

FRAMEWORK FOR AN ARCHITECTURAL KNOWLEDGE ECOSYSTEM
THROUGH THE DISTRIBUTION OF AUTHORSHIP

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ABSTRACT

FRAMEWORK FOR AN ARCHITECTURAL KNOWLEDGE ECOSYSTEM THROUGH THE DISTRIBUTION OF AUTHORSHIP

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Shifts from centralized towards socially distributed knowledge production modes are having a great impact on many fields and reshaping the understanding of knowledge production. New paradigms in the sociology of knowledge challenge the notion of single authorship through distribution, and ultimately, by means of dissolution of authorship. Accordingly, the concepts of professional expertise and professionalism lose their previous significance by the blurring of long-held demarcations between expert and non-expert knowledge. The main motivation of this research is to study the way emergent modes of social construction, organization and distribution of knowledge affect the architectural discipline and its modes of practice.

In this context, the knowledge ecosystem approach becomes prominent as it provides a new perspective to analyze knowledge assets in relation to knowledge communities, environments and the interactions between them. The main goal of this thesis is to define a knowledge ecosystem framework for architecture with a focus on the diversity of participants and the openness of the system. The use of formal language and methods are proposed as a common language in this regard.

For this purpose, this thesis scrutinizes the actors in the architectural knowledge ecosystem under three different modes: single authorship, distributed authorship and dissolution of architectural authorship. It further discusses contributions of

architectural knowledge ecosystems to design knowledge and issues related to the dissolution of architectural authorship through a detailed analysis of study-case projects from milestone conferences and exhibitions.

Keywords: Knowledge Ecosystem, Distributed Modes of Architectural Design, Dissolution of Authorship, Formal Language.

ÖZ

TASARIM MÜELLEFLİĞİNİN DAĞILIMI ARACILIĞIYLA BİR MİMARİ BİLGİ EKOSİSTEMİ ÇERÇEVESİ

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Merkezi bilgi üretiminden sosyal dağılımlı modlara geçiş, pek çok alanı önemli derecede etkilemekte ve bilgi üretimine bakışı yeniden biçimlendirmektedir. Bilgi sosyolojilerinde ortaya çıkan yeni paradigmlar, müellifliğin dağılımı ve en nihayetinde tamamen erimesi aracılığıyla, tekil müelliflik kavramını sorgulamaktadır. Uzman olan ve ya uzman olmayanlar tarafından üretilmiş olan bilginin ayrımının ortadan kalkmasıyla, mesleki uzmanlık ve profesyonellik kavramları da önceki önemlerini yitirmeye başlamıştır. Bu araştırmanın ana yönelimi, bilginin sosyal oluşumu, örgütlenmesi ve dağılımı ile ilgili ortaya çıkan bu modların, mimarlık disiplini üzerindeki etkilerini araştırmaktır.

Bu kapsamda bilgi ekosistemi yaklaşımı, bilgi ile ilgili kavramların incelenmesinde, bilgi toplulukları, bilgi çevreleri ve bunlar arasındaki etkileşimler gibi yeni bakış açıları sunarak öne çıkmaktadır. Bu bağlamda tezin ana amacı, mimarlık için katılımcıların çeşitliliği ve sistemin açıklığına vurgu yapan bir bilgi ekosistemi çerçevesi oluşturmaktır. Mimari bilgi ekosistemindeki aktörlerin detaylı incelemesi

öncelikli olarak üç kategoride yapılmıştır: tekil tasarım müellifliği, dağılımlı tasarım müellifliği ve tamamen erimiş müelliflik. Buna ek olarak bir mimari bilgi ekosistemi oluşması adına dönüm noktası sayılan uluslararası konferans ve sergilerden seçilen örnek proje incelemesi çalışmasıyla mimari bilgi ekosistemi modelinin mimarlık disiplinine katkısı olumlu ve olumsuz yönleriyle tartışılmaktadır.

Anahtar Kelimeler: Bilgi Ekosistemi, Dağılımlı Mimari Tasarım Modları,
Müellifliğin Erimesi, Formel Dil

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CHAPTER 1

INTRODUCTION

Shifts from centralized towards socially distributed knowledge production modes are having great impact on many fields and reshaping our understanding of the world. New ways for social construction, organization and distribution of knowledge have emerged. Social construction of knowledge challenges previous ideas associated with knowledge production such as centralized authorship, superiority of expert knowledge and professionalism. Knowledge produced by a diverse range of actors is treated as more socially accountable and reflective than that produced by a limited number of experts.¹ In other words, epistemic authority is increasingly recognized to be shaped in and by the social sphere.² This approach suggests a new methodology that blurs the boundaries between expert and non-expert, knowledge producer and consumer, author and receiver.

In the age of information and networked societies, production of knowledge does not follow what has been known as the single authorial paradigm. There has been a shift from the traditional approaches to knowledge management, such as the understanding of knowledge as generated within a disciplinary context and within disciplinary boundaries, following a hierarchical organization between knowledge producers and users, towards the idea of distribution and, ultimately, dissolution of authorship.³

¹ Gibbons, Micheal, et al. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. Sage, 1994.

² Swidler, Ann, and Jorge Ardit. "New Sociology of Knowledge." *Annual Review of Sociology*, vol. 20, 1994, pp. 305–29.

³ Gibbons, et al. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*.

The ‘knowledge ecosystem’ approach becomes prominent as it provides a new perspective to analyze knowledge assets.⁴ The concept of a knowledge ecosystem is the result of the transfer of biological concepts into knowledge assets, whereby biology is proved to be a strong analogy for analyzing the spread of intellectual matter, including knowledge.⁵ In biology, an ecosystem denotes the community of all interacting organisms and their physical environment.⁶ Correspondingly, a knowledge ecosystem would denote the community of diverse agents for the production, distribution, and the use of knowledge that operate through interactions in knowledge environments.⁷ Similar to biological ecosystems thriving on the diversity of species and open organization, knowledge ecosystems thrive on the diversity of their community of knowledge producers and the openness of the system.

The sociological changes related to knowledge production, along with the dissolution of authorship and professionalism, opened up new epistemologies for knowledge production; and the open source proved to be a practically working methodology where social authority shapes the authoritativeness of knowledge.⁸

1.1 Research Scope and Problem Definition

The scope of this research is outlined from a general perspective of the sociological approach to the knowledge production paradigm. The main motivation of this thesis

⁴ Papaioannou, Theo, et al. “Knowledge Ecologies and Ecosystems? An Empirically Grounded Reflection on Recent Developments in Innovation Systems Theory.” *Environment and Planning C: Government and Policy*, vol. 27, 2009, pp. 319–39.

See also Noenniga, Jörg Rainer, et al. “Towards Knowledge Ecosystems: Modelling Knowledge Dynamics in Environmental Systems.” *Procedia Computer Science*, vol. 35, 2014, pp. 1360 – 1369.

⁵ Dawkins, Richard. *The Selfish Gene*. Oxford University Press, 1976.

⁶ Molles, M. C. *Ecology: Concepts and Applications*. 7th Edition, McGraw-Hill Education, 2016.

⁷ Bahrami, Homa, and Stuart Evans. *Super-Flexibility for Knowledge Enterprise A Toolkit for Dynamic Adaptation*. Second edition, Springer, 2010.

See also Yang, Jae-Suk, et al. “Agent-Based Approach for Revitalization Strategy of Knowledge Ecosystem.” *Journal of the Physical Society of Japan*, vol. 78, no. 3, 2009.

⁸ Swidler and Arditi. “New Sociology of Knowledge.”

is defined as to study and discuss the ways emergent modes of social construction, organization and distribution of knowledge affect the architectural discipline. Euphoric or biased approaches to the subject, are existing, however a balanced study of what these new epistemologies of social production of knowledge bring and take from architecture is needed.

The open source movement and the related discussion of blurred boundaries between experts and layman, knowledge producers and users are the main starting point of this present research. Open source, originating in the software industry, expanded beyond being a particular type of software into a paradigm shifting movement that changed attitudes regarding authorship and use of knowledge. Open source also became a powerful metaphor in a variety of domains, including architectural discourse.

