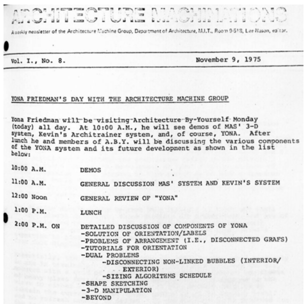
123. Johnson, Timothy, Guy Weinzapfel, John Perkins, Doris C Ju, Tova Solo, and Deavid Morris. 1970. *IMAGE: An interactive graphics-based computer system for multiconstrained spatial synthesis.* Cambridge, Mass.: MIT Department of Architecture.

124. Sutherland, Ivan. 1963. Sketchpad: A man-machine graphical communications system. *AFIPS Proceedings*.

125. Guy Weinzapfel, "Interview by Theodora Vardouli" (Audio Recording, Cambridge, Massachusetts, 2012). See Appendix C.

126. Architecture Machine Group. 1978. *Architecture machinations: A weekly newsletter of the architecture machine group.* Cambridge, Mass.: MIT Department of Architecture.

127. Ibid.


ARCHITECTURE MACHINATIONS

A weekly newsletter of the Architecture Machine Group, Department of Architecture, M.I.T., Room 9-518, Lee Nason, editor.

Vol. I., No. 8. November 9, 1975

YONA FRIEDMAN'S DAY WITH THE ARCHITECTURE MACHINE GROUP

Yona Friedman will be visiting Architecture-By-Yourself Monday (today) all day. At 10:00 A.M., he will see demos of MAS' 3-D system, Kevin's Architrainer system, and, of course, YONA. After lunch he and members of A.B.Y. will be discussing the various components of the YONA system and its future development as shown in the list below:

| | |
|---|---|
| 10:00 A.M. | DEMOS |
| 11:00 A.M. | GENERAL DISCUSSION MAS' SYSTEM AND KEVIN'S SYSTEM |
| 12:00 Noon | GENERAL REVIEW OF "YONA" |
| 1:00 P.M. | LUNCH |
| 2:00 P.M. ON | DETAILED DISCUSSION OF COMPONENTS OF YONA<br>-SOLUTION OF ORIENTATION/LABELS<br>-PROBLEMS OF ARRANGEMENT (I.E., DISCONNECTED GRAFS)<br>-TUTORIALS FOR ORIENTATION<br>-DUAL PROBLEMS<br>-DISCONNECTING NON-LINKED BUBBLES (INTERIOR/EXTERIOR)<br>-SIZING ALGORITHMS SCHEDULE<br>-SHAPE SKETCHING<br>-3-D MANIPULATION<br>-BEYOND |

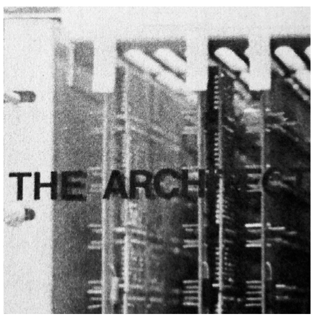


**Figure 20:** A day with Yona Friedman, during the *Architecture-by-Yourself* Project in the Architecture Machine Group's weekly newsletter *Architecture Machinations.*

**Figure 21:** The Architecture Machine.

instructor of Architecture at MIT by the Head of the Department, Laurence Anderson.[128] However, the unexpected medical leave of a faculty member of the MIT Mechanical Engineering Department made Negroponte shift gears, having been appointed for the instruction of his subject. The Architecture Machine group (ArcMac) was born under the auspices of Mechanical Engineering, although the Lab Space offered to the Group was located in the Architecture Department. The Architecture Machine Group's research started with small contributions from a Chicago based institute, which soon escalated to generous packages by the National Science Foundation.[129] However, Negroponte admits in conversation, that the NSF funding found the Group having already drifted away from architectural implementations, and shifted towards computer graphics applications.[130]

### *b. URBAN 5*

Since the beginning of the Architecture Machine Group, Negroponte was advocating for the reconception of the computer from a rigid, counterintuitive machinery, to a tool for personalization and creativity. The area of computer aids to design offered a very fertile ground for the exploration of this premise as it seemed to bring together the medium of the computer with the par excellence creative human activity of design.

Negroponte's first major work in the area of Computer Aids to Design (CAD) was URBAN 5, a research project for computer-aided architecture initiated in 1966 under the joint sponsorship of the IBM Cambridge Scientific Center and MIT.[131] Opposite to the popular understanding of CAD at the time, frequently perceived as drafting aids, Nicholas Negroponte's envisioned to create a computer system which would be capable of assisting in the conception of a design. Referring to URBAN 5 in the *History and Context* section of the NSF proposal for *Computer Aids to Participatory Architecture,* Negroponte states:

> *This effort (URBAN 5) was the first and largest comprehensive computer system ever developed to assist architects with those activities they call "design" (as against specification writing, preparation of working drawings, accounting, etc...).*[132]

In the 1975 collection *Reflections on Computer Aids to Design and Architecture*, Negroponte confesses that his first endeavors in CAD were limited by his assumptions about what computers could afford designers: checking violations in constraints and criteria surpassing the cognitive capacity of the designers, who could only examine a small problem space.[133] However, he soon became self-critical of this approach for taking only explicit input from the user and "mimicked the additive genre of composition, popular in school at the time and epitomized in Habitat."[134] The realization that "the

128. Negroponte, "Interview by Theodora Vardouli." See Appendix B.

129. Ibid.

130. Ibid.

131. 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. ———. 1967. URBAN 5: An on-line urban design partner. *IBM Report.*:320-2012.

132. Negroponte and Groisser, *Computer Aids to Participatory Architecture*, 58.

133. *Reflections on computer aids to design and architecture.* 1975. , ed. Nicholas Negroponte. Petrocelli/ Charter.

134. Ibid., 8.

system could really change itself to reflect the design attitudes of a particular designer"[135], urged Negroponte to cease the two year Program on URBAN 5 and explore a question which would become central in his later discourses: interaction.

*c. The Architecture Machine: Toward a more human environment*

Negroponte's contact with the Artificial Intelligence Department at MIT, which was at the time conducting experiments in Computer Vision, opened a new field of possibility. These potentialities were explored in the first book publication of the Architecture Machine Group entitled *The Architecture Machine: Toward a More Human Environment*.[136] The publication of the *Architecture Machine* coincided with the organization of the Urban Systems Laboratory which initiated a series of experiments in linguistic and graphical interfaces[137] under a Ford Foundation Grant.

*The Architecture Machine* presented the vision of a network of personal, in-house machines connected to a central host, operating not any more as problem solving devices, but contributing to the design as problem worrying partners. 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,"[138] where the machine would "exhibit alternatives, suggestions, incompatibilities and oversee the urban rights of individuals."[139]

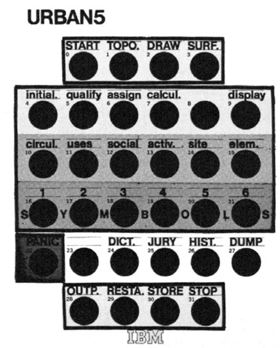



**Figure 22:** The URBAN 5 Keyboard.

**Figure 23:** The Architecture Machine.

### 4.3.2. Computer Aids to Participatory Architecture

*a. The 1970s trend of participatory architecture and Negroponte's change of attitude*

The transition from URBAN 5 to The Architecture Machine, consolidated two ideas which formed the basis for Negroponte's further explorations in the area of computer aids for design participation: first, the idea of a machine humanism linking all scales in one functioning system, and second the idea of a computer as a "partner"; an amplifier of its user's creativity.

Participatory architecture was a shift of focus in the Architecture Machine Group's orientation which occured in the early 1970s. In the section *Introduction to my Own Reflections* in *Reflections on Computer Aids to Design and Architecture* Negroponte states:

> *Today, my major change in attitude is the following: given that an artificial intelligence is distant, let us consider removing the architect as opposed to emulating him. The theory is simply that many design endeavors (not hospitals or airports, but homes in particular) can be achieved by those for whom the environment will ultimately have* a

135. Negroponte and Groisser, *Computer Aids to Participatory Architecture*, 59.

136. Negroponte, Nicholas. 1970. *The architecture machine: Toward a more human environment.* Cambridge, Mass.: MIT Press.

137. Negroponte and Groisser, *Computer Aids to Participatory Architecture,* 60.

138. Ibid., 1.

139. Ibid., 7.

*meaning. While this position has enjoyed a popularity in circles of advocacy planning, it has usually not encountered the support of computer aids (often a symbol of the antithesis). It has received the serious attention only of Yona Friedman, in Paris, France.*[140]

At the time that this change of attitude occurred, participatory design was gaining unprecedented popularity in the Anglo-American debates on Architecture and Planning. In 1965 Paul Davidoff had articulated the principles of *Advocacy and Pluralism in Planning*, and the need to actively engage citizens in the decision processes of public policy. Davidoff had portrayed the planner not as a prescriptor of the future urban life, but as an advocate between public policy and local decision groups, informed about their interests and empowered to express them in the language of the technicians. [141] Only five years after Davidoff's text, the idea of participatory design had become a ubiquitous trend, to such an extend that the architecture critic Reyner Banham would proclaim:

*One begins to have the feeling that this (participatory design) is, in Donald Schon's terms, one of those "ideas in good currency" and therefore dead; one of those ideas that everyone has heard of, everybody can discuss, everyone knows what it means.*[142]

Banham's comment was made in the September 1971 *Design Participation* Conference of the Design Research Society in Manchester. The Conference was organized by Nigel Cross, in collaboration with Chris Jones and Reg Talbot.[143] As Nigel Cross would state in the Preface of the conference proceedings, the agenda of the conference was to explore the possibilities and problems of participatory design, at a time when the public demand for user decision-making in Planning was growing, and the idea of design being executed by those who would be affected by its outcome was emerging as a solution to the "undesirable side-effects of technology."[144]

Both Yona Friedman and Nicholas Negroponte participated in the Conference, which was infused with a strong interest towards issues such as "social technology, participation in Planning, adaptable environments, computer aids and design methods."[145] Yona Friedman presented a short version of *Toward a Scientific Architecture* under the title *Information Processes for Participatory Design*,[146] while Negroponte presented a paper entitled *Aspects of Living in the Architecture Machine* discussing the idea of "responsive architecture."[147] As Negroponte stated, this concept: "takes both movements (computation and participation) to their limiting cases; in some sense invalidating the corner stones of their existence."[148] In the chapter *Computer-Aided Participatory Design* in his 1975 book *Soft Architecture Machines* Negroponte would

140. Negroponte, *Reflections on Computer Aids,* 10.

141. Davidoff, Paul. 1965. Advocacy and pluralism in planning. *Journal of the American Planning Association* 31 (4): 331-8.

142. Banham, Alternative Networks, 15.

143. Conference on design participation. Proceedings of the Design Research Society's conference, Manchester, September 1971. ed. Nigel Cross. London: Academy Editions.

144. Cross, Nigel. 1972. Preface. In *Design participation.*, ed. Nigel Cross. Academy Editions, 6.

145 Ibid.

146. Friedman, Yona. 1972. Information processes for participatory architecture. In *Design participation.*, ed. Nigel Cross, 45-50. London: Academy Editions.

147. Negroponte, Nicholas. 1972. Aspects of living in an Architecture Machine. In *Design participation.*, ed. Nigel Cross, 63-67. London: Academy Editions.

later propose a model of an "informed" machine as an intermediate stage before  the accomplishment of his final goal, an "intelligent" space, responsive to its inhabitants. This machine, named the "Design Amplifier," would engage in dialogue with the non expert user in order to draw inferences about implicit needs and desires and allow them to resolve them in built form.

The anti-professionalism and the demand for user participation, developed within the vogue of participatory design, offered a new ambitious challenge to the Architecture Machine Group's research on CAD: replacing the architect by a system responsive to the user's intimate needs and desires. This rhetoric aligned with a series of influences which had formulated Negroponte's attitudes towards the relationship of the architect and the user, and of the user and the machine.

*b. Redefining the architect-user Relationship: Rudofsky, Friedman, Soleri*

In personal conversation, Negroponte identified Bernard Rudofsky's 1964 exhibition *Architecture without Architects: A short Introduction to Non-Pedigreed Architecture* at the Museum of Modern Art[149], as one of the main influences which inspired his the anti-architect discourse. Rudofsky had articulated a polemic against the specialists whose professional opportunism detached them from the true problems of living, and had applauded the sustainability, creativity and inventiveness of the vernacular solutions. In *Architecture without Architects*, the vernacular was viewed from a highly technological perspective. In the exhibition catalogue Rudofsky wrote:

> *We learn that many audacious "primitive" solutions anticipate our cumbersome technology; that many a feature invented in recent years is old hat in vernacular architecture - prefabrication, standardization of building components, flexible and movable structures, and, more specifically, floor heating, air conditioning, light control, even elevators.*[150]

Negroponte's personal experiences from the vernacular architecture during his frequent visits in the Greek island Patmos, resonated with the approach of this influential exhibition. In his later research on *Computer-Aided Participatory Design*, vernacular architecture would be a key reference, offering the main diagram of his computational system.[151]

Another major influence for the removal of the architect from the process of design was Negroponte's personal contact with influential figures of the radical architectural scene of the 1960s-1970s. In his early twenties Negroponte became acquainted with Yona Friedman and Paolo Soleri.[152] Friedman and Soleri were both renowned

148. Ibid., 63.

149. Rudofsky, Bernard. 1964. *Architecture without architects: An introduction to nonpedigreed architecture.* Museum of Modern Art; distributed by Doubleday, Garden City, N.Y.

150. Ibid.

151. Negroponte, *Soft architecture machines*, 103.

152. Negroponte, "Interview by Theodora Vardouli," op. cit. See Appendix B.

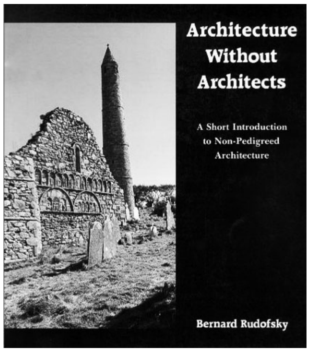



**Figure 24:** Bernard Rudofsky's *Architecture without Architects* at the MoMA (1964).

for their bold architectural utopias, advocating for a model of collectivism through individualism. Friedman's and Soleri's "wild thinking" strongly influenced Nicholas Negroponte at an age where, as he confessed, he was generally "impressionable."[153] In *Soft Architecture Machines* Negroponte would refer to this model as "architectural do-it-yourself-ism" as a counterpoint to other timid, yet popular, models of design participation such as the "doctor planner," the "egalitarian planner," or the "soft cop."[154]

*c. Redefining the user-computer relationship: Licklider, Pool, "Machines"*

The strong political flavor of Friedman's and Soleri's proposals was not shared by Negroponte. As Guy Weinzapfel observed in interview, Negroponte was disinterested in social politics, but deeply concerned with, what Weinzapfel referred to as, the "politics of computers."[155] The invention of time-sharing and the optimism stemming from the field of Artificial Intelligence, were key in the development of the two central ideas which underpinned the activities of the Architecture Machine Group throughout the 1970s.

The first idea had to do with a "humanism through intelligent machines,"[156] which Negroponte had already outlined in *The Architecture Machine*. Negroponte identified the *Machines* (1968) exhibition at the Museum of Modern Art (MoMA) in New York, as an important influence in the the adoption of this approach. In the exhibition's catalogue, encased in a characteristic hinged metal box, the curator of the *Machines* exhibition, had marked a shift from the mechanical age to the age of systems imitating brain and neural processes, and discussing Art as the gateway to the achievement of a new machine humanism "the totality of human life on this planet." [157] In a similar spirit, the possibility of the domestication[158] of intelligent machines by the "general populace,"[159] made possible by time-sharing, allowed Negroponte to envision systems where the part and the whole, the local and the global could coexist, interact and retroact, escaping the reductionist logics of the myopic look to the small scale, or the oppressing generalizations of the large.

The second idea, and perhaps the most central one, as Weinzapfel argued in interview, was the notion of interactivity, as human-computer partnership.[160] In personal conversation, Negroponte recognized as a milestone in his thinking about machines, J.C.R Licklider's[161] influential paper *Man-Computer Symbiosis*.[162] The paper is well appreciated in the field of human-computer interaction, as being amongst the first to advocate for a partnership between computers and humans, where computers operate as thinking aids and not as mechanical automatons.

153 Ibid.

154. Negroponte, *Soft architecture machines*, 100-101.

155. Weinzapfel, "Interview by Theodora Vardouli," op. cit. See Appendix C.

156. Negroponte, *The architecture machine*, 1-7.

157. Hulten, Pontus. 1968. *The machine: As seen at the end of the mechanical age.* Museum of Modern Art.

158. Negroponte, *The architecture machine*, 55-57.

159. Negroponte and Groisser, *Computer aids to participatory architecture*, 1.

160. Weinzapfel, "Interview by Theodora Vardouli," op. cit. See Appendix C.

161. J.C.R. Licklider was head of the Information Processing Techniques Office (IPTO) at Advanced Research Projects Agency (ARPA) and is considered as the intellectual father of ARPAnet which later became the Internet.

162. Licklider, J. C. R. 1960. Man-computer symbiosis. *IRE Transactions on Human Factors in Electronics HFE-1* 4-11.

*d. The bricolage of computer aids to participatory architecture*

In the beginnings of the 1970s, all the components for Nicholas Negroponte's bricolage of computers, Architecture and design participation were already present. Yona Friedman's system, as described in *Toward a Scientific Architecture,* offered Negroponte a convenient conceptual basis for the combination of these ideas in the concept of *Computer-Aided Participatory Design.* Friedman's system was "computational enough"[163] to be easily implemented in a computer: the graph theoretical formalization of the design process that Yona Friedman had proposed in his book could be almost instantly programmed in computer language,[164] and aligned with the state-of-the-art of research in automatic layout generation.[165] At the same time, it could be argued that Friedman's reputation as a radical figure of participatory design, played a symbolic role in the Architecture Machine Group's operations, who were trying to dissolve the ideas that the computer was a tool for the "military-industrial complex only."[166]

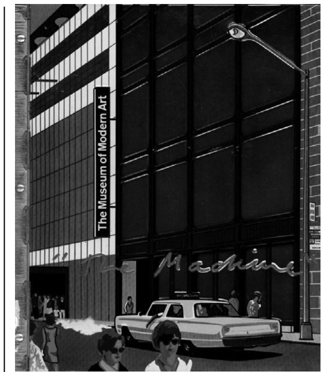



**Figure 25:** Pontus Hulten's *Machines* at the MoMA (1968).

Negroponte's discussion of computer aids to participatory architecture can be viewed as an extreme testing case of his main research agenda; computers as tools for personalization and creativity. The discussion of user empowerment in design, was fueled by Negroponte's possibly even stronger desire to empower the machine in design; to allow it to interface with the real world, to make it a sentient design partner. In Nicholas Negroponte's and the Architecture Machine Group's research agenda, user empowerment in design was a subset of a broader negotiation of the computer as a tool for creativity and personalization, which Negroponte continued pioneering after the abandonment of the participatory design discussion in the mid-1970s. This shift in the computational metaphor to acquire metaphors of creative individualism, is important for the understanding and evaluation of the current discussions of tools for design "democratization."

## *Afterword for Chapter 4*

*Toward a Scientific Architecture* and the research in computer aids to participatory architecture, as described in the Architecture Machine Group's 1971 NSF proposal and a few years later in *Soft Architecture Machines,* are condensers of an intricate net of ideas, influences and contexts, which coalesce in the merging of computation and participatory design. The purpose of this historical narrative was to illustrate some of the conditions which legitimized the analogy between computation and design participation.

When the concept of computation and the concept of user participation in design, as defined by Friedman and

163. Negroponte, "Interview by Theodora Vardouli," op. cit.

164. Weinzapfel, "Interview by Theodora Vardouli," op. cit. See Appendix C.

165. For example see Grason, J. 1971. An approach to computerized space planning using graph theory. *Proceedings of SHARE-ICM-IEEE. Design Automation Workshop*: 170-9.

166. Negroponte, *Soft architecture machines*, 99.

Negroponte, were placed side by side and started to negotiate their boundaries they were already alike. In Negroponte's work one can clearly discern a shift from the conception of the computer as a tool of military domination to a tool for creative expression and personalization. Conversely, Friedman's work is an indicative example of an attempt to accommodate creative expression and personalization in an "objective" informational system.

Friedman and Negroponte adopted the same rhetoric against architectural paternalism and engaged in the same enterprise to develop tools and methods in order to remove the architect-middleman from the process of design and give the control to the user. The collaboration of Yona Friedman and Nicholas Negroponte in the *Architecture-by-Yourself* project of the Architecture Machine Group further indicates the "compatibility" of their models for design participation, even though these originated from very different contexts and were underpinned by different intentions. This invites further inquiry into the models themselves in order to respond to the question: In what are they similar? In what are they different?

The following chapter focuses in *Toward a Scientific Architecture* and Negroponte's writings on computer-aided participatory design, in order to extract and diagram the way that the two systems are set up, their principles and structures. This can allow for a comparison of the diagrams of the two models and the identification of similarities and differences in their computational structures.

# *5. Description*

## *Intentions and implementations in Toward a Scientific Architecture and in Computer Aids to Participatory Architecture / Computer-Aided Participatory Design*

## *Foreword for Chapter 5*

This chapter describes Yona Friedman's and Nicholas Negroponte's systems for design participation from the perspective of their computational structures. These structures are abstracted and diagrammed from Friedman's book *Toward a Scientific Architecture,* and from Negroponte's writings on computer aids to participatory architecture. In the case of Nicholas Negroponte, the description is informed both from the Architecture Machine Group's proposal to the NSF entitled *Computer Aids to Participatory Architecture*, and the *Computer-Aided Participatory Design* chapter in his *Soft Architecture Machines* book.

The goal of this chapter is to condense the mathematical representations and interaction protocols of the proposed systems in two diagrammatic descriptions. These diagrams can then be discussed comparatively, revealing affinities and discrepancies between the two authors' approaches. At the same time, these abstracted computational structures can be analyzed and critiqued in relation to their authors' arguments, in order to reveal assumptions which are implicit in the texts, or to identify potential contradictions between the authors' intentions and the systems' implementations.

In this chapter, the *Argument* sections describe the vision of each author, the problem to which he is trying to respond ,and the principles of the solution which he proposes. The *Computational system* sections abstract first, the way that a design problem is described and input to the machine, and second, the way that the machine internally represents and processes the design problem in order to resolve it in built form.

# 5.1. Diagramming *Toward a Scientific Architecture*

### 5.1.1. Friedman's argument

- Vision: Remove the architect - middleman from the process of design and give control to the future inhabitant.
- Problem: The traditional informational model of Architecture does not give users the right to choose and the right to change their habitat.
- Proposed solution: A new informational process of Architecture based on a "language" understandable and communicable to everyone.

Yona Friedman's vision is to emancipate the future user from the architect's "patronage" and, simultaneously, make the architect useful to the user.[167] In *Toward a Scientific Architecture* he describes a system of axioms and methods which aim to remedy two pressing problems of architectural processes. The first problem is related to the architect's handling of the amount and complexity of information involved in design problems, while the second refers to building's adjustability to the shifting needs and desires of its future users.