Researchers that suggest an open-source architectural practice claim that architects' authority has completely disappeared in the building process and that the current role of architects has been reduced.⁹ The current working methods of the architectural discipline are not answering the need for the field to react to emerging socio-technological developments. Even though researchers such as Mario Carpo have highlighted that participation and distribution of authorship are important issues in the architectural discourse, a working model for the realization of a collaborative architecture is much different than an online collaborative encyclopedia.¹⁰

Moreover, "*Open Source Architecture*" has emerged as a broad and incoherent term with non-homogeneous meanings. Adopting the open source metaphor can lead to misuses with little concern for its actual meaning. There is a multiplicity of definitions attributed to open source architecture, leading to confusions, misuses and abuses due to the trendiness of the terminology. Besides, these terms are stretched so that they would only be used sporadically with a limited meaning leading to hollow appropriations. Accordingly, without being limited to the scope of open source

⁹ Kaspori, Dennis. "A Communism of Ideas: Towards an Open-Source Architectural Practice." *Game Set and Match II. On Computer Games, Advanced Geometries, and Digital Technologies*, edited by Kas Oosterhuis and Lukas Feireiss, 2006.

¹⁰ Carpo, Mario. "Authors, Agents, Agencies and the Digital Public." *ARCH'IT*, 2009.

architecture, this research focuses on the paradigms of open source movement such as blurring boundaries between knowledge producers and user, experts and non-experts.

1.2 Research Arguments

In line with the motivation stated above, this field of research is defined as a knowledge ecosystem and its methodological framework belongs to that of evolutionary epistemology. From a knowledge management perspective, the general outline of knowledge ecosystems is utilized in order to develop a knowledge ecosystem model for the architectural discipline. This field of research is divided into three sub-fields: knowledge communities, knowledge environment and the interactions between these.

For an architectural knowledge ecosystem framework to be constructed, firstly the knowledge community needs to be defined in terms of its participants. This research suggests that the diversity of participants and the openness of the system are the key points for an architectural knowledge ecosystem. This argument is supported by studying the shifting process from a centralized towards a socially distributed knowledge production in architectural practice. Departure from the single authorial paradigm gives rise to distributed modes of architectural authorship and, ultimately, the dissolution of authorship. The comparative study of three different modes (single, distributed, and dissolved) from an architectural authorship perspective is important to define the architectural knowledge community participants.

Distributed authorship is reinforced by the distribution of authorship between architects and professionals from other building design and fabrication disciplines. In this perspective, building design is turning into a collaborative effort with an increasing number of other professionals and experts involved in the complex collective mode of designing.¹¹ Both the distribution between design professionals

¹¹ Bernstein, Phillip G. "Design Instruments of Service in the Era of Connection." *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 60–67.

and the distribution between architects and non-professionals present a departure from the single authorial paradigm. This approach involves increased participation of actors out of the domain of building design disciplines, such as owners, clients, investors, final buyers, design customers and consumers. Moreover, distribution between human and non-human agents contributes to further distribution of architectural authorship.

The analysis of different modes of architectural authorship shows that there are some important issues to be resolved related to the cultivation of architectural knowledge ecosystem. Without a common language, diverse participants of the knowledge community cannot be united to achieve distributed creativity. This thesis suggests the use of formal languages as a common communication interface for architectural knowledge ecosystem. The use of formal languages is scrutinized for opening the architectural design process to diverse actors and to increase participation. The above-listed arguments are grounded on a social construction of knowledge, on which more is developed below.

1.3 Methodology

In addition to the biological analogy, the knowledge ecosystem is studied as an outcome of the methodologies suggested by the social construction of knowledge. This means that the epistemological approach adopted here is that of social constructionism, marking a paradigm shift towards the social grounding of knowledge production, grounding as well the construction of a knowledge community based on diversity of participants, and openness and denying the limitation of knowledge production to a specific community of experts and professionals with centralized authority.

Knowledge ecosystem is a developing approach in knowledge management and the applications of it in architectural discipline are very limited. There are not yet enough theories related to architectural knowledge ecosystems. Hence the research approach of this thesis is based on theory building for the proposal of an architectural knowledge ecosystem.

The observations of this research are based on the ones from design theory (distributed creativity, distributed cognition), observations on working methods of architectural firms and emerging methodologies in building design field (changing trends from traditional design-bid-build model to architect led integrated design and building process) and case studies from selected design projects that emphasize opening the architectural design process to diverse actors.

From these observations, the research aims to detect patterns and similarities as characteristic of a knowledge ecosystem for architecture. These patterns and common characteristics are used to develop general conclusions. In other words, an inductive approach is utilized for this type of exploratory research. Following this research methodology, this work aims to propose an architectural knowledge ecosystem model by constructing an understanding of the meaning that architectural discipline attached to the issue of participation in the design process. As mentioned above, in social constructionism, epistemic authority is increasingly recognized to be shaped in and by the social sphere. These observations are applied to propose that the architectural discipline can utilize this approach by opening the design process for increased participation.

In the absence of an initial theoretical framework, the proposal for an architectural knowledge ecosystem model is developed from the qualitative data generated of observations.

1.4 Overview of the Thesis

Chapter 2 provides the general outline of knowledge ecosystems from a knowledge management perspective with a focus on a biological analogy. A knowledge ecosystem model is defined, following the biological ecosystem description based on three main components: the communities, which are composed of species; the environments; and the interactions between species and with their environment. These three components are defined for a knowledge ecosystem model. Diversity of participants and openness of the system both in biological and knowledge ecosystems are highlighted as a way to define success and balance of the ecosystem.

From the context of blurring boundaries between knowledge producers and user, experts and non-experts, the open source movement is scrutinized as a practical model for a knowledge ecosystem.

The process of shifting from a centralized towards a socially distributed knowledge production is analyzed through a comparative study between three different modes. Mode 1 and Mode 2 are borrowed from Michael Gibbons. Additionally, a third mode, “dissolution of authorship”, is presented herein in order to refer to currently emerging epistemologies, such as open source. Mode 3 is the type of knowledge production in knowledge ecosystems. Hence, it constitutes the epistemological research foundation for the proposal of a knowledge ecosystem for architecture.

The study related to reflection of these three different modes of knowledge production into the architectural practice and the shift between these modes as the architectural authorship perspective are presented in detail in Chapter 3. This chapter, starts with a brief historical tracing of the emergence of architectural authorship, and continues with the departure from the single authorial paradigm, giving rise to distributed modes of architectural authorship and, ultimately, the dissolution of authorship.

Distributed modes of architectural authorship are studied under 4 categories. Firstly, distribution between architects are exemplified by present working principles of the architectural studios, e.g. Gehry Technologies, Foster + Partners, Zaha Hadid Architects, OMA, UNStudio, Servo. Moreover, open distribution between architects are exemplified by UNStudio’s proposal for a knowledge platform; and Alejandro Aravena who had shared his four built social housing projects openly with the public knowledge. Secondly, distribution between architects and professionals from other building design and fabrication disciplines are studied as a result of building design turning into a collaborative effort with an increasing number of other professionals and experts involved in the complex collective mode of designing.¹² The third category of distribution of architectural authorship covers the distribution between

¹² Ibid.

architects and non-professionals, allowing for the participation of actors out of the domain of building design disciplines, such as owners, clients, investors, final buyers, design customers and consumers. Finally, distribution between human and non-human agents are studied in the fourth category of distribution.

In Mode 2, distributed architectural authorship is important due to the fact that it represents a breaking point from the single authorial paradigm. However, Mode 3 type of architectural authorship involves the dissolution of authorship as a step further from its distribution. The Turkish Pavilion at the 2018 *Venice Biennale*, Vardiya (the Shift), is studied as an example that serves as a physical and digital environment for Mode 3 type of knowledge production.

The main output of the Chapter 3 is the identification of important issues to be resolved related to the cultivation of architectural knowledge ecosystem. Chapter 4 aims to bring light to these issues through a detailed study of example projects from milestone conferences and exhibitions with the common characteristic of opening the architectural design process to diverse actors by use of formal languages. The ideas related to the widening of the single authorial paradigm in architecture were proposed for the first time as the main theme of the 1971 *Design Participation Conference*. Many design models presented in the conference proposed the use of formal languages and computation to increase user participation. Therefore, design models suggested by Charles Eastman, Yona Friedman, and Nicholas Negroponte are specifically chosen for the content of research because each one represents a different approach in user-design model interaction.

Friedman, Eastman, Negroponte and their contemporaries had produced their models as technological imaginaries of the 60's and 70's as speculative computational rendering of future design models.¹³ Only after another decade, the digital technologies, software and hardware systems required to actualize and materialize those imaginaries would start to become available. The research of John Frazer

¹³ Vardouli, Theodora. "Who Designs? Technological Mediation in Participatory Design." *Empowering Users through Design: Interdisciplinary Studies and Combined Approaches for Technological Products and Services*, edited by David Bihanic, Springer, 2016, pp. 13–41.

would develop and actualize ideas of pioneers related to utilization of computation for further distribution of the design process among numerous actors and ultimately among a knowledge ecosystem.¹⁴ Accordingly, two design models from his “*An Evolutionary Architecture*” book and exhibition are selected for the context of the fourth chapter.

The *Non Standard Architectures* and *Naturalizing Architecture* exhibitions were not curated with the main purpose of proposing a knowledge ecosystem for architecture. However, the design models presented in these exhibitions provided an important contribution to the opening of the architectural design process to a diverse range of actors by use of a formal language. Consequently, four projects that were exhibited in these exhibitions are mentioned in detail in Chapter 4.

As a result of the detailed study of work models and design models in the Chapter 3 and 4, the conclusion chapter revisits the main research goal and research questions presented above. The main goal is achieved by the construction of an architectural knowledge ecosystem; and defining its related knowledge community, knowledge environments and interactions from the architectural perspective.

¹⁴ Frazer, John. *An Evolutionary Architecture*. Architectural Association Publication, 1995.

CHAPTER 2

KNOWLEDGE ECOSYSTEM

In this chapter the focus will be on the definition of a knowledge ecosystem, followed in the next chapter by its discussion from an architectural perspective. For the definition of a knowledge system for architecture, the present thesis suggests a biological approach, i.e. a knowledge ecosystem. Biology is proved to be a strong analogy for analyzing the spread of intellectual matter, including knowledge. Hence, the concept of a knowledge ecosystem is the result of the transfer of biological concepts into knowledge assets. In biology, an ecosystem denotes the community of all interacting organisms and their physical environment. Correspondingly, a knowledge ecosystem is the community of diverse agents for the production, distribution, and use of knowledge that operate through interactions in knowledge environments. Similar to biological ecosystems thriving on diversity of species and open organization, knowledge ecosystems thrive on the diversity of their community of knowledge producers and the openness of the system.

2.1 Biological Analogies and Knowledge Management

Knowledge Management is a discipline that studies the knowledge assets such as creating, storing, using, distributing, sharing and use of knowledge.¹⁵ In the 70's, information management replaced data processing. The available computer technology of the time was well-suited to manage data, but less for information, and even less for knowledge. Knowledge was perceived as difficult to capture on computers since it is usually associated with not only information, but more with

¹⁵ Carlsson, Sven A. "Knowledge Managing and Knowledge Management Systems in Inter-Organizational Networks." *Knowledge and Process Management*, vol. 10, no. 3, 2003, pp. 194–206.

See also Shariq, Syed Z. "Knowledge Management: An Emerging Discipline." *Journal of Knowledge Management*, vol. 1, no. 1, 1997, pp. 75–82.

learning and intuition. As the computer capacities and machine learning technologies started to develop in the mid 80's, knowledge management emerged as a new branch of the knowledge management discipline.¹⁶

There are different approaches in the existing literature of knowledge management discipline depending on different kinds of knowledge and different ways of its management.¹⁷ As mentioned above, the traditional knowledge management approach emerged as a continuous evolution of data into information and of information into knowledge, driven by an interest in the utilization of advances in computer science and emerging information and communication technologies.¹⁸ Given this approach, knowledge is treated as a combination of data and an interpretation of its meaning. According to traditional knowledge management approaches, the interpretation is carried out by a human being.¹⁹ However, this type of knowledge management shows its limits due to an impossibility of the interpretation of large-scale data sets without the help of computers because of the sheer volume of data.²⁰ Rather than being an asset, increasing data volume and increasing speed of knowledge accumulation and knowledge production is actually turning into a problem.²¹ Traditional knowledge management approaches that root in computer science have been showing deficiencies and there has been a need for new ways to organize knowledge between human and artefacts.²²

Recently, there has been a shift from the traditional approaches towards biological systems.²³ Biology is proved to be a strong analogy for analyzing the spread of intellectual matter, including knowledge: What is called as the meme theory in this

¹⁶ Pór, George. "Nurturing Systemic Wisdom Through Knowledge Ecology." *The Systems Thinker*, vol. 11, no. 8, 2000, pp. 1–5.

¹⁷ Russell, Helene. *Knowledge Management Handbook*. The Law Society, 2012.

¹⁸ Pór, "Nurturing Systemic Wisdom Through Knowledge Ecology."

¹⁹ Antezana, Erick, et al. "Biological Knowledge Management: The Emerging Role of the Semantic Web Technologies." *Briefings in Bioinformatics*, vol. 10, no. 4, 2009, pp. 392–407.

²⁰ *Ibid.*

²¹ *Ibid.*

²² Papaioannou, et al. "Knowledge Ecologies and Ecosystems? An Empirically Grounded Reflection on Recent Developments in Innovation."

²³ *Ibid.*

regard was coined by Richard Dawkins, who suggests that there are existing analogies between the spread of human culture and biological genes.²⁴ As genes are the carriers' biological attributes, the memes are defined as carriers of knowledge. Dawkins asserts that the spread and evolution of memes follows biological rules.²⁵ Based on this theory, recent studies in knowledge management have an increasing focus on the ecological modelling of knowledge²⁶ that resulted in the emergence of the concept of a knowledge ecosystem as a natural outgrowth of knowledge management.²⁷

The concept of a knowledge ecosystem is the result of the transfer of biological concepts into knowledge assets.²⁸ In biology, an ecosystem denotes the community of all interacting organisms and their physical environment.²⁹ The ecosystem has three main components: the communities, which are composed of species, the environments, and the interactions between species and with their environment. A knowledge ecosystem studies knowledge assets based on these components of an ecosystem.

In biology, species are the basic elements in an ecosystem, which are composed of single individuals. A group of organisms of the same species form a population. Several populations gather together to become a biological community.³⁰ In a natural ecosystem, individuals have permeable boundaries through which they can interact with each other and their environment, which is a complex formed of physical, chemical and biotic factors that act upon the interacting biological community. The interactions between different species in a community, called as interspecific interactions, is the main factor that regulates population growth and abundance in ecosystems: These types are defined according to different effects on

²⁴ Dawkins, *The Selfish Gene*.

²⁵ Dawkins, *The Selfish Gene*.

²⁶ Noenniga, et al. "Towards Knowledge Ecosystems: Modelling Knowledge Dynamics in Environmental Systems."

²⁷ Pór, "Nurturing Systemic Wisdom Through Knowledge Ecology".

²⁸ Papaioannou, et al, "Knowledge Ecologies and Ecosystems? An Empirically Grounded Reflection on Recent Developments in Innovation."

²⁹ Molles, *Ecology: concepts and applications*.

³⁰ Ibid..

the two participants, which may be positive (+), negative (-), or neutral (0).³¹ There are five main types of interspecific interaction: mutualism (+/+), commensalism (+/0), competition (-/-), predation (+/-), and parasitism (+/-).³²

2.2 What is a Knowledge Ecosystem?

Following the biological definition of an ecosystem as described above, a knowledge ecosystem model can be defined. A knowledge ecosystem is the community of diverse agents for the production, distribution, and utilization of knowledge that operate in knowledge environments through interactions between participants and with their environment.³³ A knowledge Ecosystem is composed of three components: knowledge communities, knowledge environments, and interactions between individuals and with their environment. The present dissertation focuses on defining a knowledge ecosystem for architecture. Accordingly, the ideas related to the concept of knowledge ecosystem presented herein are developed in the next chapter for such a definition of an architectural knowledge ecosystem.