Friedman contends that these are essentially problems of information manipulation.[168] He argues that the nature of every science and art can be defined by the emission, transmission and reception of a significant message and that, therefore, information theory can account for any epistemological concern.[169] Following this proposition, Friedman describes architectural processes as "information processes" where the user is the "transmitting station," the architect is the "channel," and the building, which he refers to as "hardware," is the "receiving station." The "message" transmitted, processed and received in this circuit are the future user's needs and values, which are resolved into a building in the receiving edge of the information process.[170] In this scheme, the ability of the "hardware" to respond to these needs is defined as the "feedback."[171]

Friedman recognizes two "informational short circuits" caused by the traditional information processing diagram in Architecture.[172] The first is that the complexity of the building projects and the large number of users who these projects seek to accommodate, is unmanageable by the architect. The architect's traditional response to this "jammed circuit" is the invention of a fictive entity, the "average user," who represents the statistical means of the largely diverse body of future users. The figure of the "average user" replaces the informational "jamming" with a "broken circuit," where the architect's design decisions are made to accommodate a non-existent entity instead of the "real" users of Architecture. The "informational bottleneck" is also manifested in the inability of the user to modify the end product of the process (the building) so as to respond to changes in needs and desires.[173]

These phenomena are condemned as immoral and oppressive, as they exclude the future user from the rightful ability to decide on how he/she desires to live. In his book Friedman argues characteristically:

> *The point of such a long introductory chapter is to insist on the fact: the power of choice rightfully belongs to the user. That is why this chapter is entitled "democratization," for the word democracy indicates that everybody has his share in making the decisions [...]*

167. Friedman, *Toward a scientific architecture*, xi.

168. Ibid., 4.

169. Ibid., 6.

170. Ibid., 4.

171. Ibid.

172. Ibid., 6.

173. Ibid., 6.

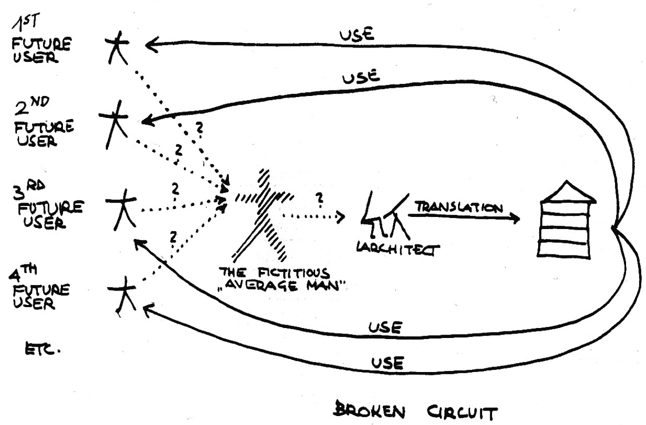



**Figure 26:** Yona Friedman's "broken circuit." Unable to handle the particularities of each user, the human architect resorts to oppressive statistical generalizations (i.e. the "Average Man.")

> *[...] Any system that does not give the right of choice to those who must bear the consequences of a bad choice is an immoral system. But this is exactly the way that architects and planners work. They make the decisions and the users take the risks.* [174]

Friedman's response to these problems, is a remodeled architectural process which changes the information flow between the users and their habitat. The purpose of this new diagram is to give the future user the possibility to directly decide on a design knowing all the "risks" involved, and to be able to realize and evaluate it without distortions or interpretations from mediators. Friedman argues that this is contingent on the user being "informed," being able to "read" a design and communicate any desired changes and alterations in the same language.[175] The readability, communicability and evaluability of the language is in turn argued to rely on its "objectivity." According to the working definition in *Toward a Scientific Architecture*, "objective" systems are systems where the descriptions are transferrable as instructions, regardless of contextual differences or the subjectivity of the observer, while "intuitive" systems are systems where descriptions are based on symbols and codes, inevitably context dependent and open to interpretation.[176]

Following Friedman's syllogism, the establishment of an "objective" architectural "science" necessitates the development of a methodology which allows for a complete description of any architectural problem in a way that it is general and valid for everyone, regardless of context, culture or personal preferences. For this purpose, the discipline of Architecture and Planning is separated in two parts: an "objective" system which operates based on strict and unambiguous rules, and an "intuitive" system contingent on meaning and interpretation. This foundational division where the "objective" system belongs to the architect-expert while the "intuitive" system belongs to the user, allows for a conceptualization of Architecture as a scientific discipline based on an objective "infrastructure" allegedly fostering unlimited intuition.

174. Ibid., 12-13.

175. Ibid., 13.

176. Ibid., 16.

### 5.1.2. Friedman's computational system

- Description of the architectural problem:
    - An unambiguous axiomatics: A complete planar graph of three axioms;
    - Applying the axiomatics for the description of any architectural problem: Points, links, labels.
- A remodeled Architectural process: Complete combinatorial lists of n planar graphs, connected and labeled.
- New roles in design: The architect/machine as menu-maker and the user as informed menu-picker.
- Evaluation of a design: The path matrix as a personalized metric.
- Realization of a design: An infrastructure supporting choice and change.
- Computational implementation of Friedman's method: The FLATWRITER machine.

Friedman proposes that Architecture should be redefined from a "prenticeable" to a "teachable" discipline.[177] This suggests that its description should be based on statements which can be understood and verified by everyone, users, architects and builders, regardless of contextual and cultural differences. This requirement in turn, posits the question of how one can inter-personally describe a statement in an unambiguous way.

*Architectural axiomatics:* Friedman defines a statement as a system of propositions placed in a logical sequence. Any statement can therefore be represented one-to-one by a connected graph, where propositions correspond to points, and the logical order of propositions to links. Based on the assumption that the graph is a one-to-one mapping of a statement, Friedman uses graph theoretical operations to identify the requirements of a "generally valid axiomatics" for the science of Architecture.[178] He contends that in order for an axiomatics to be universally understandable, acceptable and verifiable,[179] thus fulfilling his programmatic proclamations on an objective architectural language, the statements of the axiomatics have to fulfill three conditions: consistency (no statement contradicting other statements), non redundancy (only use a statement once) and completeness (no instance of the described system which cannot find a place in this description). Drawing from graph theory, he conjectures that the optimal representation of any axiomatics would therefore be a complete planar graph consisting of three axioms: more than three axioms would either need additional statements to dissolve the ambiguity in the direction of the links, or would imply unenunciated statements in the crossovers of the graph.

177. Ibid., 12.

178. Ibid., 20.

179. Ibid., 21.

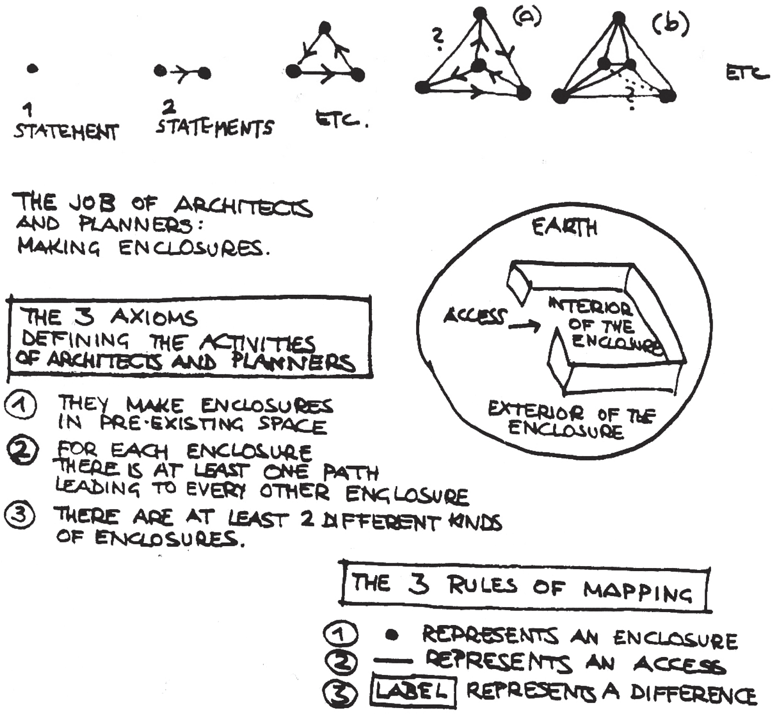



**Figure 26:** Yona Friedman's axiomatical description of the discipline of Architectute.

This closed tripartite axiomatics is consistent with the general mechanism with which Friedman claims all humans construct meaning out of reality. Humans, he observes, make sense of the world in three steps: identification (putting a mental label on something), delimiting (asserting that this thing is unique) and comparison (establishing relations between this thing and the other things).[180] The information content of Architecture, the message, can therefore be universally described through three statements (axioms): first, that Architecture produces enclosures in space (identification), second that these enclosures need to be connected (relation) and third that at least two linked enclosures are different (uniqueness). According to Friedman this axiomatic is successful, as it allows for a clear description of the object of Architecture in a way that anyone can understand it and because it can accommodate "any solution imaginable proposed by any human being imaginable within the realm that they define, except for those that are physically impossible."[181]

This axiomatical description formalizes any architectural problem as a mathematical (computational) problem of creating of a number of enclosures where each enclosure is connected to at least one other and where at least one enclosure is different than the others. The mapping that Friedman proposes for any architectural problem is:

enclosures --> points
access --> links
formal/functional differentiations --> labels

180. Ibid., 20.

181. Ibid., 26.

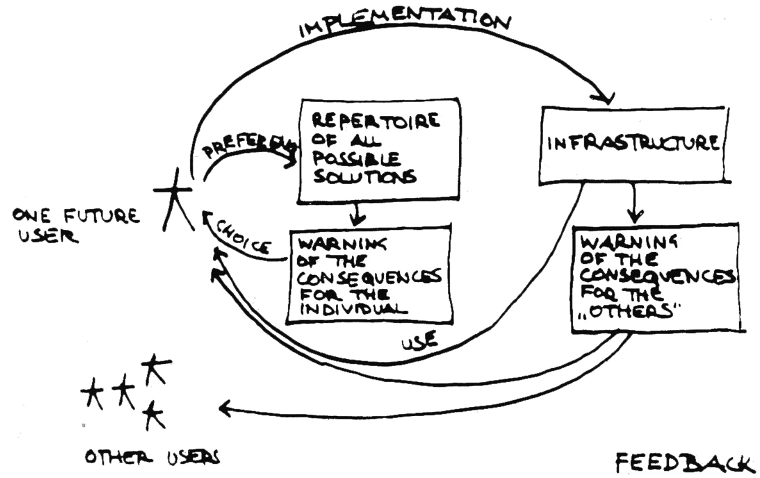



**Figure 27:** Yona Friedman's remodeled architectural process.

Therefore, condensing Friedman's proposition:
Any solution to a design problem has an underlying spatial structure which can be one-to-one mapped as an n planar graph, connected and labeled by means of (n-1) labels of one kind and one at least label of another kind.

*A new informational process:* Based on this new system of description Friedman proposes a "remodeled version of the (architectural) process."[182] This process consists of the construction of complete repertoires which hold all the possible solutions to a problem, i.e. all the possible valid spatial structures which can be generated for a given number of enclosures. The items of these repertoires can be transposed to the physical world thanks to Friedman's axiomatic notation ("rules of mapping") which allows for any spatial configuration to be isomorphically represented as an n planar graph, connected and labeled. These abstract spatial structures are concretized based on "labels" reflecting the user's preferences. Every element of Friedman's "menu" is accompanied with an evaluation metric ("warning") which informs the user and the user's community about the implications of each design decision. These metrics are calculated based on the mathematical properties of the graph theoretical representation of each design solution by taking into account the user's living habits over a given period of time.

*The expert's role:* The role of the "expert" in this new process, is to construct complete combinatorial lists of all the possible configurations for a given number of enclosures and an intuitive and subjective list of labels (i.e. functional and formal differentiations). The architect-expert's operation can be replaced by a machine such as the FLATWRITER, which would perform the same combinatorial operations and ourput a complete list of design possibilities. Friedman's promise of empowerment is that the user will not only

182. Ibid., 9.

be presented with a complete list of combinations, but that these combinations will also come with an evaluation of the implications of each decision in the future users life and comfort. This new architectural process is analogized by Friedman to “eating out:”[183] The architect / machine prepares the “menu” of solutions and lists a “price” for each option, warning the user and the community about the results of each choice.[184]

*The non-expert’s role:* The role of the user is to “read” the “menu” and to make an informed choice of an architectural “meal” (building configuration). The user also participates in the menu-making activity by selecting the labels (formal and functional attributes) to be overlaid in the abstract spatial configurations of the graph.

*Evaluation metrics:* The “price” or “warning” for each element of the combinatorial list of design possibilities is based on the intrinsic characteristics of the composition (the topology of the graph) and the future user’s living habits.[185] All possible configurations are accompanied with a series of evaluative metrics, which are derived from their structural diagrams, but are personal to each user. These metrics, referred to as “warnings,” come in the form of a matrix, which corresponds to the distance between any nodes of the linkage, multiplied by the “weights” of these nodes (how many times the user enters a specific room for a given time).[186] Friedman refers to this metric as the “effort matrix.”

183. Ibid., 33-34.

184. Ibid., 33-34.

185. Ibid., 6.

186. Ibid., 40.

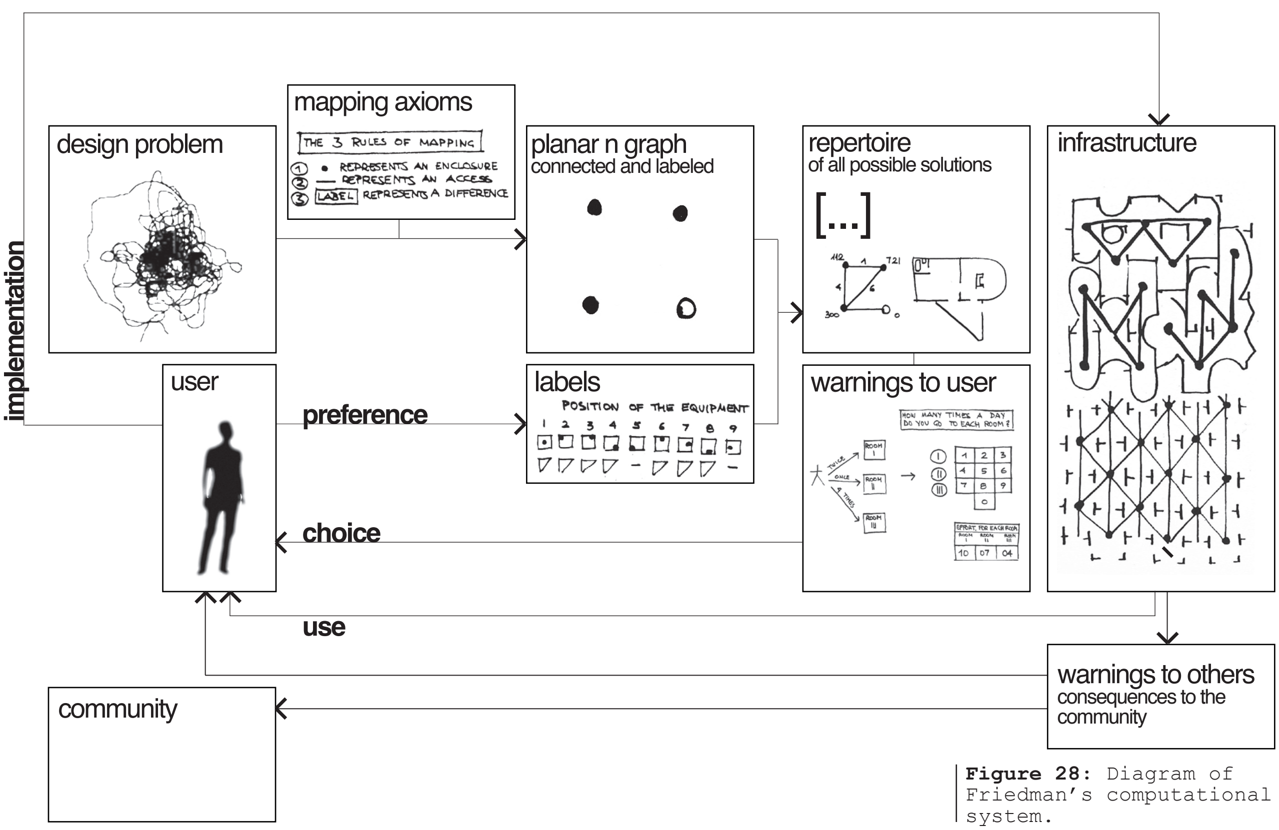
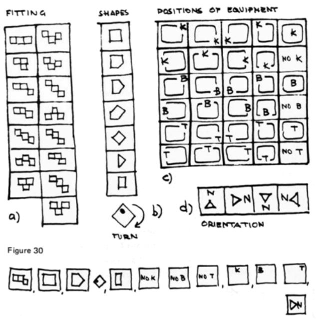



**Figure 28:** Diagram of Friedman’s computational system.



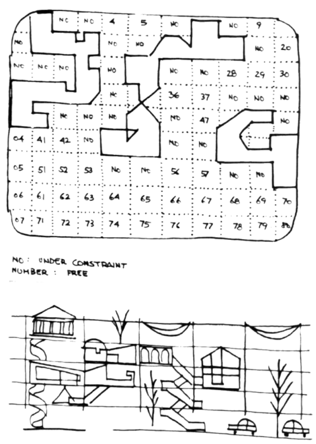




**Figure 29:** A case of the FLATWRITER personalized keyboard, with labels designated by the user.

**Figure 30:** Possible outputs of the FLATWRITER machine, in plan and section.

The effort matrix operates as the "warning" which informs the users about the efficiency of choosing a specific linkage and using it in a specific way. This evaluation system is proclaimed to empowers users to mentally experiment with a series of possible arrangements, "without actually having to build them all,"[187] and to establish a common ground for the comparison of all the elements of the repertoire, based on hard, objective metrics and thus avoiding "the mistakes usually made in intuitive comparisons."[188] The scenario is that through this mental gymnastics the user will be able to choose the architectural solution that would result in greater satisfaction.

*The infrastructure:* This complete combinatorial list of possibilities produced by the architect-machine, has to be supported by a physical infrastructure which would allow for the realizability of all possible spatial configurations. Friedman argues that the infrastructure able to accommodate the entire n list of combinatorial possibilities, is either the non connected n graph or the saturated n graph. The physical equivalent of this representation is a standardized spatial division, resembling to a space grid, which can be physically manifested in two ways. The first case corresponds to the non-connected graph, where the infrastructure contains no connections available between the nodes (space-units) and access is established through a process of opening holes in the infrastructure. Friedman calls this "the troglodyte model."[189] The second case is that of the saturated n-graph, where all the possible connections are already established and the specific spatial configuration selected by the user is realized by cutting down some of the spatial links (placing temporary dividers). Friedman calls this the "skeleton model."[190] In this model of structure and infill, the infrastructure (graph - objective system) is stable, while the user settlements (infill - subjective system) are ephemeral, allowing for change and infinite variation. This is Friedman's model of the *Spatial City*, presented as an inevitable result of a rigorous epistemological inquiry into Architecture.[191]

*Configurational histories:* If the infrastructure accommodates all possible combinations, then every physically possible future choice that the inhabitant will make will be within the initial system. Friedman proposes that the notation of the graph and the labels will allow the user to keep a history of modifications for a given span of time, reflecting either the different selected sconfigurations of the linkage or the various ways that a specific linkage is used (weights). The recording of these personal and collective "configurational histories" could, according to Friedman's claim, be used for the detection of regularities, which will allow for Planning to become what he refers to as a "scientific (or simply a conscious) activity."[192]

*The FLATWRITER:* The FLATWRITER[193] is a concept machine for participatory design, which takes the position of the architect in constructing the "repertoire" of architectural solutions for a given

187. Ibid., 42.

188. Ibid., 43.

189. Ibid., 46.

190. Ibid., 47.

191. Ibid., xi

192. Ibid., 50.

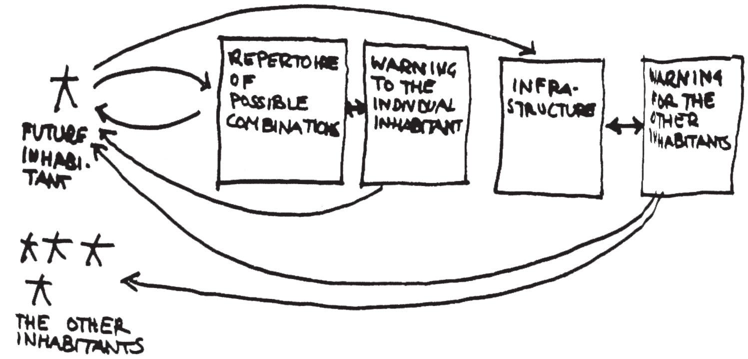



**Figure 31:** The FLATWRITER's computational "organigram,"showing the "two loops," one with one's self and one with one's community.

problem. It creates a complete combinatorial list of linkages which can be populated with labels suggested by the users and formalized in a personalized "keyboard." Friedman observes that the need to rely on a computer for the setting up of the large combinatorial lists, makes the mapping notation that he has selected (the graph, alternatively represented as a matrix), particularly convenient: the graph theoretical notations are already in computer language, thus avoiding the necessity of further transcription in order for his system to be implemented by a computer.[194]

The operational diagram of the machine consists of two feedback loops: one with the user and one with the user's neighborhood. In the first loop the user, who Friedman refers to as Mr. Smith, is presented with a keyboard with all the possible linkages, and all the possible configurations of a space in relation to a label. The personalized "keyboard" therefore, through a small number of keys, potentially contains thousands of possible layouts which can be generated by their combination. The user "designs" an apartment by successively selecting a number of keys.

In the second step of the process the user is presented with a "keyboard of weights"[195] in order to self-monitor the personal usage of every room in the selected configuration for a given period of time. The FLATWRITER calculates the "effort" for the chosen configuration and issues the first "warning" to the user. This provides the user with the possibility to either select an alternate configuration or even modify his lifestyle. After the configuration has been chosen the user is presented with a diagram of the infrastructure, where he can occupy the "free" areas. Every planning selection is accompanied by a second warning issued this time to the community according to sets of urban criteria, also expressed by a means of "effort." The machine comprises a "control mechanism" which can "check" if a user's personal choice negatively affects the neighboring dwellings in terms of light, air, access etc.[196] For every user selection, the FLATWRITER reassesses the overall configuration of the infrastructure in order to extract the new global "effort" diagram corresponding to the way that the new settlement will affect the usage of the city, in terms of circulation, noise,

193. Ibid., 53-60.

194. Ibid., 32.

195. Ibid., 55.

commercial value etc. If no conflicts occur then the user acquires an instant building permit and realizes the construction.

Friedman states:

> *The FLATWRITER thus puts a new informational process between the user and the object he will use; it allows for almost limitless individual choice and an immediate opportunity to correct errors without the intervention of professional intermediaries.*[197]

Friedman's two-loops system, one between the user and the machine and one between the user and the community, is the basic organizational diagram of Nicholas Negroponte's proposal for *Computer-Aided Participatory Design*.

## 5.2. Diagramming *Computer Aids to Participatory Architecture / Computer-Aided Participatory Design*

**Figure 32 and 33:** Images from the Architecture Machine Group's NSF Proposal *Computer Aids to Participatory Architecture.* Top: A vernacular settlement; Bottom: Mass standardized housing.