2.2.1 Knowledge Community

A knowledge community is a group of participants with diverse skills, who are unified by a common set of values in the production of knowledge.³⁴ Developments in information and communication technologies and recent research in computer and cognitive sciences have first shown that knowledge communities are not bound to geographic and time limits, and secondly that knowledge communities are not only

³¹ Ibid.

³² Ibid.

³³ Bahrami and Evans, *Super-Flexibility for Knowledge Enterprise A Toolkit for Dynamic Adaptation*.

See also Yang, et al. "Agent-Based Approach for Revitalization Strategy of Knowledge Ecosystem."

³⁴ Pinch, S. "Knowledge Communities." *International Encyclopedia of Human Geography Volume 6*, edited by Rob Kitchin and Nigel Thrift, Elsevier, 2009, pp. 25–30.

limited to human agents but artefacts as well.³⁵ Knowledge communities are formed from multiple actors, (both human and artefact) who are distributed across places and times.³⁶ In this context, the term knowledge community has progressively detached from its earlier association with local neighborhoods of knowledge.³⁷

When limited to local neighborhoods, knowledge production carries risks of not being able to go beyond silo thinking, but instead focusing on differing social locations and interests of individuals or groups.³⁸ The result of researchers working within silo boundaries, in isolation from other disciplines or from other research groups of the same disciplines, would be limited in terms of innovation due to fixed philosophy.³⁹ Direct personal contact is essential as a basis for local neighborhoods of knowledge.⁴⁰ For instance, often students develop on their teachers' work; researchers present their works to each other in annual conferences, etc.

In this approach, production of knowledge is an attribute of experts with proper training and resources⁴¹, where experts are people with skills and knowledge in a particular field and expertise is consensually associated to social power, authority, elite, upper-class and exclusiveness.⁴²

Knowledge production within a knowledge community is without physical, social, intellectual, political and economic barriers. Actors of knowledge community are not obligated have met personally but they should share a number of common values keeping the community united. Expansion of knowledge producing actors from a

³⁵ Glăveanu, Vlad Petre. *Distributed Creativity Thinking Outside the Box of the Creative Individual*. Springer, 2014.

³⁶ Carrara, Gianfranco, et al. "An Ontology-Based Knowledge Representation Model for Cross-Disciplinary Building Design A General Template." *ECAADe*, 2009, pp. 367–73.

³⁷ Pinch, "Knowledge Communities."

³⁸ Swidler and Arditi, "New Sociology of Knowledge."

³⁹ Pinch, "Knowledge Communities."

⁴⁰ Ibid.

⁴¹ Hara, Noriko, and Jylisa Doney. "Social Construction of Knowledge in Wikipedia." *First Monday*, vol. 20, no. 6, 2015.

⁴² Bourne, Lyle E., et al. "Expertise: Defined, Described, Explained." *Frontiers in Psychology*, vol. 5, no. MAR, 2014, pp. 4–6.

See also Swidler and Arditi, "New Sociology of Knowledge."

specific privileged group to a wider community leads to a new perspective wherein knowledge is regarded not as a thing or a stock (as in the case of data or information) but as a social process. These type of social processes are central to understanding how knowledge communities operate.⁴³

Social construction of knowledge challenges previous ideas associated with knowledge production.⁴⁴ Knowledge produced by a diverse range of numerous actors is treated as more socially accountable and reflective than that produced by a limited number of experts.⁴⁵ This approach suggests a new methodology that blurs the boundaries between expert and non-expert, knowledge producer and consumer, author and receiver.⁴⁶ Accordingly, it challenges professional expertise and the concept of professionalism.

Professionalism is a social construct that changes over time: professional structures are not permanent.⁴⁷ There are two main elements in the social construct of professionalism: trust and the exercise of judgment based on specialist knowledge.⁴⁸ The rise of the professionalism had done a peak in the first half of the 20th century. In his book, *The Rise of Professional Society*, Harold Perkin notes that ‘class society’ has turned into ‘corporate society’, where professionals are treated as elites of the society.⁴⁹

In the beginning of the 21st century, professionalism has started to decline, including the architectural discipline. It is argued that architecture “needs to place more emphasis on the public good by creating and sharing an open-ended, disinterested, interdisciplinary body of knowledge.”⁵⁰ Like other disciplines, architectural design has been affected from the new methodologies and epistemologies related to the

⁴³ Pinch, “Knowledge Communities.”

⁴⁴ Hara and Doney, “Social Construction of Knowledge in Wikipedia.”

⁴⁵ Gibbons, et al. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*.

⁴⁶ Swidler and Ardit, “New Sociology of Knowledge.”

⁴⁷ Duffy, Francis, and Andrew Rabeneck. “Professionalism and Architects in the 21st Century.” *Building Research & Information*, vol. 41, no. 1, 2012, pp. 115–22.

⁴⁸ Ibid.

⁴⁹ Ibid.

⁵⁰ Ibid, 115.

social construction of knowledge as well. The existing professional monopolies in design expertise started to dissolve.⁵¹ This enabled the emergence of a knowledge community for architectural knowledge production.

The new sociology of knowledge suggests that “new kinds of social organization make whole orderings of knowledge possible.”⁵² As mentioned above, a common set out values are needed in order to unify distributed participants into a community of knowledge. Members of the community need to share a common language where the vocabulary of the language represents a shared understanding.⁵³ A shared understanding is essential, not only because it dissolves the boundaries between people into a meaningful whole for geographically and time-wise distributed actors. Thus, participation of distributed community members does not mean randomness or anarchy. It should be mentioned however that the creation of a united knowledge community is a very specific way of resolving the tension between the individuals and assuring collective coordination.⁵⁴

2.2.2 Knowledge Environments

Information and communication technologies play a key role in knowledge ecosystems. Technological perspectives together with social and physical ones that aim to facilitate the production, distribution and utilization of collaborative knowledge are central in the constitution of knowledge environments. The changes in the socio-technological climate reciprocally affect the organization of knowledge systems, including changing modes in knowledge production and distribution.⁵⁵ The

⁵¹ Banham, Reyner. “Alternative Networks for The Alternative Culture.” *Design Participation Proceedings of the Design Research Society’s Conference*, edited by Nigel Cross, Academy Editions, 1972.

⁵² Swidler and Arditi, “New Sociology of Knowledge.”

⁵³ Bahrami and Evans, *Super-Flexibility for Knowledge Enterprise A Toolkit for Dynamic Adaptation*.

See also Tunçer, Bige, and Sevil Sariyildiz. “Facilitating Architectural Communities of Practice.” *ECAADe*, 2010, pp. 707–716.

⁵⁴ Kelty, Christopher M. *Two Bits: The Cultural Significance of Free Software*. Duke University Press, 2008.

⁵⁵ Swidler and Arditi, “New Sociology of Knowledge.”

fact that “shifts in the media through which knowledge is transmitted, have dramatic effects on the entire organization of knowledge systems”⁵⁶ is consequential to the emergence of a new sociology of knowledge.

Knowledge environments bring together a diverse range of actors of the knowledge community. They enable participants to operate from different locations via reflexive feedback loops of communication and exchange.⁵⁷ New knowledge environments provide for a reinforced connectivity and interaction with distributed knowledge production sites along various places and times. The decentralizing effects of knowledge environments allow for distributed communication and collaboration, not only between individuals, but also between individuals and artefacts, across places and time. The individuals that are physically, culturally and even time-wise apart from one another become part of knowledge production. The implications of these ideas can be encountered at the scale of design, architecture and city planning.