### 5.2.1. Negroponte's argument

- Vision: Remove the architect - middleman from the process of design and give control to the future inhabitant.
- Problem: The human architect is unable to handle the complexity of the particulars and resorts to oppressive generalizations.
- Proposed solution: A personal machine-partner understanding the user's idioms and idiosyncrasies.

Nicholas Negroponte articulates his vision as an architectural do-it-yourselfism, which removes the professional (middleman) from architectural processes and gives the future inhabitants full control of the design of their own environment, as they are the ones who bear the risk of failure.

The problem statement of the Architecture Machine Group NSF proposal *Computer Aids to Participatory Architecture* is that human designers are incapable of handling the growing complexity of architectural problems and thus resort to statistical generalizations which suppress the particularities of the individual. This raises ethical concerns which are epitomized in the English writer's Aldous Huxley's quote, cited in the introduction of the 1971 proposal to the NSF: "It is the particulars which interest and excite us. For particulars, as everyone knows, make for virtue and happiness; generalities are intellectually necessary evils."[198]

In the chapter *Computer-Aided Participatory Design* of *Soft Architecture Machines*, Negroponte broadens his argument to

196. Ibid., 59.

197. Ibid., 60.

include a polemic against the paternalism of the professional architect, who imposes empirically learned values and taught theories upon the future users of a design. He raises the question whether an expert's expertise can, apart from a competence in means, be extended in an expertise in goals and values, followed by a suspicion on the "distortions" that the architect's "wisdom" and "ability to pre-experience" bring in the user's initial intentions.[199]

In response to these concerns, Negroponte envisions a system of interconnected personalized design machines, capable of simultaneously accommodating the whole and the part without resorting to the simplifications of the intermediate, "average," scale.[200] His vision is to promote of "individualism" and "personal choice" and to provide the "general populace" with the means to shape their own environment without the political mediation involved in the paradigm of advocacy planning.[201] In *Soft Architecture Machines* Negroponte would proclaim that the architectural do-it-yourself-ism, inspired by Yona Friedman's model, is the only true kind of genuine user participation in design.[202]

Negroponte's proposal consists of a system of personalized machine-partners, assisting non-expert users in the expression of their intuitions in design, by engaging with them in a non-paternalistic conversations. He argues that the means to achieve the end goal of expressing the user's needs and values in the built form, is the construction of a model of the user based on which the machine can draw inferences on the user's operations and assist in their design resolution.[203]

With this objective, Negroponte proposes a system which operates in three steps: First, the machine creates a model of the user by interacting with him, following the maxims of good conversation (mutual observation, mutual interruptibility etc.). Second the machine refines the user's model of himself, through a dialogue where the machine acts at the same time as a "thirsting student" and a "benevolent educator."[204] Third, the machine produces spatial configurations tailored to the user's needs and desires, based on the model that it has created of the user and a knowledge about Architecture which has been "imbedded" in it.[205] This "knowledge" consists mainly of quantifiable goals, "criteria," which represent variables to be maximized or minimized through heuristic programming. According to Negroponte, opposite to "constraints" which point to the upper and lower bounds of variables, "criteria" indicate directions and general goals which operate in a spectrum rather than exact metrics.[206]

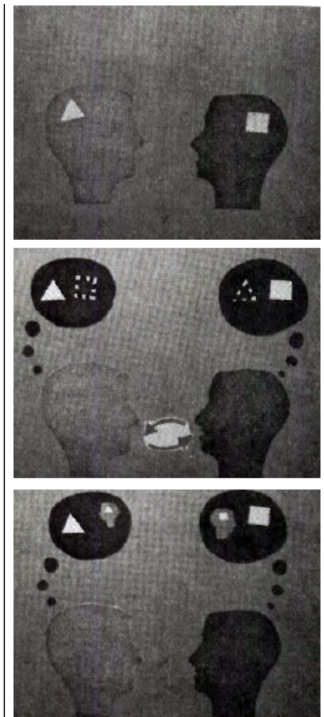


**Figure 34:** Three models for succesful inference: the machine's model of you,its model of your model of it, its model of your model of its model of you.

198. Huxley, Aldous. 2006. *Brave new world*. Harper Perennial Modern Classics ed. New York: Harper Perennial Modern Classics.

199. Negroponte,*Soft Architecture Machines*, 102.

200. Negroponte, *The architecture machine*, 1.

201. Negroponte and Groisser, *Computer aids to participatory architecture*, 1.

202. Negroponte, *Soft architecture machines*, 101.

203. Negroponte and Groisser, *Computer aids to participatory architecture*, 1.

204. Negroponte, *Soft architecture machines*, 108.

205. Negroponte and Groisser, *Computer aids to participatory architecture*, 7.

206. Ibid., 22.

### 5.2.2. Negroponte's computational system

- Description of the Architectural Problem: A messy and incomplete description via a labeled sketch.
- The Design Amplifier: Probabilistic inference based on planar graphs, connected and labeled and list of criteria.
- New roles in design: The machine as an expert "surrogate you," the user as a learner.
- Evaluation of a design: Visual evaluations and user intuition.
- Realization of a design: A (virtual) infrastructure supporting choice and change.

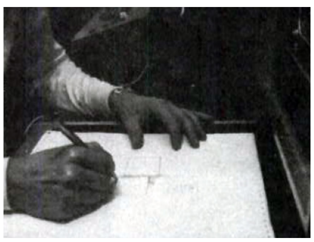


**Figure 35:** Sketched user input via the Sylvania tablet, from the ArcMac's NSF 1971 proposal.

*User idioms and sketching:* Negroponte's objective is the creation of a fluid dialogue between the user and the machine. He argues that architecture processes are inherently dependent on metaphor and context and it is therefore impossible to devise general rules and axioms,[207] as for example in Friedman's system. In order to accommodate the user's intuitions and idiosyncrasies, the initial problem statement is input to the machine via a sketch made by the non-expert user with a light pen on a tablet, thus avoiding the tedius questionnaires which were, at the time, employed in programs for design automation.[208]

Negroponte's system is based on implicit and unstated criteria,[209] inferred by the machine in a process of mutual understanding and partnership with the user. The user's lack of expertise in sketching makes the problem even harder, as the sketch from which the machine draws inferences is usually not drawn proficiently. However, besides the inconsistency in proportion and wobbly, indecisive lines,[210] Negroponte construes that the non-expert user's sketches are very successful in capturing spatial relations reflecting the user's mental image of a space.[211] Through sketch recognition algorithms, the machine can therefore extract the spatial relations implied in the user's sketch and represent them through a linkage capturing adjacencies and connections of spaces. This linkage is the description of the architectural problem, inferred from the user's sketch. Apart from these spatial relations, the machine collects data on various sketch attributes so as to infer the user's state of mind while making the sketch. The data about how the sketch was made is captured in an 1-D structure, while a 2-D structure corresponds to visual elements.

The computational representation of the sketch is as follows:
design elements --> points
relations, connections, adjacencies --> links
sketch attributes (reflecting user preferences, states of mind) --> list

207. Negroponte, *Soft Architecture Machines*, 33.

208. An indicative example of such programs, eliciting information from the user based on tedious questionnaires was for example the ARCHIT program by Huck Rorick. Rorick, Huck. 1971. An evolutionary architect wright. *Journal of Architectural Education 26* (1 and 2): 4-7.

209. Negroponte and Groisser, *Computer aids to participatory architecture*, 23.

210. Negroponte, *Soft architecture machines*, 121.

211. Ibid., 121.

Therefore, in Negroponte's system:
The sketch is abstracted to a planar graph, a relational structure without metric, accompanied by a list of variables which contain data about the user, inferred from his/her sketch.

Based on the relational structure extracted from the sketch, and the data structure of sketch attributes, the machine, "half listens to a story" (by the user) and makes recommendations which would be interesting to the user.[212] These recommendations are combinatorial possibilities on the structure extracted from the user's sketch. Through a probabilistic chaining of functions and procedures the machine "decides" which of these recommendations would fit the user's model, complying at the same time with a set of external, objective criteria.

*The expert's and the non-expert's role:* In Negroponte's proposal the architect is removed from the process of design and control is given to the future inhabitant, who becomes "his own architect" through the assistance of a personal machine. The user's role is to work the architectural problem together with a machine partner, capable of inferring the user's architectural intentions and express them in physical form. The user converses with the machine graphically (by sketching) and linguistically (by setting values to quantitative variables) until a mutual understanding is reached. Until then the user can interrupt the machine and agree or disagree with its output.[213]

212. Ibid., 121.

213. The idea of mutual understanding and interruptibility as keys to a successful human-machine conversation were already articulated in the section "Prelude to an architect-machine dialogue" in Negroponte, *The architecture machine*, 9-15.

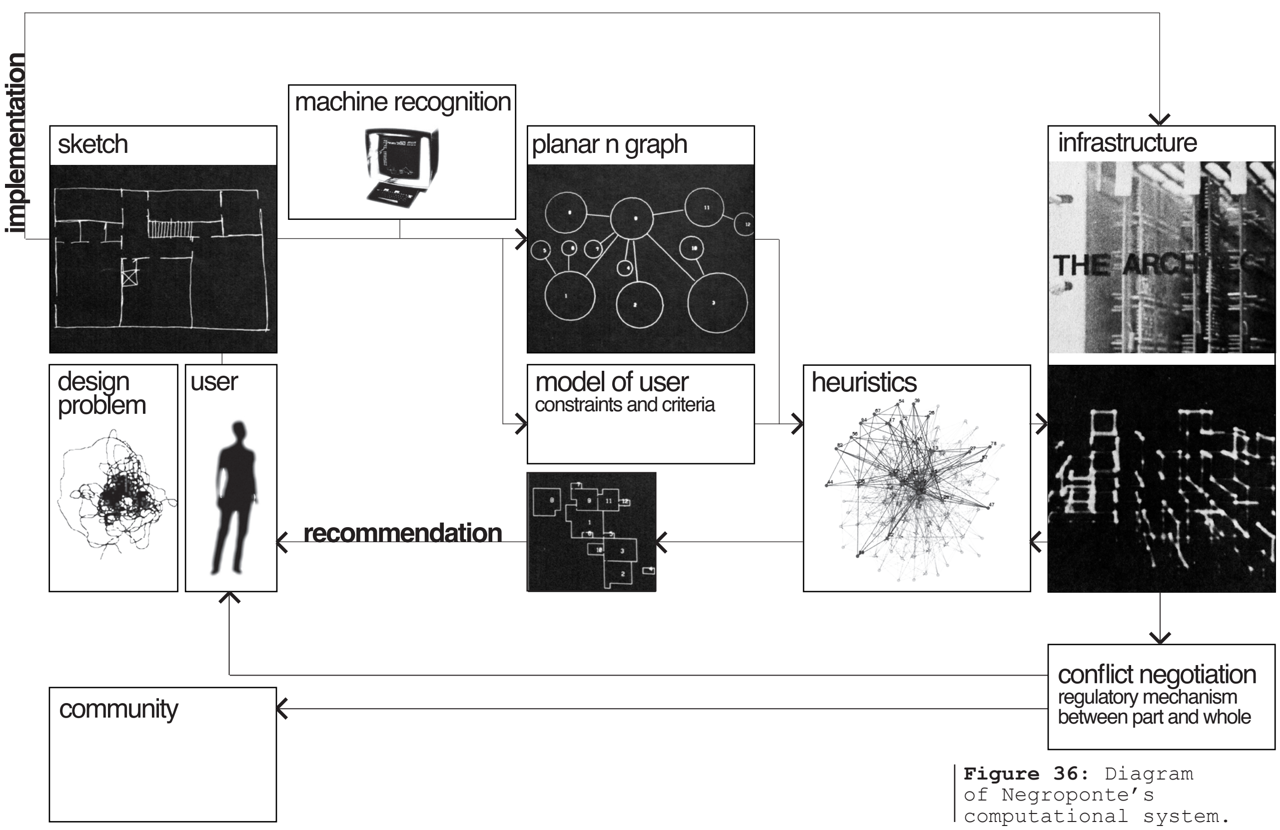
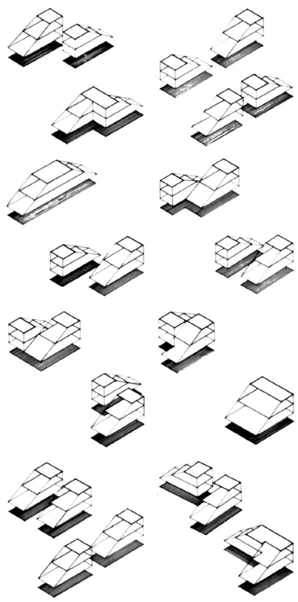



**Figure 36:** Diagram of Negroponte's computational system.



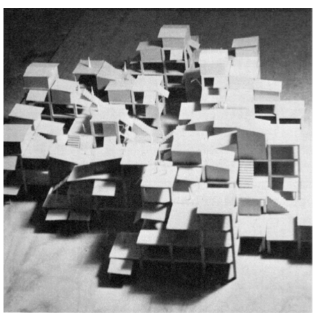


**Figure 37 and 38:** Possible outcomes of a computer-aided participatory design process shown in *Soft Architecture Machines*.

The role of the machine is then what Negroponte conceptualizes as "a sympathetic conversant."[214] According to Negroponte, the goal of the system is not to learn Architecture, as this is already hardwired in it, but to "learn the user."[215] By establishing a "congenial partnership" with the user, the machine mediates between the user's intentions and a set of objective criteria (structural, urban, environmental etc.).

The machine starts with a partial list of explicit variables (spaces, metrics etc) which is constantly updated with new variables and criteria inferred by the user-machine dialogue or by shifts in the general context. These criteria can be invented on the fly and do not have to be stated from the beginning; "The user must come to realize that each and every verbal and graphical act by him or by the machine results from or directly affects some stated or unstated criterion."[215] The search and evaluation of the possible combinations on the structure extracted from the user's sketch is internal to the machine.

*Evaluation:* Based on the structure abstracted from the user's sketch and the list of external criteria, the machine produces a plan recommendation which is exhibited to the user. The user evaluates this recommendation in a visual fashion. This visual evaluation of a sketch's "architecturalization" by the machine can either result in the user's acceptance of the recommendation or the production of a new sketch, and the continuation of the "conversation" until an agreement is reached.

*Design Amplifiers:* This approach to design participation is further articulated in *Soft Architecture Machines*, where Negroponte refers to indigenous architecture as a model for his system. In the chapter *Computer-Aided Participatory Design*, Negroponte describes a model of Design Amplifiers, all linked together and connected with a variety of host machines, as allowing for a reciprocal relation between local needs and desires and global criteria or constraints. He observes that in vernacular architecture, global forces, such as "structural materials, climate, traditions from previous but now defunct environmental causes"[216] ensure the unity of the whole and allow for liberty in the local level. Negroponte continues to denote that this model is affine with the two-loop informational process that Yona Friedman had proposed in the FLATWRITER, where the "vulgarization" of the objective parts of the system and a simple feedback mechanism between personal and collective decisions, opens the door to a large variety of intuitive solutions.[217] The scheme of the interconnected design amplifiers and communicating host machines would allow users to negotiate their personal choices within what Negroponte defines as a "regulatory framework." [218]

Negroponte admits that the realization of the personalized design recommendations produced by the machine is dependent on the

214. Negroponte and Groisser, *Computer aids to participatory architecture*, 1.

215. Ibid., 7.

215. Ibid., 23.

216. Negroponte, *Soft Architecture Machines*, 103.

217. Ibid., 103.

existence of an "infrastructure," which in his case takes the form of a combination of virtual and actual structures. The infrastructure is defined as a set of physical and conceptual elements "composed of a resilient building and information technology" which constitute a "subtle but preponderant force" in the process of design participation.[219] Within this context, the Design Amplifier assists the interfacing between the user's constantly changing needs and the infrastructure.

## *Afterword for Chapter 5*

Chapter 5 presented descriptions of Yona Friedman's and Nicholas Negroponte's systems for design "democratization." The outline of their arguments and the abstraction of two comparable diagrams of their computational structures, brings forth salient convergences and divergences. The two systems share a common anti-professional vision and employ the same double loop control mechanism to envision an architectural do-it-yourself-ism within a global regulatory framework.[221] However, Yona Friedman's advocacy for objectivity, science and explicitness appears antithetical to Nicholas Negroponte's argument for context, metaphors and inferences. Besides these antithetical approaches resulting in salient differences in the input and output channels of the two systems (universal language VS personal idioms, repertoire of possibilities VS one personalized recommendation) the two computational proposals employ the structural model of the graph in order to internally represent a design problem and compute alternative solutions. Comparing Yona Friedman's and Nicholas Negroponte's systems, one is faced with two seemingly different black boxes, which however present the same contents once opened. This convergence in the internal workings of the two systems invites the following questions: What is the motivation and the significance of this representational convergence? Can the same computational representation accommodate such vastly different programmatic agendas as far as the interaction of the user with the control system (machine) is concerned?

The graph was (and still is) a pervasive model for computation. Its pervasiveness is primarily based on its representational convenience for an informational machine. The graph is a discrete mathematical structure, consisting of entities (vertices) connected by relations (lines), therefore seamlessly aligning with the discrete, binary nature of informational machines, which operate on rule-based combinations of 0 and 1. Friedman's observation that his graph representations were already in "computer language"[222] applauds this property. Conversely, Nicholas Negroponte was already building on a background of computer graphics applications such as ARCHIT which were using graphs to represent spatial relations. At the same time, Artificial Intelligence research and applications, which highly enthused Negroponte, were establishing the graph as the model of the computer's "mind," using it from knowledge representation to search and probabilistic inference.[223] From this perspective the employment of the graph by both authors could be interpreted as a utilitarian choice, a convenient mathematical representation for the implementation of their systems by a machine. Is the graph (only) an opportunistic choice aligning with the "innate" logic of an informational machine?

The following chapter supports the hypothesis, that apart from a utilitarian role, the graph is also central in the framing of the authors' proclamations of non-paternalism. The analytical framework developed in it seeks to illuminate the authors' optimism about the neutrality (even the "morality") of the graph and to problematize it as a device which allows the authors to reconcile their positivist dispositions and their allegedly democratizing intentionalities.

# *6. Analysis*
## *The role of the Infrastructure, the Interface, the Graph in the debates of "non-paternalism"*

## *Foreword for Chapter 6*

Yona Friedman's and Nicholas Negroponte's key proclamation is the non-paternalistic character of the computational processes that they propose. Opposite to the architect-middleman, who distorts the user's needs and values according to personal preferences and learned professional assumptions, the computational medium is advertised as empowering users to directly express their own hypotheses in the design of their habitats. The question framed in the introduction of this thesis, regarding the replacement of the architect's paternalism by a machine paternalism, can thus be recast as follows: How does the machine mediate the users needs and values without distorting them with external hypotheses?

In the afterword of the previous chapter, the graph was identified as a mathematical representation which is common in Yona Friedman's and Nicholas Negroponte's computational systems, yet vested with divergent significations. For Friedman, the graph operates as a universal descriptive apparatus, allowing for science and objectivity, while in Negroponte's proposal the graph is employed as a way to model and emulate the user's subjectivity. However, both authors implicitly assert it as a neutral (or even "moral") medium, consistent with their promise of non-paternalism. This chapter problematizes the discursive role of the computational structures of the two systems in relation to their authors' proclamations of non-paternalism, in order to reveal the assumptions underpinning the authors' optimism about the non controling and neutral character of their mathematical representations.

# 6.1 Yona Friedman: The graph as a tool for objectivity and science

### 6.1.1.Friedman's call for a Science of Architecture

The title of *Toward a Scientific Architecture* explicitly reflects Friedman's intention: his goal is to develop a "scientific" method for Architecture and Planning. In the 1960s the discussion on scientific approaches to these disciplines was gaining momentum in the Anglo-American scene , through the operation of the Design Methods movement. One year before the publication of Friedman's *Toward a Scientific Architecture* in French, Herbert Simon had published the influential book *The Sciences of the Artificial*,[224] while three years earlier Christopher Alexander had developed his argument for logic and objectivity in his book *Notes on the*

218. Ibid., 103.

219. Ibid., 103

220. Negroponte, *The architecture machine*, 1.

221. Negroponte, *Soft architecture machines*, 103.

222. Friedman, *Toward a scientific architecture*, 32.

223. Negroponte and Groisser, *Computer aids to participatory architecture*, 60.

224. Simon, Herbert A. 1996. *The sciences of the artificial*. 3rd ed. Cambridge, Mass.: MIT Press.

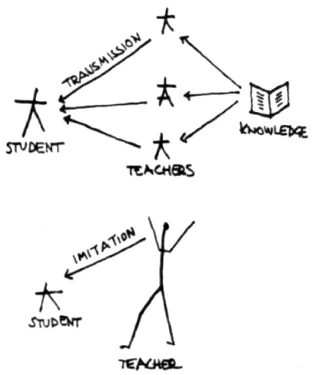



**Figure 39:** "Teachable" vs "prenticeable" disciplines. Sketch by Yona Friedman.

*Synthesis of Form.*[225] In view of the technological possibilities, the implications of mass production, as well as the almost unmanageable complexity of design problems, caused by the "great numbers" and the accelerating rhythms of change, the Architectural thought of the 1960s gradually shifted from the attributes of the architectural object to the accommodation of the user's needs.[226]

In a surface reading, *Toward a Scientific Architecture* seems to embark in a similar enterprise to use information theory in order to produce a systematic knowledge around the design and evaluation of "man made things and systems."[227] In the first chapter of the book, Friedman states characteristically:

> *Today, there are no strict rules, either in Architecture or in city planning, which allow us to predict accurately the results of a particular decision. Both professions make use of the tricks of the trade. These tricks do not necessarily work in every case and it is often difficult to tell the difference between a case when they will work and a case when they will not.*[228]

Friedman's statement reveals his belief on the necessity of a scientific methodology as a response to the empirical methods ("tricks of the trade") that the architects were so far employing, as these proved unresponsive to the growing complexity of design problems. However, Friedman's political commitment to the principle of democracy and non-paternalism, prevalent throughout his personal work, makes his call for science distinguishable from the most of the 1960s tendencies advocating for the "need for rationality." [229]

Instead of viewing Friedman's call for science as a symptom of scientific determinism, this chapter analyzes it as denouncing the mystical opportunism of the architect-"master," and framing the ethical obligation of the architect to adhere to the future user's desires. Friedman seeks to transform the architect into a scientist, not anymore a genius, but an expert, who can operate within clear and transparent rules, understood and verifiable by everyone.

In order to comply with the imperative of "objectivity," Friedman redesigns the architect as a "neutral and transparent operator"[230] restrained to mechanical calculations. Within Friedman's "objective" system, it is allegedly possible to explore possibilities and develop evaluation mechanisms, understandable and verifiable by the "non-expert" future user. This decision gives full responsibility to the user:

> *It is he who takes responsibility for the entire process, since he has been forewarned of the implications of the particular solution he has chosen. [...] No special channel, no interpreter is necessary in these two loops. [...] Actually*

225. Alexander, Christopher. 1964. *Notes on the synthesis of form.* Cambridge, Mass.: Harvard University Press.

226. Bayazit, Nigan. 2004. Investigating design: A review of forty years of design research. *Design Issues* 20 (1) 16-29.

227. Archer, Bruce. 1981. A view of the nature of design research. *In Design : Science : Method.*, eds. R. Jacques, J. Powell. Guildford: Westbury House.