The power of the new environments reveals itself in society as a growing awareness and wish for direct participation rather than a limited apprehension of the process. The Occupy Movement, which started May 2011 in Madrid and bloomed September 2011 in Wall Street New York, and which has globalized with millions of participants in many cities across the world between 2011 and 2013, is an important indication of such a sociological context.⁵⁸ While demonstrating the communicative and connective power of new knowledge environments, it highlighted the requirement to react to the social desire for direct participation.⁵⁹

2.2.3 Interactions Types

There is multiplicity of meanings attributed to interaction and each discipline defines different interaction types according to its area of interest. As mentioned above, in

⁵⁶ Swidler and Arditi, “New Sociology of Knowledge.”

⁵⁷ Hight, Christopher, and Chris Perry. “Introduction.” *AD Collective Intelligence in Design*, vol. 76, no. 5, Wiley, 2006, pp. 5–9.

⁵⁸ Rice, Louis. “Occupied Space.” *AD The Architecture of Transgression*, vol. 83, no. 6, 2013, pp. 70–75.

⁵⁹ Ratti, Carlo, and Matthew Claudel. *Open Source Architecture*. Thames and Hudson, 2015.

biological ecologies the main types of interaction are defined according to the effect on participants. This logic of defining interaction types according to effects on participants combined with the General Systems Theory provides a more detailed classification of interaction types in knowledge ecosystems.⁶⁰ However, since knowledge ecosystem aims to foster production of knowledge, biological interaction types involve a negative effect (competition, predation, and parasitism), which does not convey much meaning in this context.

The General Systems Theory provides a framework for the structure of systems that has important applications in a diverse range of disciplines, from natural to social sciences⁶¹, having had effects on biology, economics, psychology and demography.⁶² The general systems theory is appropriate in the study both biological and knowledge ecosystems. There are numerous works that study ecosystems from the General Systems Theory perspective.⁶³ As a matter of fact, even though the term ecosystem was first used in 1935, a scientific research program in a Lakatosian sense started in ecosystem ecology only after incorporating the ideas of the General Systems Theory.⁶⁴

⁶⁰ Pask, Gordon. *Conversation Theory: Applications in Education and Epistemology*. Elsevier, 1976.

⁶¹ Boulding, Kenneth E. "General Systems Theory: The Skeleton of Science." *Management Science*, vol. 2, no. 3, 1956, pp. 197–208.

⁶² Bertalanffy, Ludwig von. *General System Theory: Foundations, Development, Applications*. George Braziller, 1968.

⁶³ Marin, Victor H. "General System Theory and the Ecosystem Concept." *Bulletin of the Ecological Society of America*, no. January, 1997, pp. 103–04.

⁶⁴ In the philosophy of science, the impact of Imre Lakatos's has been enormous especially with his work on the methodology of scientific research programmes where Lakatos provided the demarcation between scientific and pseudoscientific programmes. According to Lakatos, the basic difference is that a research programme can be considered as scientific if it is *theoretically and empirically* progressive, and pseudoscientific or degenerating if each new theory in the sequence does not have excess empirical content over its predecessor.

"Imre Lakatos." *Stanford Encyclopedia of Philosophy*, 2016, <https://plato.stanford.edu/entries/lakatos/>.

A scientific research programme in a Lakatosian sense started in ecosystem ecology only after incorporating the ideas of the General System Theory.

Marin,. "General System Theory and the Ecosystem Concept."

Economist Kenneth Boulding, who is the cofounder of the General Systems Theory, with biologist Ludwig von Bertalanffy, describes the theory's influence as:

“Another phenomenon of almost universal significance for all disciplines is that of the interaction of an "individual" of some kind with its environment. Every discipline studies some kind of "individual" electron, atom, molecule, crystal, virus, cell, plant, animal, man, family, tribe, state, church, firm, corporation, university, and so on. Each of these individuals exhibits "behavior," action, or change, and this behavior is considered to be related in some way to the environment of the individual - that is, with other individuals with which it comes into contact or into some relationship.”⁶⁵

Bertalanffy describes the main aim of proposing a General System Theory view as “to encourage the development of theoretical systems which are applicable to more than one of the traditional departments of knowledge⁶⁶. For this purpose, in 1954, Boulding and Bertalanffy initiated the *Society for General Systems Research*, which today is referred as *The International Society for the Systems Sciences (ISSS)*.⁶⁷ Research in General Systems View and the related society served “to promote the unity of science through improving the communication among specialists; to help in useful transfers from one field to another; and to eliminate the duplication of theoretical efforts in different fields”.⁶⁸

The ‘General System Theory’ provides a common language in order to construct a shared belief system with embracing goals and values. Gordon Pask developed these ideas into a domain independent constructivist model of human knowing known as ‘Conversation Theory’⁶⁹. By bringing a diverse range of participants unified by a shared language, the ‘General Systems Theory’ can be seen to serve as a knowledge

⁶⁵ Boulding, “General Systems Theory: The Skeleton of Science.”

⁶⁶ Bertalanffy, *General System Theory: Foundations, Development, Applications*.

⁶⁷ *Origin and Purpose of the ISSS*. <http://iss.org/world/about-the-iss>. Accessed 30 June 2018.

⁶⁸ Ibid.

⁶⁹ Pask, *Conversation Theory: Applications in Education and Epistemology*

ecosystem, as defined above. Therefore, it provides a valuable grounding for the construction of theories related to the knowledge ecosystem.

The General System Theory describes systems as "entities composed of interacting parts"⁷⁰. Adapting the definition of classes of interaction that Pask had already built in General System Theory, in a knowledge ecology interaction types are categorized into three: linear, circular single loop and circular double loop.

In the first type of linear interaction, the system can only react to the input. This type of interaction is the most limited form of interaction; indeed, it could even be described as reaction rather than interaction. The output of the first mechanism provides input for the second. The second mechanism has no choice in its response, it reacts without any feedback to the first mechanism. Pask refers to this type of interaction as "it-referenced" interaction "because the controlling process treats the controlled process like an object without choice; like an it".⁷¹ This type of interaction shows resemblance to commensalism, where one of the parties of the system does not have any effect.

In the second interaction type, circular single loop, the system is not only able to react, but can also interact by sending feedback to the input source. The difference between the second and third type of interaction is that the circular single loop does not involve a learning mechanism. Circular loop systems, both single loop or double loop, show resemblance to mutualism, where both parties of the system have effect on the system which is positive.

In the third interaction type, the circular double loop, the system not only reacts to the input by sending a response, but each input contributes to the learning of the system. Pask refers to this type of interaction as "I/you referenced" interactions "because there is no controlling or controlled process; each side is a participant."⁷² From the perspective of knowledge environments, the interactions in peer to peer

⁷⁰ Bertalanffy, *General System Theory: Foundations, Development, Applications*.

⁷¹ Pangaro, Paul. *The Architecture of Conversation Theory*. 2002, <http://www.pangaro.com/L1L0/ArchCTBriefly2b.htm>. Accessed 30 June 2018.

⁷² Ibid.

platforms⁷³ are an example of this type of interaction.⁷⁴ As Hugh Dubberly et al. point out, in this type of interaction both parties learn from each other:

“...not just by discovering which actions can maintain their goals under specific circumstances but by exchanging information of common interest. They may coordinate goals and actions. We might even say they are capable of design—of agreeing on goals and means of achieving them. This type of interaction is conversing (or conversation). It builds on understanding to reach agreement and take action.”⁷⁵

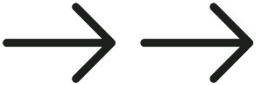
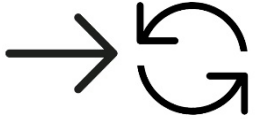
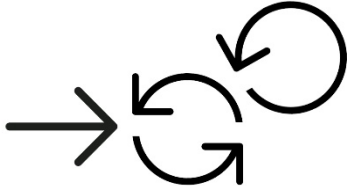
Accordingly, among these three interaction types the third one is the most convenient for nourishing a knowledge ecosystem where the actors of the system are active participants of the system. Therefore, environments that enable this type of interaction, work as a conversing and learning platform of knowledge production and sharing.