228. Friedman, *Toward a Scientific Architecture*, 11.

229. Alexander, *Notes*, 1.

230. Jones, Caroline A., Peter Galison, and Amy E. Slaton. 1998. *Picturing science, producing art.* New York, N.Y.: Routledge.

> *it is a little different; in fact, the channel has not been eliminated in the new process. The channel is the repertoire itself, or more precisely, the notation (mapping) used in the repertoire.*[231]

When Friedman was attacking the modernist (pseudo-) theories of Architecture in the mid-1950s, he was not rejecting the desire to establish Architecture as a well defined body of knowledge (a science), but the fact that the science of Modernism was not founded on the right tools and methods. The solution of the statistical generalization in order to handle the complexity of the "many," exemplified in the invention of the "average man," was dismissed by Friedman as immoral and politically oppressive.

Friedman's program of scientification comprises two operations. The first, is the separation of an intuitive and an objective system in Architecture. Friedman states:

> *The situation in Architecture and Planning needs to change with respect to objectivity and intuition. I divided the discipline into two distinct parts; the part that concerns the planner has become an objective system, while the part that is intuitive involves the user.*[232]

This epistemological statement presents a strong conceptual affinity with the basic scheme of Friedman's earlier theories. The premise of the *Mobile Architecture* and the *Spatial City* was, similarly, a separation between an objective, mechanical system which condensed all the necessary functional constraints, thus offering the substrate for freedom, fluidity and intuition. This separation of the "objective" from the "intuitive," allows Friedman to focus his descriptive efforts on the objective part of the discipline, which is communicable and workable.[233]

The second operation in Friedman's epistemological discussion is the choice of a model of description for the "objective" part of the system. In Friedman's quest for a model of representation, the graph emerges as a powerful mathematical apparatus. It constitutes a potent machinery which allows him to conceive of an architectural science very different than the one that he was criticizing; a new science permitting mathematical objectivity, avoiding however quantitative reductionism. In the 1960s and 1970s graph theory and topology played a protagonistic role in the "scientification" of qualitative fields of research, which were until then approached empirically or statistically. These debates may offer productive analogues in culturally and historically situating Friedman's fascination with the graph and his persistent calls for science.

231. Friedman, *Toward a scientific architecture*, 9.

232. Ibid., 17.

233. Ibid., 18.

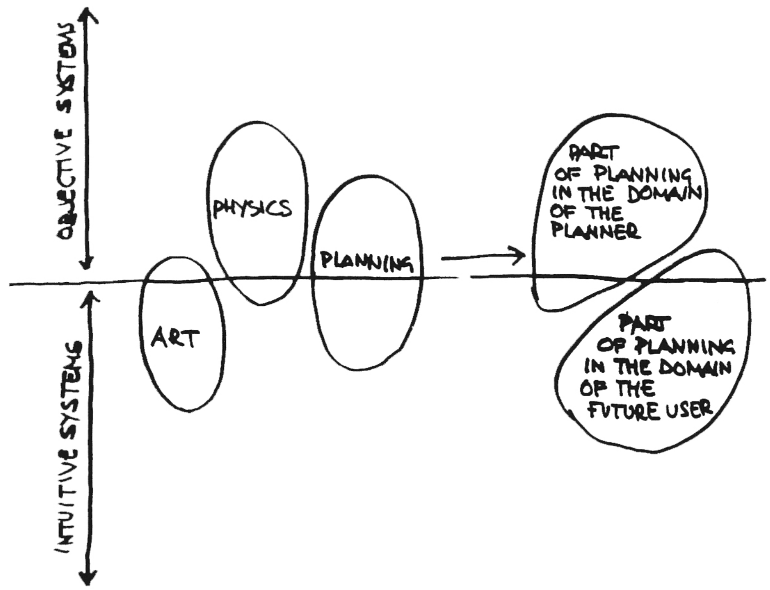



**Figure 40:** The separation between the "intuitive" and the "objective" part of the discipline of Architecture and Planning. Sketch by Yona Friedman.

### 6.1.2. Scientification debates outside Architecture

*a. Conceptualizing the sciences of man: The infrastructure and the graph*

Friedman's epistemological discourse does not emerge in vacuum. The scientification of what he refers to as the "behavioral sciences,"[234] was rising as an ethical and philosophical imperative since the 1950s. There was growing consensus amongst the "soft" sciences that empirical or statistical methods were insufficient for the description of the growing complexity of phenomena pertinent to the study of man. The need for cross-disciplinary collaboration and the employment of a common language of communication which would break the barriers between the "hard" and the "soft" sciences had brought significant epistemological changes in fields such as linguistics, psychology, anthropology, philosophy, literary theory etc.

One of the epicenters of these transformations was Paris, with thinkers such as Levi-Strauss, Lacan, Althusser, Barthes and others, who came to be classified under the historical category of "structuralism." Although Friedman does not comment on his influence from the vogue of structuralism, one cannot fail to observe that his discussion presents striking affinities with these broader epistemological discourses. The establishment of new scientific methodologies for scientific inquiry into qualitative fields of human activity was based on the same two fundamental operations

234. Ibid., 2.

that Friedman describes in his discussion of a new Achitectural epistemology:

The first movement was the separation of the objective from the intuitive part of the field of study. This opened the objective system to structural and mechanical interpretation,[235] while it asserted the unpredictable and intuitive system as a result of combinative operations on the objective, "deep" structure. The separation of the objective from the intuitive system as a pathway towards a scientific description of a qualitative field, was inaugurated in linguistics by the Swiss linguist's Ferdinand de Saussure. In his early twentieth century *Course in General Linguistics*, Saussure had proposed the separation of language from speech, and had suggested that language consisted of distinct, separate and identifiable elements (phonemes) linked with relationships governed by traceable laws.[236] This was a conceptual shift of extraordinary significance as it presented the possibility to isolate language, a phenomenon inextricably connected to meaning, as an object of scientific study, and to understand speech as a field for probabilistic calculus.[237] The mediation of language in all human communications motivated the spread of this program beyond the boundaries of linguistics, to anthropology, sociology, psychology etc.

The second foundational movement for the scientification of fields of study which were until then approached empirically, was the selection of an adequate mathematical apparatus for the description of the object of study. Graph theory, as "a novel and daring form of mathematical thought,"[238] allowed for the conception of mathematical rigor and scientific exactitude without quantitative reductionism. *The Mathematics of Man*, an introduction to the 1954 International Social Science Bulletin, written by the father of structural anthropology Claude Levi-Strauss, is indicative of the optimism with which graph theory was vested at the time. Levi-Strauss refered to graph theory as "qualitative mathematics" indicating that "rigorous treatment no longer necessarily means recourse to measurement."[239] He also contended that this new kind of mathematics was easier to intuitively evaluate. He wrote:

> *The things talked about are much smaller, they are no longer abstractions" [...] "their operations correspond to things we already know from everyday life, not losing historical and psychological significance*[240]

Frank Harary, one of the main influences of Yona Friedman for the writing of *Toward a Scientific Architecture,* was an admirer of Levi-Strauss, in whose structuralist theories, he saw both a recognition of the importance of graph theory and a invitation for its applications.

235. Levi Strauss, The mathematics of man, 582.

236. de Saussure, Ferdinand. 2006. *Writings in general linguistics*. London ; New York: Oxford University Press.

237. Levi Strauss, The mathematics of man, 582.

238. Ibid., 585.

239. Ibid., 585.

240. Ibid., 586.

### 6.1.3. The Infrastructure, the Graph and Yona Friedman's debates on "non-paternalism"

*a. An (Infra)structure for Limitless Expressive Freedom*

The illustration of the conceptual analogies between broader epistemological discourses in the "sciences of man" and Yona Friedman's discourse in *Toward A Scientific Architecture* offers additional insight in the discursive role of the infrastructure and the graph in Yona Friedman's scientification debates. The key argument of the analysis developed in this chapter is that the conceptual substrate for Friedman's model of an architectural science is infused with structuralist assumptions, which were in the air in the 1960s and 1970s.

His counter-intuitive argument that the "vulgarization of the objective part of the system"[241] can allow for unpredictability, freedom and spontaneity, is perhaps easier to understand when viewed within the broader epistemological discussions of his time. The superposition of an objective and an intuitive system was at the time pervasive in linguistics theory and was gradually migrating to all the domains of the study of man. Friedman's statement that "a highly technical and therefore impersonal system [...] can be used to express the most personal feelings of the people who use it"[242] presents striking analogies with Saussure's proposal that an objective linguistic infrastructure could accommodate the infinite expressivity of speech.

Friedman's systematical avoidance to reveal his sources of inspiration, apart perhaps from his dog,[243] leaves the hypothesis of his structuralist influences unconfirmed. However, his persistent reference to design as information processing, points to at least, a fascination with information theory, which was being developed along similar assumptions. Since the early years of communication theory researchers were asserting that all human communications shared the same three characteristics: first, that they are based on a combinatory operation on ordered elements, second that they depend on compatibilities and incompatibilities between the elements, and third, that freedom of choice within language is a field for probabilistic calculation.[244]

This leads to another intriguing question which exceeds the boundaries of this thesis, and will be eagerly explored in future work: Does the conceptual and representational convergence between the philosophical assumptions of structuralism and the modi operandi of information theory, (meaning emerging combinative operations of atomic elements linked in meaning-free structures) infuse structuralist preoccupations in design and computation? Once asserted as information processing, does computational design spontaneously adopt a structuralist logic?

241. Friedman in Negroponte, *Soft architecture machines*, 103.

242. Friedman, *Toward a scientific architecture*, 10.

243. Friedman, "Interview by Theodora Vardouli," op. cit. See Appendix A.

244. Shannon, Claude Elwood, and Warren Weaver. 1949. *The mathematical theory of communication*. Urbana: University of Illinois Press.

245. Levi-Strauss, The mathematics of man, op. cit.

*b. The Graph as an Isomorphic Model of Reality*

The emergence of the "qualitative mathematics" of graph theory as a response to the "immoral" statistical simplifications which were until then being employed for the mathematical description of qualitative fields,[245] found a fertile ground in Friedman's polemic against the statistical reductionism of the "average man" and his call for a new architectural science able to address the complexities of architectural problems. In Friedman's new informational process of Architecture, the graph operated as the "channel" between the user, who "transmits" a set of needs and values, and the "hardware" which receives the content of the user's message. This calls for further inquiry into the reasons that Yona Friedman accepted the graph is an adequate "channel." Key to understanding Friedman's optimism about the graph is its alleged isomorphism to reality, or what Friedman refers to as an "one-to-one mapping."

The assumed one-to-one correspondence of a graph to the spatial structure of a design ensures the transparency of the channel. The user can intuitively understand, verify and cognitively manipulate this mathematical abstraction in the sphere of everyday experience. This one-to-one mapping also supports Friedman's argument on objectivity. No translation is necessary between the graph and the real world; it operates as a medium for the registration of reality without intervention. [246]

Through this isomorphic mapping the graph captures pure structure, not meaning. The representation of the syntactic component of the system only, enables a series of mechanical, "scientific" operations such as the extraction of evaluation metrics (weights), the mapping of configurational histories etc. The semantics (attachment of symbols, meanings etc.) are left to the intuition of the user, who assigns meaning to the graph (labels the nodes). The representation of the graph enables the computation of the infinity of possible combinations which are potentially contained in the "infrastructure," and allows the user to "speak" in architectural language; to produce valid utterances which contain personal, intuitive meanings.

In search for the "atoms" of his architectural information theory, Friedman invents an axiomatics through which he defines design as an act of instituting divisions and separations in space and connecting them via accesses. The definition of Architecture as an operation of discretization of space supports his assumption that the graph, an inherently atomic mathematical medium, can be employed as an isomorphic descriptive apparatus, allowing for seamless transitions between reality and abstraction.

246. Frank Harary would later note that the graph appears to naturally emerge in every field which exhibits some kind of structure. Harary, Frank. 1990. On the ABC of graph applications. Le *Mathematiche* 45 (1): 75-82.

## 6.2 Nicholas Negroponte: The graph as a tool for subjectivity and conversation

### 6.2.1 Computers in Design: The syntax and semantics disjunction

Negroponte's research on computer aids to participatory Architecture has a subtext: the underpinning of his discussion on design "democratization" was an agenda which preoccupied the Architecture Machine Group throughout the 1970s: being creative with *Computer-Aided* design.[247] The vision was to transform the computer into an amplifier of creativity through the establishment of a symbiotic relationship between the user and the machine.

In 1968 Negroponte was envisioning an intimate and exclusive dialogue which would engender "ideas unrealizable by either conversant alone."[248] Apart from continuing J.C.R Licklider's influential vision on a human-computer partnership, Negroponte's early 1970s discussion on the creative potential of computation was also responding to an ongoing debate about the role of the computer in design.

Since Ivan Sutherland completed SKETCHPAD,[249] numerous applications of Computer-Aided Design started being developed, raising the question of the relationship between computers and Architecture. The predominant attitude was that computers would alleviate the architect from the burdens of the tedious, quantitative tasks involved in design, allowing for a focus of the designer's energies to the creative parts of the design process.

In the 1964 conference *Architecture and the Computer* Walter Gropius had characteristically referred to the imperative of an intelligent use of these tools "as means of superior mechanical control," offering "ever-greater freedom for the creative process of design."[250] Another assumption which would soon be commonly shared amongst the design world, was the need for a special formalization of the design problems in order to be input to the machine. The need for explicit and unambiguous descriptions of a design problem was the source of boisterous discontents to CAD. An indicative example of this dissatisfaction was Christopher Alexander's dismissal of the use of computers in Architecture, with the argument that no architectural problem had yet been formalized in a way that it could be solved by "an army of clerks."[251]

Negroponte's enterprise can be viewed as a polemical response to these attitudes. His campaigning of the computer as a partner for creative amplification sought to bridge the partitioning of the design process between quantitative and creative tasks. The main hurdle for the realization of this vision was the computer's operation on explicit, syntactic descriptions which denatured the design process and left out essential components, such as metaphor, context and

247. Negroponte, Nicholas. 1977. On being creative with Computer aided design. *Information Processing* 77 : 695-704.

248. Ibid.

249. Sutherland, Sketchpad, op.cit.

250. Gropius, Walter. 1964. Computers for architectural design. Paper presented at *Architecture and the computer*, Boston, Massachusetts.

251. Alexander, Christopher. 1964. A much asked question about computers and design. Paper presented at *Architecture and the computer*, Boston, Massachusetts.

missing information.

Inference making and sketch recognition were aimed at establishing a personal dialogue between the computer and the machine, thus bridging the gap between the semantics of Architecture and the syntactic nature of informational machines. The key to surpassing this dichotomy was the interface. Quoting from Negroponte and Groisser's 1970 article titled *The Semantics of Architecture Machines* :

> *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.*[252]

These principles were the raw material which Negroponte used in the "first loop" of human-machine interaction in his proposal of computer-aided architectural do-it-yourself-ism. The early 1970s redirection of Negroponte's interests towards the non-professional, was a thematic change, which enhanced his underlying agenda of creative man-machine partnership.

### 6.2.2 The Interface and Nicholas Negroponte's debates on non-paternalism

The "interface" is the basic computational metaphor around which Negroponte frames his debate on non-paternalism. Apart from its literal meaning the interface also plays conceptual role in Negroponte's discussion: it is the interaction protocol between constraint and choice, the infrastructure and the user, an objective and an intuitive system, the graph and the sketch. The interface therefore reconciles these antithetical entities supporting Negroponte's debate on non-paternalism. His statement in *Soft Architecture Machines* is telling:

> *I would like to assume an infrastructure composed of a resilient building and information technology and ask what role there might be for a machine intelligence acting as a personal interface (not translator) between this infrastructure and my ever changing needs.*[253]

This posits the question of how an (intelligent) machine amplify the non expert user's creative design intentions without distorting them through misinterpretation and without "falli (ing) pray to the ills of translation, ascribing meanings of its own."[254]

At a first glance Negroponte's scheme appears highly contradictory: The expert architect is accused of paternalism and thus exiled from the design process, only to be replaced by an expert machine.

252. Negroponte and Groisser, The semantics of architecture machines, op. cit.

253. Negroponte, *Soft architecture machines*, 103.

254. Ibid., 108.

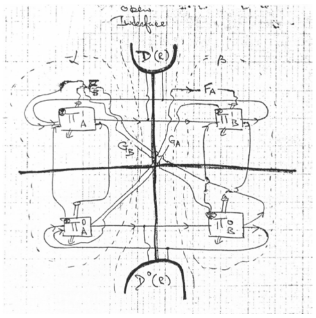


**Figure 41:** Conversation Theory, sketch by Gordon Pask featured in *Soft Architecture Machines*.

How do Negroponte's proclamations on making "every man his own architect" comply with the aggravated knowledge asymmetry between the non-expert user and the expert computational system? The central hypothesis of the analysis which follows, is that Negroponte resolves this contradiction by arguing that the Design Amplifier's mediation is "understanding", and not "translation," thus placing the emphasis in the interface between the machine's expert knowledge and the user's intuition.

The idiosyncratic cybernetician Gordon Pask's *Conversation Theory* provided Negroponte with a model of user-machine interaction, which allowed him to envision the construction of a shared space of understandings and invariants between the two conversants. The main premise of *Conversation Theory* was to respond to the problem of how to make a machine acquire symbols and construct representations by directly interfacing with the world instead of depending on pre-processed descriptions, entered by a programmer. In Negroponte's case this implies that the machine would start as a blank canvas, with no "knowledge" of the user and would acquire this knowledge gradually, through a "good" conversation complying to maxims such as fluidity, mutual interruptibility or transparency. In Paskian terms, this conversation would result in the two protagonists "reprogramming" each other so as to acquire shared models and mental structures of the topic of conversation (in this case the design of a space). The idea of a "mutual reprogramming" between the user and the machine provides insight into the fundamental premise of Nicholas Negroponte's discourse on non-paternalism: the Design Amplifier would ultimately become a "surrogate" of the user and therefore "act truly as an extension of the 'future user'[255] mediating his/her needs and desires in the "infrastructure" (the regulatory system).

Since the early 1970s Negroponte explored the possibility of non-linguistic communication between the machine and the user. This was employed in the *Architecture-by-Yourself* Program, and systemarized in a robust proposal which grew out of it,[256] entitled *Graphical Conversation Theory: Computer mediated inter- and intra- personal communication.*[257] The endeavor described in this proposal was to establish a graphical conversation with the user, where the user's model is constructed through inferences on sketched input.

### 6.2.3 The Graph and Nicholas Negroponte's debates on non-paternalism

*a. Sketch Recognition: What the machine can "see"*

As depicted in chapter 5, the diagram of Nicholas Negroponte's "first loop" in his model of design participation comprised two steps. First, the machine performed sketch recognition on the user's sketch in order to abstract its basic structure. According to Negroponte:

255. Ibid., 108.

256. Weinzapfel, "Interview by Theodora Vardouli," op. cit. See Appendix C.

257. Bolt, Richard A., and 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.

258. Negroponte, *Soft architecture machines*, 119.

"The goal is to recognize a structure of relationships and attributes in contrast to asking for a description."[258] The representation of the sketch followed Yona Friedman's model of a relational structure (graph) without metric.

Second, having extracted this linkage, which in most cases was essentially under-constrained, the machine would be able to perform combinatorial operations and thus provide alternative concretizations of this structure into floor plan layout. Negroponte refers to this combinatorial process as completing a half-told story in various ways.[259] Although the representation of the graph in Negroponte's proposal was a direct loan from Friedman's *Toward a Scientific Architecture* it carried a very different signification. Friedman's graph was a meaning-free syntactic structure of a design problem, whereas for Negroponte, the graph was the structure of a story, capturing the user's abstract mental image of a space, and concretizing it in multiple ways.

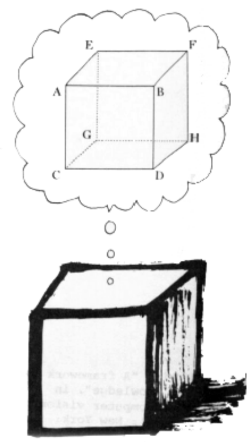


**Figure 42:** Sketch recognition; what the machine can see. From the ArcMac's NSF proposal *Graphical Conversation Theory*.

The use of the graph for the representation of the user's sketch in the Design Amplifier is a key point of tension in Negroponte's proposal. The precondition of his promise of non-paternalism is that the machine and the user reach a series of understandings through graphical conversation. This raises the question if these understandings can be reached when the user and the machine see the graphical component of their conversation in such a radically different way. The tension between the fluid, perceptual nature of a sketch and the symbolic nature of an information machine challenges the core of Negroponte's argument. Does the graph theoretical model of the sketch identify a tension between Negroponte's intentions and his implementations?

One possible response could be that the internal representation of the machine is not important, as long as its interaction protocols with the user foster self-directed learning, play and creativity. In that sense the machine could be conceived as a black box, evaluated in relation to its input and output and not its internal models of representation or thinking. However, this argument would still not address questions pertaining to the Design Amplifier's ability to operate as a non-paternalistic surrogate of the user. Opposite to Negroponte's proclamations, the machine would always have to distort the user's sketched utterances.

The first chapter of the Architecture Machine Group's NSF proposal *Graphical Conversation Theory* attempts to respond to the question of whether a graph is a good enough model of an image, which seemed to deeply concern the proposal's authors. In the introductory chapter of the proposal, entitled *Where words fail*, they discuss the tension between the fluid, perceptual, simultaneous nature of an image and the symbolic, syntactic, linear nature of language and verbal symbolism. Susanne Langer[260] and Rudolf Arnheim[261] are

259. Ibid., 122.

260. Langer, Susanne Katherina Knauth. 1957. *Philosophy in a new key : A study in the symbolism of reason, rite, and art.* Cambridge: Harvard University Press.

261. Arnheim, Rudolf. 1969. *Visual thinking.* Berkeley, CA.: University of California Press.

extensively quoted, to prove respectively, that there is an irreducible difference between visual forms and linguistic elements, and that visual forms are a crucial component of cognitive processes.

The main objective of this chapter is, clearly, to emphasize the importance of graphics in computer applications, in response to the prevalence of linguistic interfaces in CAD. However, there is another interesting implication of the argument that perceptual processes are partially linguistic. Asserting perception as something incommensurable to cognition, would compromise the Architecture Machine Group's vision of the computer as a machine for creativity. The computer, an innately symbolic, combinatorial device, would have to limit itself to the (combinatorial) complexity of speakable ideas, thus being unable to ever "see" the world in the continuous fashion of a human being, and thefore, unable to ever be a creative "partner."

As Langer would denote:

> *An idea that contains too many minute yet closely related parts, too many relations within relations, cannot be projected into discursive form, it is too subtle for speech.*[262]

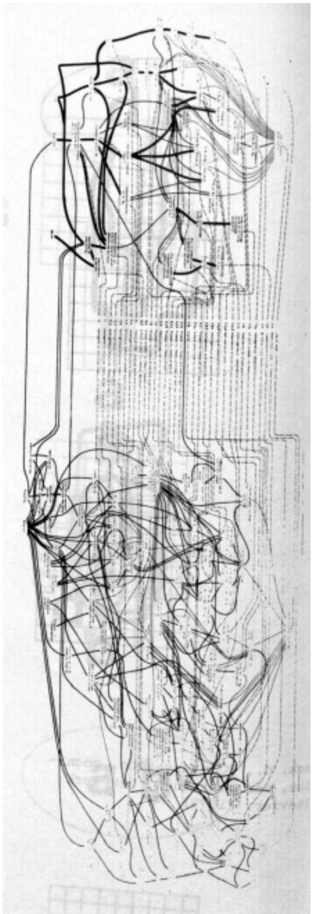
The reference of the authors to Rudolf Arnheim's *Visual Thinking* allows for the salvaging of a synergy between the visual and the linguistic, by claiming that these two modalities are inherently interconnected. Arnheim claimed that the poly-dimensional space of visual stimuli "yields good thought models of physical objects or events but also represents isomorphically the dimensions needed for theoretical reasoning."[263] Arnheim's proclamation is read by the authors of *Graphical Conversation Theory* as implying that if a visual stimulus lends itself to theoretical reasoning and theoretical reasoning is by definition discursive, then the visual stimulus always contains a discursive component. This discursive component can be represented in a language understandable by an informational machine.

This leads to the conclusion:

> *In its isomorphic aspect, the visual medium (read "graphical") is for Arnheim "...so enormously superior [to words] because it offers structural equivalents to all characteristics of objects, events, relations."*[264]

*b. The Graph as an isomorphic model of the sketch*

The reification of visual stimuli as concept-images, allows for a coalition between the Architecture Machine Group's work on graphical interfaces, and Negroponte's broader agenda of human machine mutual understanding, to propose a model of a conversation via images. The purpose of this conversation is for the machine to construct a model of the user's personal information



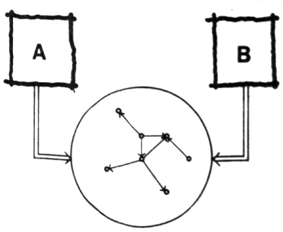



**Figure 43 and 44:** Constructing a common space of understandings through conversation. From an entailment mesh (Pask) to an entailment structure. From *Graphical Conversation Theory*.

262. Langer, *Philosophy in a new key*, 93, in Bolt et. al., *Graphical Conversation* Theory, 13.

263. Arnheim, *Visual thinking*, 232 in Bolt et. al., *Graphical Conversation Theory*, 14.

264. Ibid., 15.

265. Bolt et. al., *Graphical Conversation Theory*, 50.

space, enabling it to "act on behalf of a user as his agent."[265]

Conscious of the incompatibility between the symbolic nature of informational machines and the continuous, perceptual nature of visual stimuli, Negroponte tries to reconcile the two by establishing a fluid interface between the machine and the user. The contradiction between the user operating in the visual sphere, and the machine in the symbolic, syntactic sphere is escaped through the argument that every image has an inherent structure, which isomorphically captures the structure of the world it is trying to depict. The graph is therefore employed as an isomorphic mapping of the user's mental image of a space, communicated via the sketch. The linkage resulting from the application of the sketch recognition algorithms, is construed as having "objectively" captured the implicit structure of the user's sketch. This is perhaps the fundamental underpinning of Negroponte's discourse on non-paternalism. By implying that the machine "extracts" the graph from the user's sketch Negroponte dissolves the questions on the machine distorting, translating, or interpreting the user's utterances, and preserves the authorship of the user in the representation on which the machine performs computations.

## 6.3 Computational allegories of control

Following the discussion on the way that the two authors frame their debates on democracy, freedom and non-paternalism in relation to the implementations of their systems, this section proceeds to a comparative analysis of the two systems. The purpose is to problematize the "devices" through which the authors reconcile the control mechanisms of their systems, with their proclamations of democracy and non-paternalism.

### 6.3.1. The Infrastructure: Separating control from freedom

The operation of both systems is based on an "infrastructure-infill" foundational division, which reflects the way that the authors conceptualize the relationship between freedom and control. Apart from its literal expression in Friedman's megastructure, the "infrastructure-infill" idea is pervasive in the two systems. It is present in Friedman's epistemological discussions, where he separates the "objective" from the "intuitive" part of the discipline of Architecture and Planning. It is the basis on which both Negroponte and Friedman assign the roles of the machine/architect, as the "objective" and "competent" operator, and of the user as bearing the "talent" and the "intuition." The infrastructure is the divide between what can be mechanized, quantified and controlled and what is left to intuition, spontaneity and improvisation.

Both systems are designed so as to anticipate and accommodate any future change, without any compromises to their stability. The infrastructure is a metaphor for a closed system, a system whose descriptive capacity can account for any unpredictable result generated within it. Friedman's proposal is telling: the infrastructure is conceived as a saturated graph. Therefore, any design possibility produced by his graph theoretical formalism of any design problem will always be a subgraph of the infrastructure. Through his axiomatics Friedman implies that his system of description captures the "structure" of Architecture, the fundamental principles which define the nature of the discipline.

Negroponte also seems to allude to a form of a dematerialized "infrastructure," even though in his case it primarily the infrastructure operates as a metaphor for the constraints, the global forces of the system. His infrastructure is a veil of global "criteria," within which heuristics and rules of thumb allow for global constraints to be informed by local desires, and for local desires to be formed through global criteria. This is reminiscent of the systems theorist Ervin Laszlo's observation about the ceonceptual shift from the Newtonian paradigm of "organized simplicity," which reduced the parts from the whole or understood the whole without the parts, to the system's idea of "organized complexity" where the parts and the whole operated in one functioning organization.[266]

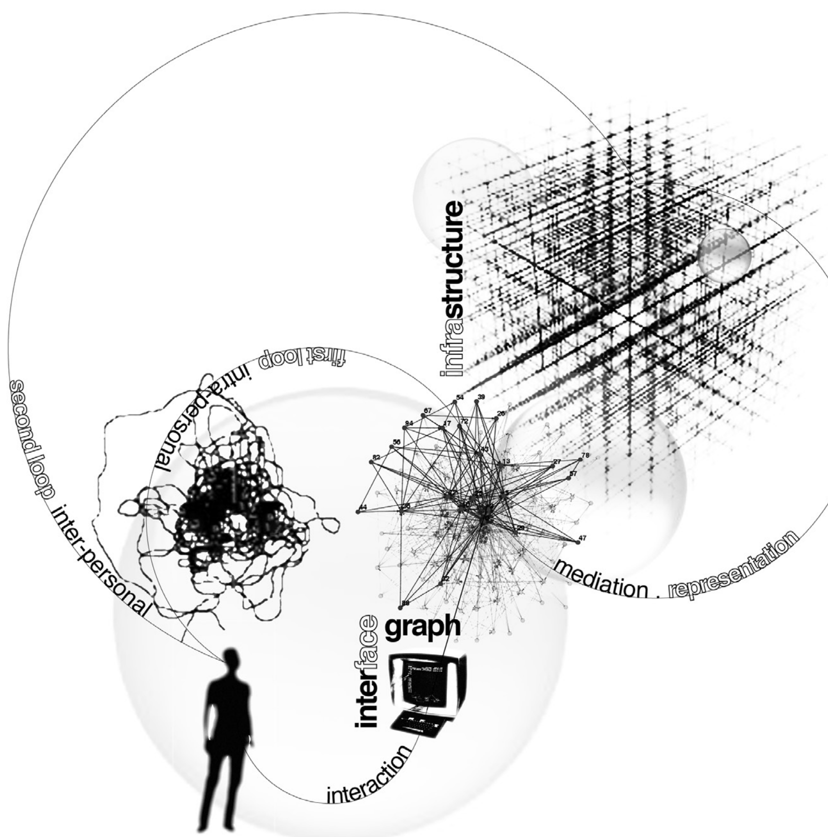



**Figure 45:** Common computational allegories of control: the infrastructure, the interface and the graph.

266. Laszlo, Ervin. 1972. *The systems view of the world; the natural philosophy of the new developments in the sciences*. New York: G. Braziller.

### 6.3.2. The Interface: Mediating between control and freedom

The separation of functionalist control and intuitive choice in two separate systems posits the question of how these two very different systems communicate and interact. In both proposals this interaction is realized via an interface. In Friedman the interface is the architect-machine. Through a set of mechanical combinatorial operations, the machine (whether it is the architect-scientist or the FLATWRITER) exposes to the user all the possible resolutions of a design problem within the generic substrate of the infrastructure.

In Negroponte the interface is the machine-subject, as a sentient surrogate of the user. The machine abstracts the user's intention and searches different ways of concretizing it within the infrastructure via probabilistic guesses.

### 6.3.3.The Graph: Representing control and freedom

The graph is a mathematical representation which lends itself both to the "objective" and the "intuitive" system of the two proposals. As Yona Friedman would proclaim in his paper entitled *Architecture-by-Yourself*:

> *The notation (graph) immediately separates the intra-personal and the inter-personal factors of the plan; thus the graph has interpersonal (communicable characteristics), which are those that generate constraints, while the labeling conveys the intra-personal (and thus not necessarily communicable) characteristics which are those that generally do not generate constraints.*[267]

On the one hand the graph allows for rigorous mathematical reasoning (extraction of metrics, probabilistic calculus, comprehensive combinatorial lists, description of constraints) and aligns with the atomic and combinatorial character of the "objective" system, whether it is Friedman's infrastructure, or the Design Amplifier's internal computational representation. On the other hand, through its alleged isomorphism with reality, it is construed to offer an acceptable model of the design problem, allowing for one-to-one transposals between reality and abstraction.

The graph's abstract nature supports the authors' proclamations of non-paternalism: this mathematical representation of the design problem allows for calculations and checking of constraints in an abstract relational space, which is concretized according to the personal preferences of the user, who ascribes personal meanings to the featureless structure. The authoring of the design is therefore assumed to be the privilege of every individual user. By operating as a controllable (infra)structure of meaning, the graph allows the

267. Friedman, Yona. 1975. Architecture-by-Yourself. in Bolt et. al., *Graphical Conversation Theory*, op. cit.

authors to reconcile their positivist impulses for order, structure and control with their ethical discussions of democracy and non-paternalism.

The authors' positivist approach to design is not only expressed in their desire to find a design apparatus which allows them to measure and constrain every future possible iteration of their system. The separation between the graph as the deep structure of design, and the assertion of meaning as surface, is essentially a separation between the rational, the cognitive and the abstract and the un-orthological, the experiential and the concrete. The participation of the non-expert user in design is cognitive and linguistic: from the creation of the classes of formal and functional differentiation of the enclosures (labels) to the monitoring of the future user's living habits. Friedman's "keyboards" in the FLATWRITER, through which the users express their intuition, are discrete symbols which are combined following the abstract topologies of the graphs. Both the design and the evaluation stage happen in an abstract sphere, through combinatorial manipulations of symbols. Experiential and perceptual concerns are excluded from the process and are expected to emerge on top of an infrastructure of pure reason, which is mathematically describable, calculable and controllable. Through the visual interfacing with the machine Negroponte appears, opposite to Friedman, to recognize the importance of perceptual fluidity in design processes. However, the surrogate of the user, the Design Amplifier, establishes reason in the process: the machine extracts a mental diagram underlying in the sketch and performs computations on this structure, in a symbolic, combinatorial way, true to its innate informational logic.

## *Afterword for Chapter 6*

The analysis of Yona Friedman's and Nicholas Negroponte's democratizing claims from the perspective of the computational structures of their systems, offered the opportunity to explore the discursive role of mathematical or computational concepts such as the "(infra-)structure," the "interface" or the "graph" in the authors' arguments. The key point of this inquiry, is that these concepts do not only belong to the sphere of the technical implementations of the two systems, but play a central role in the framing of the authors' debates of non-paternalism. Therefore, inquiry into these computational structures can open the two proposals to new readings, surpassing the distinctions between the "technical" and the "theoretical," and asserting the discursive role of both the intentions and the implementations of a computational system.

# *7. Reflections*

## *Recasting design-for-empowerment-for-design*

*Foreword of Chapter 7*

The hypothesis which supported the inquiry into Yona Friedman's and Nicholas Negroponte's works and systems, was that the orchestration of a dialogue between their early computational systems would form a productive dipole for the characterization of the problem of design-for-empowerment-for design in the present. This quest was motivated by the observed asymmetry between the currently widespread rhetoric of the vision of the user-as-designer, and a lack of discourse on the design principles of the tools which are designed for its fulfillment.

The intension of the journey back to the basal discourses of computationally mediated user empowerment in design was to provide a basis to first, trace (one of the many) cultural and historical origins of the enterprise, second, to explore foundational theoretical debates and identify questions still worth asking, and third, to develop ways to analyze and criticize the relationship between intentions and implementations, which can be used to evaluate current proposals and to trace new computational approaches to design democratization. This chapter presents reflections along these three axes; it is a collection of attitudes ranging from evaluations of the current state of the design-for-empowerment-for-design enterprise, identifications of persistent metaphors, and contemplations on future paths of exploration.

## 7.1 Reflections on "take-aways"

The inquiry into the basal discourses of design democratization shed light to one of the foundational histories of the latent computational vision of tools for the user-as-designer, which is being re-activated under current cultural and technological influences. In this way, it demonstrated that the idea of computers as tools for creative individualism or the concepts of personalization and user-centric design are neither "natural," nor new ideas, but contain traceable histories. Yona Friedman and Nicholas Negroponte are only parts of broader constellations of contexts and actors, who created the ground for the merging of computation and design participation into a model of technologically mediated architectural do-it-yourself-ism.

These constellations remain to be explored and their ambivalent and often contradictory premises revealed. However, the recognition that current participatory techno-speculations are not historical firsts, can offer a rich historical perspective to current inquiries on open design practices. When proclamations such as "The point of opensource design should be to facilitate users designing and building their own dwellings, not to continue promoting a design elite that includes current starchitects"[268] start echoing in cyberspace, one can recognize the recasting of unfinished enterprises.

Apart from establishing lines of historical precedence, the plunge into the implementation details of Yona Friedman's and Nicholas Negroponte's early computational visions, outlined elaborate diagrams and raised challenging questions, ranging from the level of theoretical articulation to the details of technical implementation. Current inquiries in tools for design participation, and in tools for design in general, would benefit from the breadth and depth of the questions asked in these early explorations. The preoccupation of most current research on computational tools for designers, with fast applications, leaves little time for reflection on characteristics of the problems which the tools are being developed to address. Inquiry into the characterization of the problem of design-for-empowerment-for-design can set forth future agendas, following Negroponte's invitation about forty years ago to "stay free from present day realities of what a machine can and cannot do."[269] Comparing the diagrams of proto-computational tools for user empowerment in design with the reductive approach of current proposals, one may observe that temporal subsequence does not necessarily mean progress.

The reading of Yona Friedman's and Nicholas Negroponte's proposals from a computational perspective, indicated that concepts which are often disregarded as "technicalities" are catalytic in the formation and evaluation of the proclamations of their authors. The analysis which was presented in the previous chapter indicated that "combinatorics," "graphs" and "probabilistic inference" are not neutral techniques, hardwired in the concept of computation, but are conscious decisions, based on assumptions about what design is and how it can be "opened" to the users. This realization supports the need for a persistent questioning of "naturalized" models of computation, in order to identify and critically evaluate potential tensions between what the tools are assumed to do and what their mathematical representations and interaction protocols allow them to do.

## 7.2 Reflections on the current State of the participatory enterprise: Persistent computational metaphors

### 7.2.1. The Infrastructure

The model of the technological "infrastructure," is the pervasive literal and metaphoric model in the way that systems for design

268. Opensource architecture, op. cit.

269. Bolt et. al., *Graphical Conversation Theory*, 10.

democratization are conceived until the present era. The concept of Open Source Architecture, as defined by Ratti et. al. and implemented in projects of mass-personalized housing is based on the separation of the "objective" from the "intuitive" system. As Larson et. al. would state regarding the *Open Source Building Alliance* organizational diagram:

> *The system as a whole provides a framework -an architecture- that allows for both independence of structure and integration of function [...] manufacturers are free to focus on the quality and performance of their sub-system - designers are free to focus on design and integration.*[270]

The complex network of manufacturers and suppliers ensures the functionality and performance of the system (the chassis), while the user-as-designer operates with the under-constrained part of the process (the infill). The separation of the "objective" parts of the process which require professional expertise from the "intuitive" aspects which are left to the user, is still the dominant paradigm of the architecture-by-yourself enterprise.

Even if the infinite standardized space grids of Yona Friedman do not exist in the visual repertoire of these proposals, the idea of an invisible, immaterial infrastructure based on the principles of prefabrication, modularity and standardization is pervasive in the Open Source paradigm, in and beyond Architecture. The "experts" collaborating on the "chassis" (infrastructure) operate on the basis of "modular standards," mutually agreed principles which allow for integration in all scales and levels.

Discussions such as "integration" or "interoperability" imply the desire to establish one single control protocol for the entire system. Not unlike the space-grid infrastructure, the Open Source "standards" ensure an objective framework of control for the avoidance of conflicts and discrepancies in intersubjective communication. When this idea is reified into an architectural object then the space grid "naturally" emerges. Prefabricated frames and prefabricated loft modules appear as a "natural" model for accommodating the "many"; the complexity of the "particulars" is organized within and on an allegedly featureless, distributed and omnipresent framework of control.

### 7.2.2. The Interface

The metaphor of the interface, as the computational system which bridges the "objective" and the "intuitive" parts of design also persists in current proposals of user empowerment in design. As discussed in Chapter 2, the most pervasive model is that of the "Configurator," offering the users choices linked together in partially enforced action sequences.[271] Other times, following the adage that "customers don't want choice; they want what they want and they

270. Larson and Intille, MIT OSBA White Paper, 1.

271. Suchman, Lucille Alice. 1987. Plans and situated actions: *The problem of human-machine communication*. Cambridge, England: Cambridge University Press. quoted by Philips, *Design by searching*, 12.

want it now"[272] the interface takes the form of preference and design engines (e.g. in the House Genome Project), which provide the users with "intelligent" recommendations by matching designs to user profiles, constructed via interfacing with the machine.

*a. Configurators are FLATWRITERS*

The Configurators can be viewed as a commercial version of the FLATWRITER. In Friedman's machine linearly configured different aspects of a design, as if typing in a typewriter. In the Configurators, users operate in a similar way, through sequential selections from lists of components. However, opposite to Friedman's mathematical argumentations on the completeness of his "repertoires," the Configurator combinatorial lists do not carry the pretense of completeness. Users are guided through lists of limited, predefined commercial components, not escaping Negroponte's argument that "the offerings of a many of solutions obviously cannot exceed the combinatorial product of the parts (which may be enormous)."[273] If in Friedman, user "freedom" was defined by attaching symbols on abstract topological configurations, Configurator interfaces operate on preset symbols forcing users to resort to a "menu picking activity."[274] Another shortcoming of the Configurators, which was taken into account by Yona Friedman through his "effort diagrams," is their failure to account for the non-expert users' inability to evaluate their choices in relation to their personal lifestyles.[275]

The assigning of "meaning" to abstract spatial configurations instead of choosing from pre-set symbols, and the personalized feedback to the user, which were key points in Friedman's programmatic diagram, are absent from current Configurator software, resulting in a highly constrained model, characterized by both a theoretical and pratical inadequacy to deliver its evangelistic promises of intuition and personalization.

*b. Recommendation Engines are Design Amplifiers*

The computational tools for design recommendations, which recently emerged as a way to go "beyond the configurator"[276] operate under the same conceptual premises as the Design Amplifier. The machine creates a surrogate (a profile) of the user interfacing with it, and then uses this model to make personalized recommendations that fit within a framework of constraints, hardwired in the system. The success or failure of the entire enterprise is contingent on the creation of an adequate model. This poses the questions of what the machine needs to "know" in order to satisfy the user's needs and values, and how the machine acquires this knowledge from the user. Negroponte's idea was based on the establishment of conversational interaction between the machine and the user which would foster exploration and self-directed learning and thus empower the non-expert user in design.

272. Pine, Joe. 1997. Markets of one. Boston: Harvard Business School Press. in Kovidvisith, Open Source building alliance ecology, 87.

273. Negroponte, *Soft Architecture Machines*, 115.

274. Ibid., 103.

275. Larson and Smithwick, Beyond the configurator, 2.

276. Ibid.

Compared to Negroponte's Design Amplifier, the "Preference Engines" fall back to rather archaic techniques which were being implemented in the late 1960s: the data through which the machine constructs the user profile, are elicited via strenuous activities such as answering multi-page questionnaires or sorting between plans. Not unlike most current artificial intelligence systems, recommendation engines adopt the statistical approach, that is probabilistic calculations on large amounts of data. This data ranges from demographic characteristics, such as sex, ethnicity and age to learning the users' taste by asking them to choose between arrangements.

Opposite to Negroponte who claimed that he isomorphically represented the user's sketch into the machine via the graph, current approaches are disinterested in establishing structural similarities between the user and his/her surrogate. Their profiles are constructed on the basis of templates, with their classes and variables hardwired in the system by its programmer. In 1970s terms, this system could be characterized as highly paternalistic, as the users has no influence on the way that their profiles are being constructed, or to the selection of attributes and parameters, important enough for them, so as to be modeled by the machine "surrogates." Anticipatory guesses are therefore made on distorted and incomplete models.

People, of course, change their minds; and especially in design. The question of whether a machine can ever predict what a user will want in the next minute, even if it has been meticulously recording the user's choices until this very moment leaves ample space for criticism. About forty years ago, in the laboratories of the Architecture Machine Group, Yona Friedman would challenge Negroponte's surrogates:

> *It was my first real experience of the non credibility of the computer. It is very funny because Nicholas (Negroponte) had a program which was based on conversation. So i was trying a simple thing: I was making voluntary mistakes that common people would make, to see how the computer would react. It got simply mad! And Nicholas was absolutely surprised!*[277]

## 7.3 Reflections on new agendas: Toward another computational analogy

The "infrastructure" model, which is an almost naturalized conceptualization of the tools for user empowerment in design is characterized by an internal contradiction: the rhetoric of the endeavor is to free the user from the patronage of the architect and to allow the him/her to express his/her own hypotheses in design.

277. Friedman, "Interview by Theodora Vardouli," op. cit. See Appendix A.

However, the role of the computational tool is to ensure that the user's design will always fall within a framework of functionalist constraints transposed to an all encompassing "infrastructure." The anticipatory logic of the pervasive "sctructure for freedom" model classifies it as a modernist and positivist approach to design.

Friedman and Negroponte argue for the neutral and unbiased character of their computational control mechanisms by alluding to the isomorphism of the internal representations of their machines (graphs) to the world that they are representing, and by fleeing in the space of abstraction. Meaning is exiled from the process of design, as something to be superimposed on the ordered, functional structures produced by the machine. However, by not allowing meaning to interfere with structure, the authors remove one of the fundamental components of design: the ability to always see things new. Imagination and creativity capitalize on constant restructuring, on ambiguous meanings, on the constant merging and addition of "nodes."

The structure-infill scheme is highly restrictive, as it does not allow meaning to interfere with the structure, to change its topologies, to interfere the number of its nodes or to suddenly cut and add its links, which is what is constantly happens when someone is designing. Asserting the process of design as a cognitive, linguistic activity, where meaning is produced as combinatorial operations on deep structures, makes it perhaps easier to implement in a symbolic machine but does not offer the user the opportunity to improvise, to make discoveries while designing and to yield unexpected, unpredictable results. Therefore, Negroponte's promises of a system which would allow to "attach whatever symbols we wish, apply whatever metaphors we like, and ascribe personal meanings,"[278] and Yona Friedman's call for improvisation, remain inspiring, yet unfulfilled, visions.