⁷³ Peer to peer (P2P) is an emergent term of the open source movement for mass collaboration. Peer production is a production system that depends on self-organizing communities of participants where a large number of people is coordinated towards a shared outcome. Peer production takes advantage of emergent tools of electronic communication and collaboration. Most significant examples of peer production are *Wikipedia*, and *Linux*. The inventor of Wiki, Ward Cunningham, who created the first Wiki, described the essence of the Wiki concept as a webpage or software that invites all users to easily edit by using only a plain web browser without any extra add-ons. Later, Jimmy Wales thought that such a system would be suitable for creating an encyclopedia. Thus Wikipedia was created as a source of information for the whole world which has been created entirely by volunteers who do not necessarily include experts on the items. Nowadays, Wikipedia is the most popular Wiki and peer production to date.

⁷⁴ Bertalanffy, *General System Theory: Foundations, Development, Applications*.

⁷⁵ Dubberly, Hugh, et al. “What Is Interaction? Are There Different Types?” *ACM Interactions*, vol. 16, no. 1, 2009.

Table 1 Interaction Types

Linear Interaction	Circular Single Loop	Circular Double Loop
System can only react to the input	System not only reacts but also can interact by sending feedback to the input source	System not only reacts to the input, but involves learning
		

2.3 Diversity of Species and Openness of System

The knowledge ecosystem approach utilizes features of biological ecosystems in order to analyze and propose better ways for knowledge production and management. Ecosystems consist of individuals (species), groups of individuals (population) and a diverse range of species to form a community. Diversity is a way to define success, an ecological balance where unstable ecosystems are more likely to lose species. The higher the diversity of species, the more robust the community and the fitter for longevity. Diversity is achieved in ecosystems by the openness of the system and the active interaction between species.⁷⁶ One of the elementary principle of ecosystems are openness. In fact, ecosystems are an example of biological and physical open systems.⁷⁷

As biological ecosystems thrive on diversity of species, knowledge ecosystems thrive on diversity of its community of knowledge producers. Diversity in knowledge ecosystems is achieved by the coming together of participants with diverse skills who share their knowledge, expertise and insight that cross fertilize

⁷⁶ Holt, Robert D., and Michel Loreau. “Biodiversity and Ecosystem Functioning: The Role of Trophic Interactions and the Importance of System Openness.” *The Functional Consequences of Biodiversity*, edited by Ann P. Kinzig et al., Princeton University Press, 2002.

⁷⁷ Jørgensen, Sven E., et al. “Ecosystems Emerging: 3. Openness.” *Ecological Modelling*, vol. 117, no. 1, 1999, pp. 41–64.

and feed one another.⁷⁸ As Michael Gibbons highlights, the diversity of species implies “increasing importance of groups constituted through the interplay of experts and non-experts as actors in the shaping of knowledge.”⁷⁹ A knowledge ecosystem distributes the knowledge production and redefines the authority and power distribution in knowledge production with blurred boundaries between disciplines and knowledge producers and users. Homogenous, deterministic and hierarchically organized knowledge does not nourish this type of relationships and diversity. Accordingly, in knowledge ecosystems, knowledge is organized as open systems.

As a philosophical concept, openness refers to freedom of knowledge and information distribution. In addition to transparent, free and unrestricted access to knowledge and information, openness refers to collaborative or cooperative decision-making instead of a central authority.⁸⁰ The concept of openness influences knowledge and authorship, characterizing epistemologies, societies, politics, institutions or organizations, and even individual personalities.⁸¹ Open work (literature), open systems (system theory), open source (software), open design, open government (politics), open access (publishing) and many other terms are derived from the concept of openness.

In system theory, openness refers to enabling external interactions. A system that has external interactions is called an open system. These interactions can take the form of information, energy, or material transfers into and out of the system. The open systems terminology expands from organicism, thermodynamics and evolutionary theory, and the concept has its applications in the natural and social sciences due to the fact that the open systems concept has expanded with the advent of general

⁷⁸ Chira, Camelia, et al. “An Ontological and Agent Based Approach to Knowledge Management within a Distributed Design Environment.” *Design Cognition and Computation*, edited by John S. Gero, Springer, 2004, pp. 459–78.

⁷⁹ Gibbons, et al. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*.

⁸⁰ Peters, Michael A. “Open Education and Education for Openness.” *Encyclopedia of Educational Philosophy and Theory*., 2014, <http://archive.is/JaBJt>. Accessed 30 June 2018.

⁸¹ *Ibid.*

systems theory.⁸² Openness in computer software refers to software that is free to be used, changed, augmented, and developed by others via access to the source code. As discussed above, these properties constitute the basic characteristics of open source. Today, *Linux* is generally considered a prime example of an open work and open system in software industry.⁸³ Open source movement originating in software industry that expanded as a paradigm changing movement is discussed below in detail in relation to its contribution to knowledge ecosystems.

This notion of openness is the main key in the work organization of knowledge ecosystems. Open work is never complete in this dynamic process; it is always changing according to the interpretation of user, promoting individualism and personalization. Umberto Eco, discusses openness in his book *The Open Work*, published originally in 1962, not only from a literature point of view but from a wider perspective of music, literature, painting and architecture. He defines “open work” as the product achieved by the author’s effort to arrange a work in a way that each individual receiver can modify the original composition created by the author. Accordingly, the author presents an open product with the intention that his particular composition enables the receiver to enter into a stimulus-response interplay depending on the receiver’s unique capacity for reception of the work, while it is still being appreciated and received as in the form the author devised.⁸⁴

According to Eco, openness and dynamism are the advent of a new scientific awareness through phenomenology that questions the objectivity of natural sciences⁸⁵. This sort of openness is at the heart of every act of perception and

⁸² Luhann, Niklas. *Social Systems*. Stanford University Press, 1996.

⁸³ Keltly, *Two Bits: The Cultural Significance of Free Software*.

⁸⁴ Eco, Umberto. *The Open Work*. Harvard University Press, 1989.

⁸⁵ Emergence of open source results in a change in the notion of authorship and object-subject relationship and a reorientation of knowledge and power. This change cannot be dealt separately from the hermeneutical phenomenology that enabled multiple readings of an unfinished work through interpretation; and the emergence of new methodologies with respect to the hermeneutical critique of objectivism. In the early 20th century, the movement of phenomenology and hermeneutics started a search for getting beyond the limits of the concepts of the methods set by natural sciences and their methodological ideal of objectivity by the works of the philosophers such as Edmund Husserl (1859 –1938), Martin Heidegger (1889–1976) and Gadamer. The work of Hans-Georg Gadamer (1900-2002); who was a

characterizes every moment of our cognitive experience.⁸⁶ In his definition of open work, openness does not mean complete chaos, because it still needs to be seen as a form of work, i.e. not just as an accumulation of random components which are ready to emerge from the chaos and permitted to assume any form whatsoever.⁸⁷ He defines open work as a dynamic structure of relationships rather than a finished work. This dynamic structure is achieved within a given field of relations defined by the author, by defining organizing rules which govern these relations.⁸⁸

Through the openness and diversity of participants, the ultimate goal of the knowledge ecosystem framework is to nurture collective intelligence and wisdom. The focus is “on discovering better social, organizational, behavioural, and technical conditions for knowledge creation and utilization.”⁸⁹ The knowledge ecosystem approach requires new ways of knowledge production, organization and distribution. “Knowledge ecosystems are complex adaptive systems. Their power exists in the flexible and evolving relationships among the elements of the system, which interact in complex and often surprising ways.”⁹⁰ (Pór, 2000) Accordingly, a knowledge ecosystem blurs boundaries between disciplines and knowledge producer and users by redistribution of the authority and power.

2.3.1 Open Source Movement

The software industry was one of the first to redefine its methodology with a focus on increased diversity of participants and open work. What is called as ‘Open

pupil of Martin Heidegger, can be seen as an elaboration of Heidegger’s thought. Gadamer published his seminal work “Truth and Method” in 1960, where he searches for the answer to the following question: “How far the truth claim of modes of experience outside science can be philosophically legitimated.” Gianni Vattimo (b.1936), a theorist of aesthetics, a leading phenomenological thinker in Italy and a former pupil of Hans-Georg Gadamer, who has translated Gadamer’s Truth and Method into Italian, outlined ‘weak thought’ (il pensiero debole) as a continuation and elaboration of the works of his German precursors Nietzsche, Heidegger and Gadamer.

⁸⁶ Eco, *The Open Work*.

⁸⁷ Ibid.

⁸⁸ Ibid.

⁸⁹ Pór, “Nurturing Systemic Wisdom Through Knowledge Ecology.”

⁹⁰ Ibid.

Source' then turned into a paradigm shifting movement, not only in technology, but also in social and cultural theory aiming for a reorientation of power and knowledge.

⁹¹ Open source is a mode of distributed production that is created as an open work and that is freely available for use. It is a distributed production among people and machines across locales and time zones. Open source has become analogous with democratization, free speech, free press, free assembly and petition; reorientation of knowledge and power where everyone can communicate and collaborate.⁹²

In the mid 60's, MIT researchers Richard Stallman, Ken Thompson and Dennis Ritchie started working on *Unix* aiming to develop a workbench for programmers for writing software in which they could reuse, change and adapt Unix code for their work. Since then, the *Unix* system has had an important impact on other operating systems, which resulted in many other Unix-like software, such as the paradigm-shifting *Linux*.

In 1991, a twenty-one-year-old computer science student at the University of Helsinki, Linus Torvalds, coded an operating system. He did not start to write Linux from scratch; instead, he started by reusing code and ideas from *Minix* ⁹³, another Unix-like operating system, which had its complete source code available for academic use. Near completion of the code, he posted it with a short message into an online forum to ask for casual feedback.⁹⁴ This operating system would grow into *Linux*, which is a software that is free to be used, changed, augmented, and developed by anyone with a computer and internet access. Until 2015, the estimated user count reached tens of millions and thousands of suggested changes had been sent by users. In the end, even though all the *Minix* code had been completely rewritten by many contributors, it had provided scaffolding for the *Linux* program. As a result, *Linux* became a piece of software that had been built by an open and distributed team of developers. *Linux* became the most popular Unix-like software and one of the most well-known examples of free and open-source software. *Linux*

⁹¹ Kelty, *Two Bits: The Cultural Significance of Free Software*.

⁹² Ibid.

⁹³ Raymond, Eric S. *The Cathedral & the Bazaar Musings on Linux and Open Source by an Accidental Revolutionary*. O'Reilly Media, 2008.

⁹⁴ Ratti and Claudel, *Open Source Architecture*.

left a permanent mark not only on the means and ends of software production, but the notion of access and models of production.⁹⁵

The development of software based on collaboration and sharing has a history as old as software development itself. However, this phenomenon gained increased popularity in the late 1990s, with recognition of Linux in mainstream publications like Forbes. The characteristics of open source violate the logic and principles of economy, private ownership and individual autonomy; however, there are still tens of millions of people working for open source and hundreds of millions more using it. Even though it started as an experimental system, open source turned into a paradigm shifting movement, not only in technology, but also in social and cultural theory.⁹⁶

New modes of production, communication and economic strategies have emerged as an outcome of open source: For instance, the emergence of *Linux* and of *Wikipedia* as new modes of collective work; the emergence of *Airbnb* and other *co-work and living spaces* as new modes of collective usage; the emergence of *Crowdsourcing* and *Kickstarter* as new economic models; the emergence of *Copyleft*, *Creative Commons* and *General Public License* as new modes of copyright licensing (in order to protect author rights within a modified concept of authorship).

The use of open source, open software, free source, free software and free/libre open source software (FLOSS) have been gaining momentum within the terminologies of different disciplines. Nevertheless, there is no consensus regarding the extent of their meaning. There is a multiplicity of meanings attributed to these, and occasionally even confusions, misuses and abuses due to the trendiness of the terminology. Besides, these terms are stretched so that they would only be used sporadically with a limited meaning leading to hollow appropriations. Another reason of the confusion about the meaning of attributes is related to the vagueness of the philosophical differences between free and open. On one hand, some restrict the definition of open source to being free, i.e. as pay-free usage. This point of view limits the open source

⁹⁵ Kelty, *Two Bits: The Cultural Significance of Free Software*.

⁹⁶ Ibid.

context only to economic aspects of free usage. On the other hand, others refer to open source emphasizing the openness to collaborative creation, where instead of a finished work, the product is an open work that can be altered, changed and developed indefinitely.

The two main terms, “*Free Software*” and “*Open Source*”, are the result of two narratives: one put forward by Richard Stallman and the other by Eric Raymond. However, they are two narratives for identical proposes, thus contributing to the same movement, aiming for a reorientation of power and knowledge.⁹⁷ Regarding Open and Free software, Christopher Kelty mentions in his book “*Two Bits: The Cultural Significance of Free Software*” that:

“Eric Raymond describes Open Source as an evolutionarily necessary outcome of the natural tendency of human societies toward economies of abundance, while Richard Stallman describes it as a defense of the fundamental freedoms of creativity and speech, using a variety of philosophical theories of liberty, justice, and the defense of freedom. The fact that there are different narratives for identical practices is an advantageous fact: regardless of why people think they are doing what they are doing, they are all nonetheless contributing to the same mysterious thing.”⁹⁸

Open source can act as a paradigm shifting movement only when the free and the open come together with four components: sharing source code, openness, protection of intellectual property and coordinated collaborations.⁹⁹ As a combination of these, open source can act as a mode of distributed production (production in a broader sense where code is not only limited to software production) that is created as an open work and that is freely available for use. Accordingly, open source becomes an activity distributed among people and machines across locales and time zones where openness represents a cultural exchange in which open source has become analogous to democratization, free speech, free press, free assembly and petition; reorientation

⁹⁷ Ibid.

⁹⁸ Ibid.

⁹⁹ Ibid.

of knowledge and power where everyone can communicate and collaborate.¹⁰⁰ This attitude becomes more relevant in today's post-capitalist climate. Democratic post capitalist protest movements like the *Occupy Movement*, one of the largest number of rebellions around the world in recent times, become important in the context of open source movement, both for demonstrating the power of the new tools of communication and connectivity and for highlighting the desire of society for direct participation as a result of emerging socio-political phenomena.¹⁰¹

The open source movement is a mode of distributed collaborative creation of open work that results in reorientation of power and knowledge with two key aspects: being open and being free. The harmony of these two features puts forward the product of open source as an unfinished object representing a focus shift from the finished object to the process. The role of the author is to define the process whereas the definition of end product becomes the fruit of users. Such a process would exceed static end product by means of introducing dynamic and participatory processes, systems and networks. In the open source movement, work is never complete; it is always changing according to the interpretation of the user, promoting individualism and personalization.

On the other hand, open source movement have been heavily criticized legally and ethically due to the fact that its methods, such as crowdsourcing, are very favorable for abuse. These methods have been implemented to maximize profits and generate a new form of free or very cheap labor.¹⁰² There are already many initiatives that use open source and crowdsourcing to avoid employment and taxation law regulation.

For instance, Amazon's *Mechanical Turk* enterprise has been denounced for being unethical.¹⁰³ It is described as 'an online market place for work that requires human intelligence' where employers are able to post jobs and workers (Turkers), can

¹⁰⁰ Ibid.

¹⁰¹ Gutiérrez, Bernardo. "The Open Source City as The Transnational Democratic Future." *State of Power*, 2016.

¹⁰² Sanchez, Jose. "Massive Re-Patterning of the Urban Landscape." *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 48–51.

¹⁰³ Ibid.

browse among existing jobs and complete them for payments set by the employer.¹⁰⁴ In this way, Amazon's Mechanical Turk acts as an online crowdsourcing marketplace enabling individuals and businesses to coordinate the use of human intelligence to perform tasks that computers are currently unable to do. The project has been criticized for adapting the work model of a sweatshop in digital environment.¹⁰⁵

There are similar initiatives specialized in design and even architecture, as for instance "99 Designs" (a platform to create design competitions), "UpWork" (architectural freelancing website), and the work ethics of these initiatives are under question as well.¹⁰⁶

However, the positive effects of open source movement on knowledge production methods are undeniable. The open source movement is the creation of nodes in a broad network of distributed creativity in order not only to collectively participate but also to freely share. As a combination of these aspects, open source represents a new methodology that dissolves the boundaries between experts and non experts, producer and consumers, developer and users. The open source movement has gained importance by being a practical technique for the development of collective knowledge; coordinated collaboration of thousands of individuals.¹⁰⁷

The sociological changes related to knowledge production, along with the dissolution of authorship and professionalism, opened up new epistemologies for knowledge production; and the open source proved practically to be a working methodology where "social authority shapes the authoritativeness of knowledge"¹⁰⁸ It can therefore be concluded that the open source movement is an important

¹⁰⁴ Amazon Mechanical Turk. *Human Intelligence through an API*. <https://www.mturk.com/>. Accessed 30 June 2018.