In designing for the unpredictable, can one devise a system where there are rules without structure and where the pieces are not known in advance? Can one design computational systems which allow users to participate in design in a fluid, experiential way, transcending segmentations, hierarchies and predefined ontologies and staying consistent with a vision of truly "open" design?

These questions lead to new programmatic agendas. Alternative models of calculating, which cut across modernist attitudes to computation, are valuable allies. The assertion of inter-personal communication and participation as combinative operations on neutral structures, finds a provocative counterpoint in shape grammars[279]. This mathematical formalism offers a rich basis and potent descriptive apparatus which challenges the anticipatory and structural logic of computational processes, often assumed to be their "innate" characteristic.

278. Negroponte, *Soft architecture machines*, 45.

Opposite to the phenomenological polemics on the inability of computers to accommodate what is important to design[280], and the romantic response to meaning and perception as unattainable goals, shape grammars show that it is possible to reconcile mathematical rigor with perceptual freedom. By placing seeing at the center of calculating, shape grammars allow for meaning to produce evanescent segmentations of the working scene, which are forgotten once a rule has applied. This intra-personal seeing, doing, and forgetting to always start anew, offers a compelling model perhaps also applicable to inter-personal processes. Instead of predicting participants' future moves and attempting to find the common infrastructure of all signification, the system accepts the full range of possible meanings and offers the means to accommodate them.

If Levi Strauss' "qualitative mathematics" (graph theory) sought to respond to the reductionism of "quantitative mathematics" (statistics), then shape grammars offer a third route of "perceptual mathematics," which place perception and action at the center of descriptive processes. The implications of this "perceptual mathematics," in radically restructuring the conception of the participatory enterprise, are a daring new route of exploration.

279. Stiny, George. 2006. *Shape : Talking about seeing and doing*. Cambridge, Mass.: MIT Press.

280. For example see: Dreyfus, Hubert L., 1992. *What computers still can't do : A critique of artificial reason.* Cambridge, Mass.: MIT Press.

# *8. Contributions*
## *and concluding remarks*

## 8.1. Contributions

This thesis was initiated by framing the cultural and technological relevance of the question of the user-as-designer in Architecture, through references to the Open Source culture, examples of a re-emerging technological optimism on the potential of computational tools, and the recasting of an anti-professionalist polemics. Besides the enthusiastic speculations on new user-centric diagrams of architectural design, supported by current technological possibilities, a review of current computational applications in the space of design-for-empowerment-for-design indicated a shortage of ideas, resulting in a repurposing of tools from extra-architectural fields. The lack of sensitivity of these tools to the particularities of architectural design processes, framed the necessity to characterize the problem of the design of computational tools for user empowerment in design.

Early computational discourses of design democratization were proposed as a productive field of inquiry, offering critical frameworks to evaluate of current proposals, and ways to rethink computational platforms for user empowerment in design. A key hypothesis was that the basal debates of design, computation and user participation present a generative liminality, which allows for inquiry into the boundaries between these concepts and the identification of the conditions under which they merged into a singular cultural construct, persisting until the current era.

Yona Friedman and Nicholas Negroponte were selected as foundational actors in the field of computationally mediated architecture-by-yourself, from a broader scene of individuals who shared a similar optimism on the emancipatory potential of computational tools and methods. The productive potential of a "dialogue" between these two authors, was supported by historical evidence on the intersection and cross-fertilization of their visions, exemplified by the *Architecture-by-Yourself* project of the MIT Architecture Machine Group.

Fragments of historical material and information drawn from personal conversations with these two seminal figures, was assembled into a narrative illustrating the complex network of influences and relations which formed the ground for the merging of computers and design participation. This historical inquiry illuminated the under-discussed aspects of Yona Friedman's activity in the United States, which were decisive in the infusion of graph and information theory ideas in his participatory visions, from the mid-1960s and onwards. This observation challenged traditional distinctions between the two sides of the Atlantic, and presented a case where seemingly incompatible ideas and intentions, such as these of Friedman and Negroponte, engaged in conversation and exchange. After presenting Yona Friedman's transition from his radical megastructural techno-utopias in France to a computational system for design democratization, the exploration proceeded to the shifiting of the computational metaphor in Nicholas Negroponte's research on Computer Aids to Design, to acquire connotations of creativity and personalization, which led to the development of the Architecture Machine Group's design participation agenda.

Following this historical inquiry, the focus was placed on *Toward a Scientific Architecture* and *Computer Aids to Participatory Architecture / Computer-Aided Participatory Design,* in order to abstract and diagram the computational structures of the two systems and to outline their authors' arguments and proclamations. This description allowed for the isolation of a series of converging concepts in the organization of the control mechanisms of the two systems, such as the infrastructure, the interface and the graph.

This offered the ground to inquire into the discursive role of these mathematical and computational concepts in relation to their authors proclamations of non-paternalism. The investigation of the signification of these concepts in each proposal, exposed the assumptions which supported the authors' debates on the neutrality of the computational representations of their systems.

In the case of Yona Friedman's epistemological discussions, the role of structure and the optimism of combinatorics was analyzed in relation to broader discourses of structuralism and information theory in France and in the United States. Consecutively, Nicholas Negroponte's explorations on the interface were presented as a way to reconcile the symbolic rigidity of his architecture machines with the perceptual continuity of the user-designer, drawing references from Artificial Intelligence and cognitive psychology research.

The exploration of the role of the infrastructure, the interface and the graph in the authorial debates underpinning each proposal, illustrated the conceptual foundation of both systems on a fundamental separation between functionalist constraints and intuitive meaning. The model of the "infrastructure" was framed as a device of positivist control, structurally describing the rational, the objective and the controllable, and asserting the personal, the experiential and the intuitive as a combinatorial product of the structure.

The theoretical tools and methods constructed in the exploration of design participation in the early computational era were employed as a way to reflect upon current proposals and detect the programmatic characteristics of new agendas, which transcend the inherent contradiction of the "infrastructure" model to deliver its promises for user freedom and intuition in design. In the quest for new computational avenues, ideas on alternative models of computation priming ambiguity and interpretation were identified as valuable computational allies.

## 8.2. Concluding remarks

Architectural do-it-yourself-ism as a limiting case for design and computation, a conceptual testing ground and an engineering challenge of what computers can do for designers. The success of the endeavor of computational tools for the user-as-designer is contingent on the conception of one sole computational platform, which can simultaneously accommodate the multiple unpredictable subjectivities of every possible user, account for the users' lack of expertise, ensuring the output of "valid" designs without distorting the user's intentions, and reconcile the user's local desires with global constraints, which operate on an inter-subjective level.

The way that this hard tool-making problem is traditionally conceptualized is through the model of a mediating "infrastructure." In this pervasive, almost naturalized model, the designer's control is transposed to an allegedly non-defining structure (physical, computational or both) which is proclaimed to allow for infinite freedom and intuition on behalf of the user. However, as the critical inquiry into Yona Friedman's and Nicholas Negroponte's illustrated, besides the emancipatory proclamations associated with it, the "infrastructure" model was engendered and resides in a positivist paradigm of design, as it asserts meaning and intuition as a combinative operation on underlying, featureless mathematical structures. If the infrastructure model fails to deliver its liberating proclamations then can we seek alternative programmatic agendas which address the contradictions of the infrastructure?

Through the analysis and critique of computer aids for architecture-by-yourself this thesis aims to offer an allegory, which can be extended beyond the participatory enterprise and be used to address naturalized assumptions on the way that the relationship between design and computation is approached. The "innate" discrete and combinatorial logic of information machines leads to assertion of design as information processing and to a priming of the cognitive and the mathematical versus the perceptual and the intuitive. Design is understood as a process of assembling information on hierarchical and ontological structures. If the "infrastructure" model attempts to insert mathematical exactitude in empirical design processes by excluding meaning from its descriptive spectrum, it is perhaps time to seek new allegories of control which reconcile computational rigor with perceptual freedom, and instead of tailoring the conception of design to the "natural" logic of informational machines, utilize the intuitive, ambiguous and improvisational characteristics of Design to conceive alternative models of Computation.

# Bibliography

Opensource architecture (OSA). 2012 [cited May/04 2012]. Available from http://en.wikipedia.org/wiki/Open_Source_Architecture.

OSH - definition of free cultural works. 2012 [cited May/04 2012]. Available from http://freedomdefined.org/OSHW.

Negotiate your flat / DOM research laboratory. 2011 [cited May/04 2012]. Available from http://www.domresearchlab.com/content/negotiate-your-flat.

Peer to peer urbanism. 2011 [cited May/05 2012]. Available from http://p2purbanism.blogspot.com/.

Yona friedman. 2009 [cited May/04 2012]. Available from http://en.goldenmap.com/yona_Friedman.

Free/Libre and open source software: Survey and study. 2005 [cited May/04 2012]. Available from http://www.flossproject.org/.

Blu homes. [cited May/04 2012]. Available from http://www.bluhomes.com/.

Changing places / MIT media lab. [cited May/04 2012]. Available from http://www.media.mit.edu.libproxy.mit.edu/research/groups/changing-places.

Hackitectura.net. [cited May/04 2012]. Available from http://hackitectura.net/blog/.

High-low tech. [cited May/04 2012]. Available from http://hlt.media.mit.edu.libproxy.mit.edu/.

Home genome project. [cited May/05 2012]. Available from http://livinglabs.mit.edu.libproxy.mit.edu/index.php?option=com_content&view=article&id=47:home-genome-project&catid=37:home&Itemid=81.

WikiHouse / open source construction set. [cited May/04 2012]. Available from http://www.wikihouse.cc/.

Alexander, Christopher. 1964. A much asked question about computers and design. Paper presented at *Architecture and the computer*, Boston, Massachusetts.

———. 1964. *Notes on the synthesis of form*. Cambridge, Mass.: Harvard University Press.

Alexander, Christopher, Sara Ishikawa, and Murray Silverstein. 1977. *A pattern language : Towns, buildings, construction*. New York, N.Y.: Oxford University Press.

Archer, Bruce. 1981. A view of the nature of design research. In *Design : Science : Method.,* eds. R. Jacques, J. Powell. Guildford: Westbury House.

Architecture Machine Group. 1978. *Architecture machinations: A weekly newsletter of the Architecture Machine Group*. Cambridge, Mass.: MIT Department of Architecture.

Arnheim, Rudolf. 1969. *Visual thinking*. Berkeley, CA.: University of California Press.

Banham, Reyner. 1972. Alternative networks for the alternative culture. In *Design participation*., ed. Nigel Cross. Academy Editions ed., 15-19.

Barry, Robert. 2012. Yona friedman: Ludwig museum, Budapest, Hungary. *Frieze*.

Bauwens, Michel. 2009. The emergence of open design and open manufacturing. *We_Magazine Collective Action*.

Bayazit, Nigan. 2004. Investigating design: A review of forty years of design research. *Design Issues* 20 (1): 16-29.

Bell, David. 2004. *Cyberculture: The key concepts*. New York, NY: Routledge.

Bloch, William Goldbloom. 2008. *The unimaginable mathematics of Borges' library of Babel*. Oxford University Press.

Bokulich, Peter J. M., Bokulich, Alisa. Scientific structuralism. in *Springer Verlag* [database online]. New York, N.Y., 2011.

Bolt, Richard A., and MIT Architecture Machine Group. 1976. *Computer mediated inter- and intra- personal communication*. Cambridge, Mass.: Massachusetts Institute of Technology, Dept. of Architecture, Architecture Machine Group.

Brand, Stewart. 1988. *The media lab : Inventing the future at MIT*. New York, N.Y.: Penguin Books.

Bryman, Alan. 1984. The debate about quantitative and qualitative research: A question of method or epistemology? *The British Journal of Sociology* 35 (1): pp. 75-92.

Busbea, Larry. 2007. *Topologies : The urban utopia in France*, 1960-1970. Cambridge, Mass.: MIT Press.

Cross, Nigel. 1972. Here comes everyman. In *Design participation*., ed. Nigel Cross, 11-14. London: Academy Editions.

———. 1972. Preface. In *Design participation*., ed. Nigel Cross, 6. London: Academy Editions.

Cross, Nigel. 1972. Conference on design participation. *Proceedings of the Design Research Society's conference*, Manchester, September 1971, Manchester, England.

Davidoff, Paul. 1965. Advocacy and pluralism in planning. *Journal of the American Planning Association* 31 (4): 331-8.

de Saussure, Ferdinand. 2006. *Writings in general linguistics*. London ; New York: Oxford University Press.

de Witt, Wim. 2009. The papers of Yona Friedman. *Getty Research Journal* 1 : 191-6.

Dreyfus, Hubert L., 1992. *What computers still can't do : A critique of artificial reason*. Cambridge, Mass.: MIT Press.

Fiel, Wolfgang. 2010. *Eckhard Schulze-Fielitz : Metasprache des raums* [Metalanguage of space]. Wien ; New York: Springer.

Fonds régional d'art contemporain du Centre. 2003. *Architectures expérimentales, 1950-2000*. Collection du FRAC centre. Orléans: HYX.

Frampton, Kenneth. 2007. *Modern architecture : A critical history*. World of art. 4th ed. London; New York: Thames & Hudson.

Yona Friedman, "Interview with Theodora Vardouli" (Video Recording, Paris, France, 2012).

———. 1972. Information processes for participatory architecture. In *Design participation*., ed. Nigel Cross, 45-50. London: Academy Editions.

Friedman, Yona. 2010. *Yona Friedman: Drawings & models 1945-2010,* eds. Yona Friedman, Marianne Homiridis. Paris, France: Kamel Mennour Gallery.

———. 2000. *Utopies realisables*. Paris: Editions de l' Eclat.

———. 1975. *Toward a scientific architecture* [Pour Une Architecture Scientifique]. Trans. Cynthia Lang. Cambridge, Mass.: MIT Press.

———. 1968. *L'architecture mobile*. Cahiers du centre d'études architecturales ; 3.1. Brussel:

Centre d'études architecturales.

Friedman, Yona, and Hans-Ulrich Obrist. 2007. *Yona friedman*. Conversation series (Cologne, Germany) ; 7. Köln; New York, NY: Walther König; distribution outside Europe, D.A.P./ Distributed Art Publishers.

Forsythe, Diana. Engineering knowledge: The construction of knowledge in artificial intelligence. *Social Studies of Science*. 23 (3). 445-77

Gournay, Isabelle. MoMA, the Collection, Yona Friedman. (French born Hungary 1923). 2009 [cited May/04 2012]. Available from https://www.moma.org/collection/browse_results.php?criteria=O%3AAD%3AE%3A8109.

Grason, J. 1971. An approach to computerized space planning using graph theory. *Proceedings of SHARE-ICM-IEEE. Design Automation Workshop:* 170-9.

Groisser, Leon Bennett, and Nicholas Peter Negroponte. 1971. *Computer aids to participatory architecture*. [principal investigators: Leon Bennett Groisser and Nicholas Peter Negroponte. Cambridge, Mass: Massachusetts Institute of Technology.

Gropius, Walter. 1964. Computers for architectural design. Paper presented at *Architecture and the computer*, Boston, Massachusetts.

Habraken, John. 1972. *Supports, an alternative to mass housing*. London: Architectural Press.

Hage, Per, and Frank Harary. 1983. *Structural models in anthropology*. Cambridge University Press.

Harary, Frank. 1990. On the ABC of graph applications. *Le Mathematiche* 45 (1): 75-82.

Hawkes, Terence. 2003. *Structuralism and semiotics*. New accents. 2nd ed. London ; New York, N.Y.: Routledge.

Helander, Martin, ed. 1988. *Handbook of human-computer interaction*. Amsterdam ; New York, N.Y.: North-Holland; Sole distributors for the U.S.A. and Canada, Elsevier Science Pub. Co.

Hulten, Pontus. 1968. *The machine: As seen at the end of the mechanical age*. Museum of Modern Art.

Huxley, Aldous. 2006. *Brave new world*. Harper perennial modern classics. New York: Harper Perennial Modern Classics.

Jencks, Charles. 1973. *Modern movements in architecture*. Garden City, N.Y: Anchor Press.

Jerrard, B., R. Newport, and M. Trueman. 1999. *Managing new product innovation*. London, Philadelphia: Taylor & Francis.

Johnson, Timothy, Guy Weinzapfel, John Perkins, Doris C Ju, Tova Solo, and Deavid Morris. 1970. *IMAGE: An interactive graphics-based computer system for multiconstrained spatial synthesis*. Cambridge, Mass.: MIT Department of Architecture.

Jones, Caroline A., Peter Galison, and Amy E. Slaton. 1998. *Picturing science, producing art*. New York, N.Y.: Routledge.

Joyce, John. 2006. Pandora and the music genome project. *Scientific Computing* 10 : 40-1.

Kaspori, Dennis. 2003. A communism of ideas: Towards an architectural open source practice. *Archis* 3 : 13-7.

Kovidvisith, Kalaya. 2007. Open source building alliance ecology : The internet framework for consumer driven participative design. S.M., Massachusetts Institute of Technology, Dept. of Architecture.

Lambert, Leopold, and Martin LeBourgeois. 2011. *#Architectural theories /// Pro Domo by Yona Friedman*. The funambulist: Architectural narratives.

———. 2010. *#Interviews/Yona friedman on november 14th 2007 in paris*. The funambulist: Architectural narratives.

Langer, Susanne Katherina Knauth. 1957. *Philosophy in a new key : A study in the symbolism of reason, rite, and art*. Cambridge: Harvard University Press.

Larson, Kent, Stephen Intille, Timothy Mcleish, Jennifer Beaudin, and Reid Williams. 2004. Open source building: Reinventing places of living. *BT Technology Journal* 22 (4): 187-200.

Larson, Kent, and Daniel Smithwick. 2010. Beyond the configurator: Collecting accurate data for an architectural design recommendation engine. *Working Paper*.

Laszlo, Ervin. 1972. *The systems view of the world; the natural philosophy of the new developments in the sciences*. New York: G. Braziller.

Lazzarato, Maurizio. 1996. Immaterial labour. In *Radical thought in Italy*., eds. Paolo Virno, Michael Hardt, 132-146. Minneapolis: University of Minnesota Press.

Le Corbusier, Jean-Louis Cohen, and John Goodman. 2007. *Toward an architecture*. Texts & documents. Los Angeles, CA.: Getty Research Institute.

Levi-Strauss, Claude. 1954. The mathematics of man. *International Social Science Bulletin* 6 (4): 581-90.

Licklider, J. C. R. 1960. Man-computer symbiosis. *IRE Transactions on Human Factors in Electronics* HFE-1: 4-11.

Maniaque Benton, Caroline. 2011. *French encounters with the American counterculture*, 1960-1980. Ashgate studies in architecture series. Burlington, Vt.: Ashgate.

Miessen, Markus. 2010. *The nightmare of participation : Crossbench practice as a mode of criticality*. New York, N.Y.: Sternberg Press.

Negroponte, Nicholas. 1977. On being creative with *Computer-Aided* design. *Information Processing* 77 : 695-704.

———. 1972. Aspects of living in an architecture machine. In *Design participation.,* ed. Nigel Cross, 63-67. London: Academy Editions.

Nicholas Negroponte, "Interview by Theodora Vardouli" (Audio Recording, Cambridge, Massachusetts, 2012).

———. "Interview by Theodora Vardouli" Cambridge, Massachusetts, 2011).

———. 1975. Computer-aided participatory design. In *Soft architecture machines*., 92-129. Cambridge, Massachusetts, and London, England: MIT Press.

———. 1975. *Soft architecture machines*. Cambridge, Mass.: MIT Press.

———. 1970. *The architecture machine: Toward a more human environment*. Cambridge, Mass.: MIT Press.

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.

———. 1969. The semantics of architecture. *Architectural Design*.

———. 1967. URBAN 5: An on-line urban design partner. *IBM Report*: 320-2012.

———. 1971. Computer aids to participatory architecture. [Principal Investigators: Leon Groisser and Nicholas Negroponte]. Cambridge, Mass: Massachusetts Institute of Technology.

Ophir, Yaniv. 2010. UDesign : Toward a user-centered architecture. S.M., Massachusetts Institute of Technology, Dept. of Electrical Engineering and Computer Science, and Massachusetts Institute of Technology, Dept. of Architecture.

Pedret, Annie. Dubrovnik (Yugoslavia) 3-13 august 1956, CIAM X congress: Scales of association. [cited May/04 2012]. Available from http://www.team10online.org/team10/meetings/1956-dubrovnik.htm.

Phillips, Matthew Giles. 2007. Design by searching : A system for creating and evaluating complex architectural assemblies. S.M., Massachusetts Institute of Technology, Dept. of Architecture.

Pine, Joseph. 1997. *Markets of one*. Boston: Harvard Business School Press.

Portola Institute. *Whole Earth Catalog*. California : Menlo Park.

Ratti, Carlo et al. 2011. Open source architecture (OSArc). Domus(948).

Riley, Terence, ed. 2002. *The changing of the avant-garde: Visionary architectural drawings from the howard gilman collection*. New York, N.Y.: The Museum of Modern Art.

Ritoe, Rajan V. 2011. *YONA FRIEDMAN a documentary by Rajan V. Ritoe*. DVD. Nym Fix Press.

Rocha, Altino João Magalhães. 2004. Architecture theory, 1960-1980 : Emergence of a computational perspective. Ph. D., Massachusetts Institute of Technology, Dept. of Architecture.

Rorick, Huck. 1971. An evolutionary architect Wright. *Journal of Architectural Education* 26 (1 and 2) (Winter / Spring): 4-7.

Rouillard, Dominique. 2004. *Superarchitecture : Le futur de l'architecture, 1950-1970*. Librairie de l'architecture et de la ville. 1re éd ed. Paris: Editions de la Villette.

Rudofsky, Bernard. 1964. *Architecture without architects: An introduction to non-pedigreed architecture*. Museum of Modern Art; distributed by Doubleday, Garden City, N.Y.

Nikos Salingaros, *P2P Urbanism*. Umbau-Verlag; Peer to Peer Foundation, Solingen, 2010, http://zeta.math.utsa.edu/~yxk833/P2PURBANISM.pdf.

Schoffer, Nicholas. 1969. *La ville cybernetique*. Paris: Tschou.

Shannon, Claude Elwood, and Warren Weaver. 1949. *The mathematical theory of communication*. Urbana: University of Illinois Press.

Shirky, Clay. 2007. *Generalizing peer production into the physical world*. Decentralization: Implications of the end-to-end principle. http://finance.groups.yahoo.com/group/decentralization/message/6972

Simon, Herbert A. 1996. *The sciences of the artificial*. 3rd ed. Cambridge, Mass.: MIT Press.

Smithwick, Daniel J.,II, and Massachusetts Institute of Technology. Dept. of Architecture. 2009. Architectural design 2.0 : An online platform for the mass customization of architectural structures. S.M., -Massachusetts Institute of Technology, Dept. of Architecture, June 2010.

Stiny, George. 2006. *Shape : Talking about seeing and doing*. Cambridge, Mass.: MIT Press.

Stiny, George, and James Gips. 1978. *Algorithmic aesthetics : Computer models for criticism and design in the arts*. Berkeley: University of California Press.

Stuart-Smith, Robert, Perez, Diego and Goutsou, Yiota. Behavioral urbanism. 2008 [cited May/05 2012]. Available from http://www.kokkugia.com/research/behavioralUrbanism.xml.

Sturrock, John. 1986. *Structuralism*. Paladin movements and ideas. London: Paladin.

Suchman, Lucille Alice. 1987. *Plans and situated actions: The problem of human-machine communication*. Cambridge, England: Cambridge University Press.

Sutherland, Ivan. 1963. Sketchpad: A man-machine graphical communications system. *AFIPS Proceedings*.

Thompson, Clive. 2008. Build it. Share it. Profit. can open source hardware work? *Wired Magazine*(16.11) (2008/October/20), http://www.wired.com/techbiz/startups/magazine/16-11/ff_openmanufacturing.

Toulkeridou, Varvara. 2010. Dynamic descriptions : Steps towards a design machine. S.M., Massachusetts Institute of Technology, Dept. of Architecture.

Turner, Fred. 2006. *From counterculture to cyberculture : Stewart brand, the Whole Earth network, and the rise of digital utopianism*. Chicago: University of Chicago Press.

Turner, Victor Witter. 1967. Betwixt and between: The liminal period in rites de passage. In *The forest of symbols*. Ithaca, N.Y.: Cornell University Press.

Upitis, Alise. 2008. Nature normative : The design methods movement, 1944-1967. Ph. D., Massachusetts Institute of Technology, Dept. of Architecture.

Von Hippel, Eric. 2001. User toolkits for innovation. *Journal of Product Innovation Management*.

Weber, Stephen. 2000. *The political economy of open source software*. Berkeley Roundtable on the International Economy, University of California, Berkeley.

Guy Weinzapfel, "Interview with Theodora Vardouli" (Audio Recording, Cambridge, Massachusetts, 2012).

Weinzapfel, Guy, and Nicholas Negroponte. 1976. Architecture-by-yourself: An experiment with computer graphics for house design. Paper presented at *Proceedings of the 3rd annual conference on Computer graphics and interactive techniques*, Philadelphia, Pennsylvania.

Wilden, Anthony. 1972. *System and structure: Essays in communication and exchange*. London: Tavistock Publications.

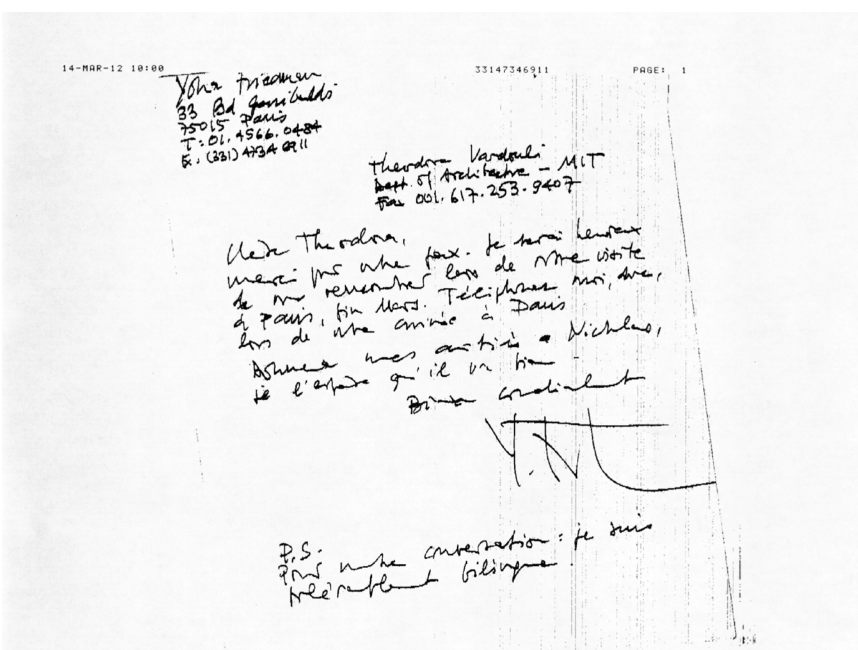
# *Appendix*

## Appendix A: Interview with Yona Friedman

**Interviewer:** Theodora Vardouli
**Date:** 03/30/2012
**Location:** 33 Rue Garibaldi, Paris, France
**Duration:** 1:28:33

**Theodora Vardouli:** *I am reading "Pour Une Architecture Scientifique" ("Towards a Scientific Architecture" in the English translation), and I wanted to know more about the context in which you wrote it, your motivations, your intentions.*

**Yona Friedman:** I have now time to prepare an exhibition with the MOMA and a group of museums; not a personal exhibition but a programmatic one. At the MOMA there was in the sixties "Architecture without Architects"; I am proposing now "Architecture without Building". I will show you a booklet that I prepared which will come out in a couple of weeks from now. The idea is that we are over-building now, and it is not necessary. For example the office blocks: they are vulnerable. You had the illustration with the Twin Towers. Also, now people work with the computer: why go to the office to work with the computer? You can do it at home. In the case of the museum I am claiming that the museum doesn't need the building: it is the exhibit. So you just need something there; if you want, showcases or some dispositions for an exhibit. I have now a project for this year which is for the Warsaw Museum of Modern Art (Yona Friedman points to a model of a Space Chain structure). They accepted this idea because it is far less expensive. Not simply in building cost, but in running maintenance.


14-MAR-12 10:00 33147346911 PAGE: 1

Yona Friedman
33 Bd Garibaldi
75015 Paris
T: 01.4566.0484
F: (331) 4734 6911

Theodora Vardouli
Dept. of Architecture – MIT
Fax 001.617.253.9407

Chère Theodora,
merci pour votre fax. Je serai heureux
de vous rencontrer lors de votre visite
à Paris, fin Mars. Téléphonez moi, dès
lors de votre arrivée à Paris
Adressez mes amitiés à Nicholas,
je l'espère qu'il va bien
Bien cordialement
Y.F.

P.S.
Pour notre conversation: je suis
parfaitement bilingue.

**Figure 46.** Fax correspondence with Yona Friedman. March 14, 2012 [personal archive]

The idea is -I will show you on DVD- that there is a simple structure and for every exhibition you can have a different shape. The exhibit can be put in the structure in every way that they want. For them (the Warsaw Museum) it was a simple solution because they had a very monumental project and no finances. This is twenty or thirty per cent of the original budget.

I was doing similar things already. Uncertainty and feasibility is always a problem, so my principle was always that architecture is too preconceived, too fixed and people, real people, cannot reorganize it, they cannot criticize it according to their life; because it is their life. Architects force people to live in a certain way. Now, at least from the 20th century, this is not any more necessary technically. I started first with a fixed frame within which people were free to do what they want. I am now going one step further: the fixed frame can be changed as well. One of the things that made the fixed frame necessary, was not simply the stability or the rigidity but also the ducts: electricity water, sewage. This has changed. You see, you came here and you don't use electricity. They (points to my video-camera and wireless phone) are more and more battery oriented. I see very easily -technically speaking- that you will buy a battery (for electricity) from the tanking station; you now buy the gas for cooking at the tanking station. They will do it with water too because -possibly- bottled water is healthier, less polluted! In any means, we are getting more and more an autonomy.

So I say that the center of the habitat, of living, it is simply people. It is not the object, it is not hardware, is not software either, I will call it simply reality. With software everything is already too formalized. This is what I am trying to prove in praxis. I am trying to show that this system (the Space Chain) simply works; it is easy and inexpensive. In the start I was told that it would be very expensive, the reality shows that it is far less expensive.

This project at MIT, Architecture-by-Yourself was based on this principle and on how to transplant it to computer. What came out of this practical experience is that the computer is not good for it. It is too fast. People need time. If they do something manually they think more. With the computer, ok, the computer gives the best answer, yes, but what best answer? Real life has a certain speed. For certain problems these computer programs can transfer reality into a game, but even then a game is very far from reality. The models work but they are not the real thing. For example in order for a group to conceive a collective building it takes about six months: the discussion between (the members of the group) will take six months. The computer helps, but it is not the right way: people do not think about the best solution, they look for what fits them. There is a big big difference! And you cannot look for this with the computer. The computer has first to make your own profile et cetera; this becomes inefficient. This is why I am telling you that the best thing is the reality. Reality can be made easy. For example for this (points to the space chain Warsaw Museum prototype) I did not give plans - there are no plans! They got the rules of how to put things together and they produced that object. But it is not necessary that the object is configured this way, they (the user/participants) can combine it in any way they want.

I am now doing a project in Berlin. There the only thing fixed are three cranes to manage the structure. Cranes are everywhere at building sites. In this project they are for seeing, sending manipulation (of the structure). The cranes are fixed, they are the only fixed points! These are the first drawings of this little book here. These drawings explain everything, they are very simple drawings and there are also some practical examples (brings hand-made booklet prototype with pictograms) It is the same thing when it comes to the communication I use: It is very simple. These drawings are a slide show. We also have it on DVD now. The booklet is an addition. Instead of plans I am giving out this kind of DVD.

**T.V:** *Following your discussion of reality now: In "Towards a Scientific Architecture" you used graph theory and graphs as a system that could transpose reality to a representation system.*

**Y.F:** Graph theory for certain Mathematicians is not Mathematics, it is not Logic, but it is a very useful tool. It is useful for people to experiment. It also helped me in doing a very funny thing: First, about the critical group size: I found it through graph theory. Now it is accepted by sociologists. The other very funny thing is when I was writing the Urban Mechanism model. I was writing this model in the early sixties and then computers were not easily available. At that time I finally got a computer for experimentation, this is a funny thing, by the Physics Department!

**T.V:** *Here? (in Paris)*

**Figure 47.** Yona Friedman interviewed by Theodora Vardouli in his apartment in Paris. March 30, 2012 [photo: Theodora Vardouli]

**Y.F:** In the States, Princeton.
The funny thing is that I didn't know why. They told me: "Yes, your idea is really interesting for Physicists". Then much much later I found that Richard Feynman had also a model with path diagrams and it was the same mathematical model (as in Urban Mechanisms). I didn't know. Simply because of this resemblance physicists were interested! Here again the idea is similar. In the "Urban Mechanism" model you think: "I don't know what happens in the city. I know that from this point there are people who go and at this point there are people who arrive. I don't know what is happening in between, but somehow this movement gives an image of how the network is charged." Feynman's idea was very similar: I shoot an electron and an electron arrives -it is not sure it is the same! The electron could take many different paths. Through this model Feynman reads the same kind of patterns. So it is essentially a summing up of the possible itineraries and adding, calculating the probabilities. The mathematical apparatus is simple. We need the computer because it can do it for a big number of departure and arrival points. I have always been always very much interested in Physics because Physics is very much linked with Mathematics - in a very questionable way.

It is very simple to explain: what is important in events is the process not the result; the same is the case with Architecture. Like in this (points to Space Chain model) people build different structures, it is the process which is important. There is only one way to know (describe) the process: it is a linear sequence. It it is a story, a history of things, which does nor follow a logic; you cannot make abbreviations.
You can do a statistical approach which is in many cases meaningless. It is like in Architecture: when I was a student I remember everyone

**Figure 48.** Yona Friedman in his apartment in Paris. [photo: Theodora Vardouli]

**Figure 49:** A model of the Spatial City, stored in Friedman's apartment [photo: Theodora Vardouli]

talking about the "Average Man". I was thinking "But this is the only one who does not exist!" Now the funny thing is that the mathematics for handling processes is still not invented. You take for example a sequence. How are you adding another sequence? It is meaningless: they are simultaneous. What are the detail sums for example? We don't know. I was giving as an example of a model for a potential Mathematics for sequences simply a musical partition: there are the different dimensions, the different instruments and they go simultaneously. The only thing in common is the time. And nobody can know the end result before someone performs it. This is important.

Let us now translate it for a moment in Physics. This would mean that the only independent variable is time. You can describe space through time -you can describe obviously time elsewhere through space- but time is the only variable you cannot manipulate. All the others you can work with. In the musical example I chose, the addition of sequences have simultaneity that means that time is common. This could be perhaps very useful for conceiving real planning; a planner could look at things like a psychological transformation on a common time scale.

Let us now leave Physics. This would be a development for Architecture and Planning. The real tool for this is the computer. This is where I see the use of the computer in Planning: that histories can be played on a common timescale. That is technical ready, we have no problem with it, what is necessary now is experimentation.

**T.V:** *Do you think that understanding the simultaneity of histories would help inform people to make planning decisions or would it be able to anticipate or predict the outcome of a scenario?*

**Y.F:** The way that this could be is: first, have a look at the simultaneities in a real case like this (points to space chain) and the second would be to do it in imaginary scenarios and to learn the language - because a language comes out of all this. There is something I wanted to add about sequences. For example any text (points to my notebook) is a sequence which has a meaning. This sequence it is not mathematizable. It can be mathematized for automatic voice, but not when it comes to the meaning. How can you add several lines of text? There is no way. Take for example that it is possible that these (the lines of text) are real histories, case histories. These case histories can be anything. For example the effective path people take in a space: this can be photographically documented. What does it mean? What comes out of it? This is a very primitive thing. Another example could be how people change the disposal of furniture. These are the "real" scenarios. Now the imaginary scenarios could be "I would like to turn this room; I want to change the window; I will cancel this room". There are many imaginary scenarios possible and if somehow these scenarios are recorded then they might show how this mathematics could look like. The simplest sequential mathematics is simply in arithmetics. You write down a number and then another number; this is a sequence we know how to operate with. Once we get through other sequences which have a meaning there is a problem. I was always of this kind of attitude: the Complicated Order; "complicated" because it cannot be mathematized, there is no way to describe it in a mathematical or logical notation, but it is an "order"! This is where I see at the moment probably the most interesting use of computer in this area. Because it is the only tool which is able to do it. This started with particle physics, but the difference is that processes in particle physics have no meaning. But then I tell you to add two lines (of text) you can put a simple mathematical rule, "adding", but it is meaningless. The problem is how to add sequences which have some meaning. This is something to toy around.

Do you read french? You can probably find easily the book I had with the simple title "Complicated Order", "L' Ordre Complique". This explains all this in more detail. It is a pocket book.

**T.V:** *You also had a part about the "Complicated Order" in "Utopies Realizables".*

Y.F: Yes, it is funny that they reprinted this book now. Many years after (I wrote it) it is now an actuality, the reality today. Somehow reality arrived to this stage. I see this potential (field of research) for a young architect a young researcher; I don't know where it leads.

**T.V:** *When you were writing about these in the 1960s-1970s...*

**Y.F:** You know, books that came out later essentially are made as collections of articles I was writing and then made a book out of. The book that was about the "Erratic Universe" argues for the principle that it is absolutely not sure that what we call laws of

**Figure 50.** Yona Friedman's apartment in Paris. [photo: Theodora Vardouli]

nature are really strict laws. There is more and more thinking in that way. If we were to speak about, let us call it a law of nature, there is only one. This law is too simple: everything existing is in equilibrium. A non equilibrium is not imaginable. The equilibrium comes automatically, we don't know how but it is a fact. Anything you make is immediately equilibrated. This expressed with a very simple mathematical formula that Summa energy points with direction is zero.

**T.V:** *Who would you say that were your major influences in these explorations?*

**Y.F:** I am a non-specialist. I have a professional Architect's Diploma but I am not working with Architecture like the craftsman-architect. I simply follow my curiosity. I don't know what to say. I had a dog; and I learned enormously from the dog. You will laugh but from the human point of view the dog is an extraterrestrial; it is completely different! So I was living for years with an extraterrestrial, observing it. It was a very intelligent extraterrestrial because it was understanding me but I didn't understand it. One thing that dogs do, is that they don't focus with their eyes. They have a hazy view of things and they therefore cannot see discrete things. If you don't see discrete things you cannot invent language. Language is names for discrete things. If you don't see discrete things you cannot invent arithmetics. So in principle a dog, let's say as a being, has a different kind of sight and it cannot invent language or arithmetics in our sense - but it can invent another arithmetics and another language. For example dogs have an emotional language and not an information language in our sense... Ok, I don't know about the arithmetics! You see I am curious about things and the hypothesis that things can be otherwise.

**T.V:** *Your ideas about the democratization of architecture are coming back. You once framed the argument that architecture can be a language that everyone can learn how to speak. In "Towards a Scientific Architecture" you talk about a way that this could be done.*

(Yona Friedman goes inside next room and brings a 15" Macbook, plugs it in and turns it on)
**Y.F:** I wanted to show you two small things.
(Pats computer on the "back" as it switches on)
**Y.F:** Because it is sleeping you have to be kind...I use this for storage.
(Launches slideshow for the Warsaw Museum project)
**Y.F:** It is exactly this Museum project. See this is a practical project. I get to prepare the visual explanation. I will then show you one in real scale, not in model. This is a new kind of architecture that you can change easily. There are a number of technical solutions. The advantage of this kind is that you can do it completely irregularly.

(Then Yona Friedman plays a real scale installation of the space chain reconfigurable structure, manipulated by cranes)
**Y.F:** This is in real scale. People take the modules and then compose the modules. This happened in 16 hours and it was large, three stories high. We had to do it manually because it was a piece for a limited time, so it had to be dismantled. But this is the real thing, not a model. This is the Architecture that I am proposing. And this can be done with containers as well. I have a model about it (points to a container model). I was also using this technique (points to a third model on bookshelf): I call it Crumpled Sheets where simply you crumble sheets of metal and they become rigid. I am interested in technics but you don't need completely these tools (the space frame). This means that people can modify the structure themselves.

**T.V:** *In "Towards a Scientific Architecture" you wrote that in order to plan, to make temporary arrangements, within the infrastructure it is necessary to have a common language between all the participants or at least keep the community informed about individual decisions. I was wondering about the processes that are going on in the infrastructure and how you think they can be made possible between people.*

**Y.F:** Now I am using a common language: it is the real thing! If they can modify the real thing, for example they can take containers, room size boxes with transparent walls and fix them in structure. If they have a crane they can do the experiment, they can do it. Evidently the containers are designed in a way that allows them to be manipulated. This thing (the real scale space frame) is built in construction, simply improvised, "Put it there! Put it there!" and they did it. I am trying to get the experimentation with the thing itself. In every flat people do this experimentation with furniture: "Put the chair there! Put there the table here!" They do not need to make drawings for that.

**T.V:** *Do you think that people have to see and then they know?*

**Y.F:** Yes, because then you can have several mental processes going on simultaneously. When you say "Oh, I like it better there", this is a complex mental process that a person does automatically. This is what I am trying to arrive here and (plays video with Container structure)
So it is there, improvised!
But they built it with a real space frame structure. The space frame structure does not need to be regular. The regular structure is just more typical to calculate and easier to experiment.
So this is actually everything: at real scale. You can experiment with a model but the real scale should be easy to manipulate with obtainable equipment. This is really what I am trying to propose.

**T.V:** *Would you say that this is a different approach that the graph theory approach? Graph theory was abstract.*

**Y.F:** The graph theory was practically a mapping of reality, but reality itself is a much better mapping! You can use graph theory, it is no contradiction, but you can shortcut it if you want. This is a prolongation of the experience I had with real cases: it takes time for people (to think abstractly). With reality it is faster. With the abstraction, people have to translate it to their reality. People don't make a sketch when they say "I like to put a chair there, like to put it here" They just put it and see. If you want a general rule, the best model for reality is reality itself.

**T.V:** *You used to visit the United States and MIT quite often; could you talk about your experiences there?*

**Y.F:** In the US; I made a proposal, which was not that well accepted, to build over the New York dock and bridge to New Jersey... I have it here (Opens the "Yona Friedman: Drawings and Models 1945-2010" edited by Yona Friedman and Marianne Homiridis). See that. So this was a bridge over the Port Authority Docks in 1964. If they did this kind of thing (points to skyscrapers connected with bridges) there would be less victims with the Twin Towers. You know, leaving the high-rise unconnected is an error.

A few years ago I had a project, an idea for a Metro for Los Angeles. I proposed simply using the freeway, simply deepening it and using it with trolley-cars. Everything is ready. Yes, there are problems at certain crossings but they are very few. They do it now! Because these ideas are simply so evident; they are stupidly evident!

**T.V:** *But people first have to see...*

**Figure 51.** Yona Friedman in his apartment in Paris. [photo: Theodora Vardouli]

**Y.F:** Sure, for example they had here the Grand Paris project and I am very much against it. It is simple to explain: somebody working in the city (Paris) makes one hour from the suburbs to the center. Yes, but you can come in one hour from Brussels and in two hours from London. So I was really posing the question: is London a suburb of Paris or Paris a suburb of London? I had this proposal -it is simply a political question, it is not technical any more. I call this "Metropole Europe," the City of 40 million inhabitants, with a suburb named London, a suburb named Brussels and Marseille or so. The fast rail connections exist, they did the investment for that. So my proposal was simply a cheap Carte Orange, that gives you a cheap travel between such and such cities. Jobs could happen that way without people moving. Europe is really a metropole and the largest imaginable one. It is there. The only thing is the political decision to subsidize a Carte Orange. So there are countries in smaller scales like Holland or Switzerland where such a fare system exists. So we can do it; take advantage of the fact that the infrastructure already exists. My proposal was was not to build something, the infrastructure is there. So it is the same thing that I said about the Los Angeles metro. My proposal is not to build something, it is already there. It is simply another mentality, another manner to use the existing.It is always political decisions, not economic, because all the economic investment has already been done.

Now with the United States, I have kept some contact with Los Angeles because of my daughter and because of the Getty. I think that now that I am here (in Paris) I can propagate ideas. I don't have the illusion that I can work too much. Because you get tired; even staying alive, because you have less tenacity to it. But I often visit places where there are mostly young people who look around for a certain approach. I do not think that it is possible to take the approach that I am taking, but a switch in some direction is ok!

**Figure 52.** Yona Friedman in his apartment in Paris. [photo: Theodora Vardouli]

**T.V:** *What was your experience from your work at MIT, when you worked with the Architecture Machine Group in the Architecture-by-Yourself Program?*

**Y.F:** It was my first real experience of the non credibility of the computer. It is very funny because Nicholas (Negroponte) had a program which was based on conversation. So i was trying a simple thing: I was making voluntary mistakes that common people would make, to see how the computer would react. It got simply mad! And Nicholas was absolutely surprised! We did not know what happened because the computer did not record the process. There was no trace. It could not find the trace of what had happened, how came the definition of the problem. The other important experiment that happened at MIT is that they (the Architecture Machine Group) were mobilizing real people, real people to plan with the machine. They could not do it, because of the speed (of the machine). This is where I first realized that the process had to be slow, the program needs to be adapted to the people's thinking speed and not to the computer's. So for me these two experiments were very important: there could be mistakes all the time but no-one learned anything because we did not know how the mistake occurred, and the speed. For me this was an important observation. You cannot solve this problem (of self planning) simply with the computer, the computer can solve other problems.

**T.V:** *When you were writing "Towards a Scientific Architecture" people like Levi Strauss here in Paris were also using mathematics (namely graphs) to describe the social. Were you interested in that, did you have any contact with these cycles?*

**Y.F:** You know I was teaching at this time at Ann Arbor in Michigan. The book Scientific Architecture was essentially the course I was teaching. So this was maybe 1964-1965. Then this was printed in french in 1970 and then it was reprinted even in the Soviet Union! It was translated in many languages. Until now I agree with all this but what I am trying to do is to expand it, to go beyond the abstraction. In the same time I could say that the result of the process came from that.
My experience teaching in the United States was surely decisive for me. When I was teaching, I think it was in 1964-1965 I was first invited first to Harvard and then I went to lecture at MIT. This is the case that Nicholas (Negroponte) says that he was picking me up from the airport! This was a period they were giving grants to researchers so I had an absolute freedom with my work in the Universities that invited me, which I did not have here.

**T.V:** *So when you were writing the book the influences were mostly from there, from the United States?*

**Y.F:** Mathematicians were interested and helped me in my work, even if I was invited in the US by architects. One of the most renown graph theorists in the States was also teaching at Ann Arbor: Harary, Frank Harary.

**T.V:** *Did you develop your theory after meeting him? The theory was there since the Ville Spatiale, but I am referring to the specific formalization with the graphs you present in Towards a Scientific Architecture.*

**Y.F:** It was essentially a simple departure. In the Ville Spatiale you can get all the combinations. What are these combinations? And now I could tell the same thing, I could put this (points to the Space Chain) in graph theoretic language but now I have a technics which makes it easy to go to the reality...

**T.V:** *In your model you said that people would actually have to see all the possible combinations to be able to select one. Do you think this is a different model from the computer only giving one solution? And which is closer to your idea of non paternalism?*

**Y.F:** People are more revolted against what I was calling "paternalism". Not completely, it is a mixture. For example at the start, I was friends with Konrad Wachsmann and he was saying that grids had to be regular. I have a demonstration that it does not need to be like that. You can do it with completely irregular grids. This is a space frame (points to a model of "Cloud" structure). In reality you have to fix the structure everywhere the metal wires touch. This structure is improvised, I cannot draw it, i cannot read the drawings, no-one can read the drawings.

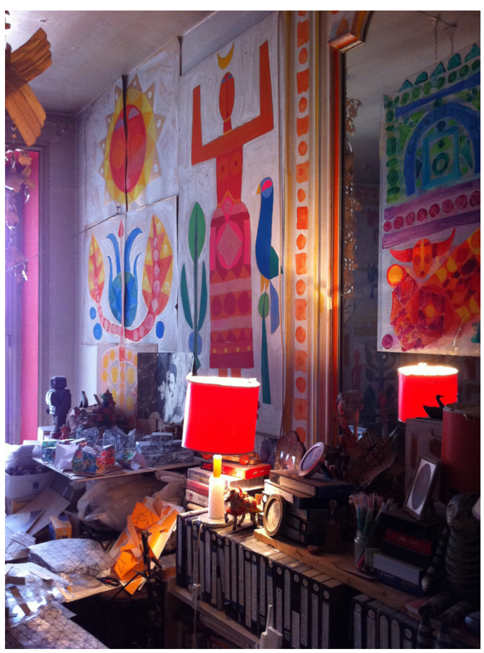


**Figure 53 and 54.** Yona Friedman's apartment in Paris. [photo: Theodora Vardouli]

**T.V:** *I was wondering if you think that by experimenting and improvising that people will learn how to think "as architects". Is there something that an architect does that everyone can learn how to do or are we all already architects?*

**Y.F:** Intelligence starts with improvisation, as simple as that. People have always improvised. Einstein improvised! So the idea is always improvisation. Let us explain what is improvisation: that you make complicated mental processes, which are not in every point conscious, they are a mixture. You find something as automatically satisfactory exactly because your unconscious works with it. It is not always the rational. Always people do something and they say "Oh, I like it better!". So I think architects improvise already but it is important that they also make improvisation by people really possible.

# Appendix B: Interview with Nicholas Negroponte

**Interviewer:** Theodora Vardouli
**Date:** 03/16/2012
**Location:** E14-433a
**Duration:** 44min 37sec

Nicholas Negroponte requested to not include a transcript of our interview in the current appendix because of its personal and informal character. In our conversation we discussed his influences from the radical architectural scene of the 1960s, his personal relationship with Yona Friedman, the people and events that spurred his interest in interfaces, systems and design participation. Professor Negroponte also described a series of anecdotes around the foundation of the Architecture Machine Group. This information is included in the *History* chapter of the main thesis body.


**Figure 55.** Nicholas Negroponte's archive. [photo: Theodora Vardouli]

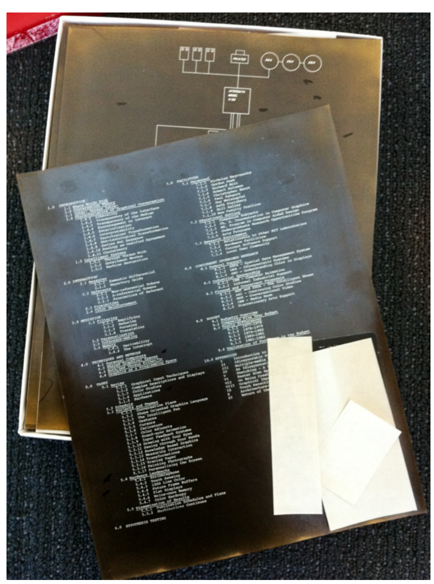


**Figure 56 and 57.** Folders in Nicholas Negroponte's Archive with images from his early publications. On the right, the table of contents from *Graphical Conversation Theory*. [photo: Theodora Vardouli]

## Appendix C: Interview with Guy Weinzapfel

**Interviewer:** Theodora Vardouli
**Date:** 03/22/2012
**Location:** Cafe Luna
**Duration:** 57min 38sec

**Theodora Vardouli:** *In our conversation last week, Nicholas Negroponte insisted that I should speak with you because you were one of the main actors of the Architecture-by-Yourself program. How did it all start?*

**Guy Weinzapfel:** There was a program called YONA in which I was involved. It was...

**TV:** *I have the paper here. I think the paper was published in '76.*

**GW:** (looks at paper) It really doesn't say but I think it was in '73-'74-'75 and we wrote the paper in '76, maybe I am off by a year. I went to MIT at '68 and I needed to work as I had ran through my money traveling around Europe. I got a Research Assistantship with a guy named Tim Johnson with a project that came to be known as IMAGE. That was a project funded by NSF. It was a continuation of the work he had done initially with Ivan Sutherland on computer graphics. Ivan had done 2D and he extended that in 3D graphics. He was looking for something to do with that and started a research project of trying to apply computer graphics to Architecture which ultimately came to be known as IMAGE. And Ivan and then Tim had instituted constraints in the implementation of graphics.
For example lines should be either mutually parallel or mutually perpendicular, when they cross they connect ... these kinds of constraints. On the basis of that Tim was looking for a way to find

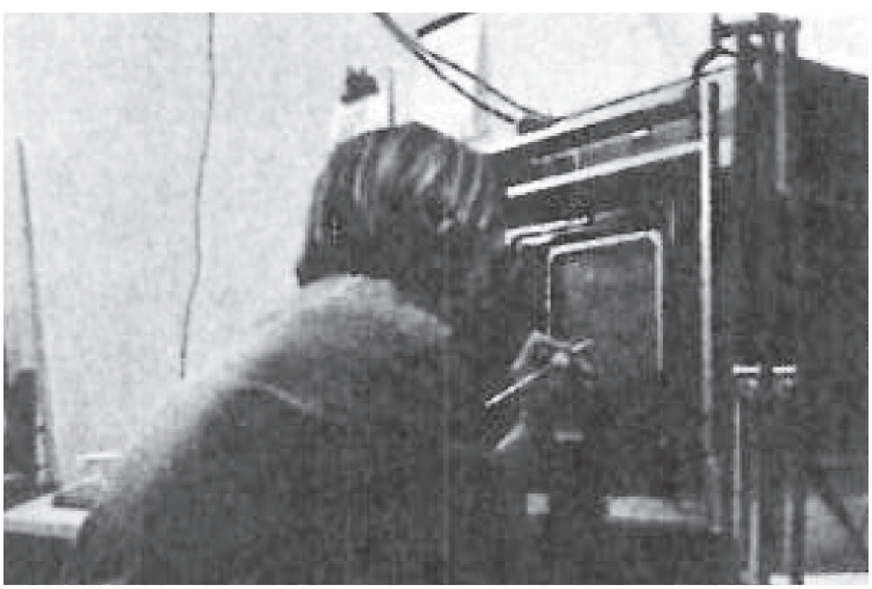


**Figure 58.** Guy Weinzapfel. Image from the NSF Proposal *Computer Aids to Participatory Architecture*.

architectural constraints that could be applied to Design. Really he was looking for ways of automatic layouts for floor plans. That was the work that I was involved in from the fall of '68 to the spring of '71. I got a follow-on grant from the NSF which was sponsored by Nick (Nicholas Negroponte). MIT requires that any funded research should be under the auspices of a Professor, which Nick was. Tim moved on; he was off doing passive energy systems and so he left me in charge of IMAGE. I submitted a follow-on grant application which was funded for 1-2 years starting in the Fall of '71 but I was dong that under the auspices of Nick. In '72 -'73- '74 Nick really begun to focus on a much broader definition, a much more flexible - I don't know if these are the right words... He wanted to change the definition of "interactive".

Give me your hand; Pull. We' re interacting right? That's interaction.

Interaction at the time was "you speak, I say whatever, and then I say you do it". That was the definition at the time: it was command oriented, I tell you something, you do it. IMAGE was very much in that line: I give you a bunch of constraints, a bunch of spaces and you arrange them according to these constraints , I don't do anything. Nick was much more interested in making the computer a design partner and to using all the emerging input and output technologies that were becoming available: touch sensitive digitizers, pressure sensors, voice input. He was interested in using all of those in ways that a computer could make an inference about the person that it was working with, not for, with. That was a completely, in my day, unique emerging definition of computer applications. He really led the field and he pushed me working on IMAGE. I was at the time doing stuff in the background like calculating HVAC requirements, and construction costs and all these things in the background. He said "All this background computing is nice but I want this to be a tool that interacts with the human"; the human sees what the computer is doing the computer sees what the human is doing, so that was the thrust. So he pushed... He had met Yona (Friedman). He pushed to have Yona come over and do this project with us. So he did.

**TV:** *So he was participating actively? He was around?*

**GW:** Yes he was there, he was present. He did not know anything about computers, he did not know anything about programming languages or anything like that, but he had worked on methods helping people think about design who were not designers. So he participated in that way, he talked with us about his methods. This kind of stuff, shapes and so forth.. Where is it? (looks at the paper) So that's what i can tell you off the top of my head. He worked with a client the Falcos - I don't remember the first name- and you know, we tried to have them design it themselves instead of having me designing it or the computer designing it. the computer would participate and I would really learn from observing them using the computer to see what else I needed to do to make the computer more interactive.

**TV:** *You implemented the YONA program and tested it with people?*

**GW:** We took IMAGE as the staring point, we made it do different things that it hadn't done before. We made it more interactive; in Nick's definition of "interactive".

**TV:** *I am reading "Soft Architectutre Machines" and Computer Aids to Participatory Architecture for my thesis research. "Soft Architectutre Machines" was written in '72 and published in '75. I was curious when this idea of participatory architecture came in (the Architecture Machine Group).*

**GW:** '72-'73-'74... There was an enormous amount going on at that point. Displays prior to that point had all been vector based, so you designated a point here and a point there and you drew a line between these two points. Now you had raster images, video images coming out, so the question was how do you make a line on a raster, on a video pixelated screen so that it appears smooth and straight; a line as opposed to some jumble of pixels. So there was a lot of work even as fundamental and basic as that going on. There was work like "Is a joystick better than a touch sensitive device, better than a light pen?", all these crazy things. People were bringing things to the Lab (the Architecture Machine Group), inventors... and we were inventing stuff right left and sideways!

**TV:** *It must have been an amazing time.*

**GW:** Yes, it really was a wonderful time, it really was.

TV: *How many people were working in the YONA project?*

**GW:** It was a very small organization. Yona (Friedman) was not doing any programming of course. Let me see that paper... I believe that Steve Handel was involved... I believe that there were only 2-3 people involved in it, maybe only one programmer. I was trying to describe to the programmer what I wanted to achieve and then Yona and I were talking about it. I think that's about it.

**TV:** *I am really curious about Yona Friedman's participation in all this because now he seems to be very "anti-computer".*

**GW:** I wouldn't be surprised. I wouldn't say he was very "pro-computer" when he was with us. He was not a computer oriented person in any way. Very interesting nice guy, liked him a lot!

Interesting in the sense that he smoked these eucalyptus cigarettes. It was really weird. I grew up in Arizona so I know all about eucalyptus. It was a pretty strong identifiable smell and I enjoyed that; but it was just odd. I honestly don't remember a lot about him. I mean, I would recognize him if I saw him on the street or I would say "I think I know that person". He had worked out a kind of participatory design modality or way of working, a description of how you do it. His objective was to make non designers their own architects. He had come up with a mechanism for tying spaces together, selecting shapes, orienting those shapes; very basic stuff which actually lent itself very well to the work that I had been doing with IMAGE. It was a very parallel non computer-based activity.

**TV**: *When I was speaking to Nicholas Negroponte, he said that Friedman's theories were "computational enough" so it was really easy to implement them.*

**GW:** Absolutely! I've been writing a kind of recollection to give to my daughter at some point and it was interesting: Tim Johnson thought in programming language, thought mathematically. I would be talking about the constraint of a line or a constraint of proportion, proximity, distance and he would program it on the board in real time! It was just phenomenal to watch. Faced with Yona's work (claps fingers) he'd have done the whole thing ... bang! It was that straightforward. Essentially with IMAGE we had done one implementation of space arrangement, with YONA we redid it, but according to his methodology. It was pretty straightforward. He must be pretty old right now.

**TV:** *Yes, he is 90.*

**GW:** Well, he was no spring chicken back then!

**TV:** I am very curious to talk to him because through talking to you and Nicholas Negroponte I have seen the "MIT side". Friedman at the time was very much involved in the radical architectural scene in Europe and the way that he was talking about his vision was quite political; the way that he was writing about it. There was always a utopian idea. I was wondering if any of that was coming through to your work at the Architecture Machine Group or if your motivations were more to take advantage of the technological infrastructure and proceed with implementations.

**GW:** It is interesting you should ask about the political aspect because clearly Yona did have a political view of the world in a way that I didn't and I believe neither Nick did, except when it came to the politics of the computer if you will. This a whole different world than social politics. You have to remember, it was at a time we got into the Vietnam war in the second half of the 1960 -we were over there as advisors before- but we got in the war -we being America- in the latter half of the 1960s. It all came to a hit about the time this was going on, because Nixon negotiated us out of Vietnam in ‘74 I believe, but that period of seven-eight years was very convulsive for society. Many people felt very strongly that society had to change, that America was heading in the wrong direction, that the world was heading in the wrong direction. I sense that Yona felt that as well. But that was not of any particular interest to the Lab, the Architecture Machine Group, nor to me.

**TV:** *It is interesting that you talk about the “politics of computers”. In the Architecture-by-Yourself paper you talk about “non-paternalism” and there are references to how computers should be seen in relation to the users. Nicholas Negroponte clearly discusses this idea in Soft Architecture Machines. Did you further articulate this idea of “non-paternalism”? Would you say that you had more specific ideas about how “non-paternalism” can be achieved or was this concept more just out in the air?*

GW: Nick more than any of us in the lab was interested in the politics of the machine and their users. He was pretty articulate about that. Most of us where less focused on that and more focused on getting things to work. One of the things that the Lab wanted to do is... For example, I walked into the room and we looked at each other and I drew inferences, you did too, I knew it was you you knew it was me and we knew why we were here. At that specific point in time, and even pretty much today, you have to tell the computer god damn everything! Even with Siri: it will make inferences, and good ones, but it is only using your voice, it is not using any visuals to say “Oh, there’s Theodora!” He (Negroponte) was pushing towards that, to the extend that we wanted to see if we can have a computer that run a bunch of other computers, and was watching visually and in other ways, so that when someone entered the room it could say “Oh it’s Theodora, I can tell by the way she is walking. Oh she is at that console”... boom! there comes your work environment! You don’t have to do anything, you just sit down and its there. That’s one of the things we were exploring.

**TV:** *You said (in the pre-interview conversation) that you had taken Computer Science classes while at MIT. Was there a lot of AI (Artificial Intelligence) speculation in the Architecture-by-Yourself project or was it more oriented towards implementable ideas?*

**GW:** Well, all of the inference making issues are AI issues. Nick really from the get-go, if not when he first begun to play with computers, certainly at the time I begun working with him in ‘71, he was already working with Marvin Minsky. When I say working I mean he was friendly with them and was trying to explore what Artificial Intelligence means. So Marvin Minsky and Seymour Papert were the two guys that he was most directly tied to. Minsky and Papert occasionally were at the Lab -although Papert now is a big guy at the Media Lab. Everyone was exploring “What does Artificial Intelligence mean?”, “What does inference making mean?”, this whole notion of I, the machine inferring “Oh, Theodora is coming into the room”. Is that an inference? So one of Nick’s first projects before I joined the Architecture Machine Group, was a suspicion or expectation that gerbils, if they have the right environment, will move stuff around to their liking and that the machine can see what they do and help to rearrange stuff that reinforce what they (the gerbils) are trying to do. As it turns out gerbils don’t have a clue what they are doing, they are just shoving stuff around! He (Negroponte) was interested in that from the beginning. So there was an AI component to it. I got involved with it while I was working at the Lab. For me AI wasn’t an issue of interest until i joined Nick in ’71.

**TV:** *Where there people from the AI Lab who were helping, advising the YONA project?*

**GW:** There were no people form AI. Any assistance or direction in that regard was provided through or by Nick. He might be talking with other people and then suggest something or push us in a certain direction. But we were trying to draw some inferences; we started with that room or that room, are connected and should be adjacent, or we are going back and forth between these rooms frequently so they should be pretty close and so on. Then we designed some areas to that. We just made bubbles which was the way in fact that I was trained as an Architect to begin thinking about a project. We would do a bubble diagram and then we would begin to get shape from that bubble diagram. There was some aspect of inference making relative to the sketching of a bubble and the pulling of a bubble: if you pull that bubble here or there if I should assume that this is a straight wall... Those were thoughts that we had. I am not sure we went very far and implemented that but we were certainly very interested in it.

**TV:** *In the Computer Aids to Participatory Architecture there is a big sketch recognition component...*

**GW:** Can i see that? I probably know this (proposal)...
I was not involved in the preparation of this proposal.
(Points at picture in the proposal of a man in front of a computer screen)
It’s me! So maybe I was (involved)!
I probably have this somewhere. This was a precursor of...
I don’t think I was involved in this particular one.

**TV:** *I don’t know if they ever submitted it (to the NSF)*

**GW:** My guess was that it was submitted and not funded. But I do not know that this lead to subsequent proposals, one of which was a much more aggressive and far reaching proposal called "Graphical Converstation Theory", and that was not funded either. It was submitted but not funded. Now at this point Nick had probably in the neighborhood of five project managers. I was one and I had the IMAGE thing or the Architecture stuff going on. Chris Herold was the other. There were Steve Gregory and others that were working, so there were maybe four, five, six program managers that had two-three-four projects they were managing at one point in time. How do we explore an environment that is interactive in our definition, that is participatory in our definition, that kind of stuff.

**TV:** *It is amazing that these things come back with an air of novelty.*

**GW:** They were done so many years ago.. Yes I was having a visit -my wife's firm was the Architect in record for the new Media Lab- so we went through the Lab in a tour and we were looking through different projects and everyone was doing sort of dog and pony shows the way we used to do. This one kid was showing a thing where they have camera watching someone watching TV and they are trying to draw inferences in what they liked and what they did not like based on facial expressions. They were asking the users after they had seen something and they were trying to build a taxonomy a vocabulary that the machine could understand what that person meant. They would test it of course by saying: "I think you are going to like this because there is a lot of gore and there is a lot of action and it has got a lot of creepy characters" and the watch the person and then if they were like (makes expression of dissatisfaction), no they hadn't gotten a good match in the taxonomy, and if they were like (makes expression of satisfaction) then they had. I said "Really? I had a student do this in 71!" (laughs)

It was clear to us woking with Nick that he had a vision and understanding for the potential of computers that we did not have. We could do a lot of stuff that he couldn't necessarily or wasn't interested in doing but, man, when it came to setting a direction or having a vision he was really the guy.

Anyway, you should look at "Graphical Conversation Theory". They were not necessarily all my ideas but I wrote a lot, because I could write.

**TV:** *Were you working with Gordon Pask? Because Nicholas Negroponte mentioned him quite a lot; he said he was a little idiosyncratic!*

**GW:** Yeah! Oh he was such a wonderful guy, a crazy guy! I think he was a doctor but he used medications and drugs of various sorts in almost and abusive manner and he got kind of thrown out of the medical profession. So it was his “conversation theory” which was: I make an inference about you based on something you do and when I then respond to that I make an inference about me. Here is an example: I am driving, I come to a road-ring, another car is coming and looks at me. If he sees that I am not looking his way he infers that I haven’t seen him and slows down. If however I look at his direction and he sees that I see him he will speed up. That is a conversation that went on, no words but we communicated. We were trying to do that graphically, have a graphical conversation. The one section I really enjoyed writing was about interaction. If you don’t find it ask Andy Lippman. You know Andy?

**TV:** *Yes, I will definitely take a look. I wanted to ask you about your training as an architect and how much of an influence it was in your projects. Were you interested in design processes or intuition or things that you maybe lose with the computer?*

**GW:** When I started college I had no idea what I wanted to do. I was pretty surprised that I got onto university, I was not quite a student. My father was a postal carrier, my mother never worked and there was nothing to suggest that I might be able to go to college; and I had no idea what I would do in college. I started with engineering and I hated it, I was really on the verge of dropping out. One of the guys with who I had gone to school in high school was in Architecture. he was a freshman, so I was an engineer he was an architect. We would drive to school together and he would show me his projects and I would ask about them. He could not answer me. I was thinking: “This guy is not the answer, he is going to crash and burn! This is terrible, I can do much better than that.” But since I was crashing and burning in engineering I went and talked to the Dean and I transferred. Even before the end of the first semester I was in Architecture. It turned out it was the best thing I had ever done. I had an innate capability, I thought three-dimensionally, I never am lost, I always know where things are. And I had drawn all my life, I was rewarded for that. Geometry was the only class I ever assed. I had all those things. When I was in Architecture I ate it out, I really ate it out. I graduated I think at the top of my class. I am sure several of my classmates thought they were at the top too! So it was just, I could do it, I could draw, I could design. I went back to MIT only because...

I was working for Walter Gropius at TAC in the last project he did before he died. And the only reason I went back to Graduate School is to get a pedigree. If you work in this community of Cambridge Mass or Boston there is a lot like “I went to Harvard or to Yale”. I thought if i get a pedigree then I will not have to put up with that. That’s how I went, got into MIT. My roommate was in Systems Building so I went there and then at work I got involved with computers. But I am an analytical kind of individual, I like to think and understand, how does this work, why does this work. So I was very interested in seeing if we could automate the design process and if in the process of automating it we could come to understand it better. One of the best Professors I ever had made little bite size... you don't eat a meal by dipping in the whole plate, no. You take a bite and you chew it and swallow it and you digest it. In all of architecture education you do the same thing. Take a little bite, taste it, chew on it for a little while, absorb it and in the end you've eaten your meal. Even though I started the work on IMAGE because I needed the job, I got interested in how can we automate this (process) and if we can automate it what do we know.

I wrote a terrible thesis, but there are some interesting points. I enjoy the thought process that went into it. It is called "The Role of Testing in Arch Design" and it is about how an architect will ignore certain constraints, requirements and will really emphasize something else in order to find a direction or to focus a certain way. That was the kind of things I was interested in.