¹⁰⁵ Pittman, Matthew, and Kim Sheehan. "Amazon's Mechanical Turk a Digital Sweatshop? Transparency and Accountability in Crowdsourced Online Research." *Journal of Media Ethics*, vol. 31, no. 4, 2016, pp. 260–262.

¹⁰⁶ Sanchez, J. (2016). Massive Re-Patterning of the Urban Landscape. *AD Digital Property: Open-Source Architecture*, 86(5), 48–51.

¹⁰⁷ Ibid.

¹⁰⁸ Swidler and Arditi, "New Sociology of Knowledge."

research motivation for this thesis' proposal of a knowledge ecosystem for architecture that also serves as a practical model for a knowledge ecosystem.

2.3 Different Modes of Authorship

Diversity of participants and openness of knowledge systems requires new types of knowledge production. Michael Gibbons devotes his book “The new production of knowledge” (1994) to the exploration of changes in knowledge production modes in contemporary society.¹⁰⁹ Gibbons refers to traditional knowledge production as Mode 1 and proposes distributed knowledge production as Mode 2. In the next chapter, the discussion related to different modes of authorship is going to be studied in detail from the perspective of architectural authorship.

2.3.1 Mode 1 Single Authorial Paradigm

In Mode 1, knowledge is generated within a disciplinary context, where problems are set and solved in a context governed by the interests of a specific community. Knowledge is produced within the boundaries and restrictions of disciplines. Due to knowledge being produced in isolation from other disciplines, there is little innovation. Therefore, this type of knowledge production is characterized by homogeneity and hierarchical organization between knowledge producers and users.¹¹⁰

Mode 1 type of knowledge production does not contribute to the construction of a knowledge ecosystem, due to the fact that this type of knowledge production is based on a singular discipline and on single authorial knowledge production and does not constitute a knowledge community. Instead, authorial power in the knowledge production is firmly centralized. Accordingly, this type of knowledge production does not require knowledge environments facilitating production, distribution and

¹⁰⁹ Gibbons, et al. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*.

¹¹⁰ Swidler and Arditì, “New Sociology of Knowledge.”

utilization of collaborative knowledge. Rather than knowledge environments, it uses disciplinary tools and toolsets.

2.3.2 Mode 2 Distributed Modes of Authorship

In Mode 2, knowledge is created in interdisciplinary contexts with overlapping disciplinary boundaries, blending assumptions and restrictions. Mode 2 knowledge production is heterogeneous in terms of bringing together multiple personal skills and experiences; it is also a heterarchical organization between knowledge producers and users. This type of knowledge employs a different type of quality control based on social accountability due to its social distribution. Therefore, the focus is on distribution of knowledge production as much as possible, rather than focusing on the differing social locations and interests of individuals or groups.¹¹¹ As Gibbons explains, “knowledge is always produced under an aspect of continuous negotiation and it will not be produced unless and until the interests of the various actors are included... Mode 2 results from the parallel expansion of knowledge producers and users in society.” Gibbons explains the desire for more socially distributed production of knowledge and increased connectivity as below:

“In recent years, growing public concern about issues to do with the environment, health, communications, privacy and procreation, and so forth, have had the effect of stimulating the growth of knowledge production in Mode 2. Growing awareness about the variety of ways in which advances in science and technology can affect the public interest has increased the number of groups that wish to influence the outcome of the research process...Socially distributed knowledge production is tending towards the form of a global web whose numbers of inter-connections are being continuously expanded by the creation of new sites of production.”¹¹²

¹¹¹ Gibbons, et al. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*.

¹¹² Ibid.

In Mode 2, the exploitation of knowledge requires participation. Consequently, communications and organization becomes the crucial factor. Gibbons uses the term “Hybrid Fora” to define the meeting point of a range of diverse actors of distributed knowledge production that is “backed up by rapid transportation and electronic communications. But this is only the tip of the iceberg”.¹¹³

Mode 2 type of knowledge production marks a point of departure from the single authorial paradigm towards the construction of a knowledge ecology with a focus of distribution of authorial powers in knowledge production. Knowledge community in Mode 2 type is distributed between human and computer agents across geographic and time zones with blurring boundaries between knowledge producers and users, experts and non-experts. Accordingly, utilization of the power of knowledge environments is vital for bringing together diverse actors in the co-production of knowledge.

2.3.3 Mode 3 Dissolution of Authorship

During the period of over 20 years after the first publication of Gibbons’ book, information and communication technologies began revealing themselves as more than just the tip of the iceberg. Today, what Gibbons called as ‘hybrid fora’, is recognized as a knowledge ecosystem that leads to a more current mode of knowledge production.



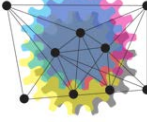
Within the context of this research, this type of knowledge production will be referred to as Mode 3, following the types of knowledge production defined by Gibbons. This mode, Mode 3, constitutes the epistemological foundation for this research this thesis for the proposal of a knowledge ecosystem for architecture.

Mode 3 is the type of knowledge production that characterizes the era of networked societies and information age. In this type of knowledge production, authorship is dissolved between diverse participants. In Mode 3, knowledge is produced in a

¹¹³ Ibid.

transdisciplinary context with transcending disciplinary boundaries, cross-fertilizing disciplinary assumptions and restrictions that resolves contradictory points of view.

Table 2 Summary of three knowledge production modes

Mode 1	Mode 2	Mode 3
Traditional knowledge production Single author or specific community	Distributed knowledge production between human and computer agents across geographic and time zones	Dissolution of authorship
Disciplinary Context 	Interdisciplinary Context 	Transdisciplinary Context 
Homogeneity of participants	Heterogeneous in terms of bringing together multiple personal skills and experiences	Increased diversity of participants and openness of the system
Hierarchical organization between knowledge producers and users	Heterarchical organization between knowledge producers and users	No boundaries between knowledge producer and users experts and non-experts

Mode 2 is important due to the fact that it represents a breaking point from traditional knowledge production, with a focus on distributed modes instead of single authorial paradigm. However, Mode 3 is the type of knowledge production occurring in knowledge ecosystems, since it represents the diversity of knowledge producers and openness.

2.4 A Knowledge Ecosystem for Architecture

Following the knowledge production modes proposed by Michael Gibbons, different modes of architectural authorship are discussed in the next chapter: the mode of architectural authorship that is accumulated in a single authority (Mode 1), in comparison to the distributed mode of architectural authorship (Mode 2). The dissolution of authorship (Mode 3) is proposed as a specific mode for architectural knowledge ecosystem that follows the trends of a networked society and the information age, such as the open source movement and crowdsourcing, with a focus on diversity of participants and openness.

Accordingly, in the next chapter these different modes of architectural knowledge production are discussed in relation to knowledge communities, knowledge environments and interactions within the community and with its environment in order to lay the foundations for the architectural knowledge ecosystem.

CHAPTER 3

ARCHITECTURAL KNOWLEDGE ECOSYSTEM

Building design has not always been “predicated upon the architect’s authorial role”.¹¹⁴ Architects struggled for the acceptance of their architectural work as an authored property and as a professional service. Architectural discipline had difficulty positioning their authority within the building disciplines and placing their copyrights within artistic ones.¹¹⁵ One could wonder why architects should surrender their centralized authority and authorship rights in the face of current practices that bring into play a discussion of the dissolution of architectural authorship. Would the dissolution of architectural authorship really mean surrendering authority? How does the dissolution of architectural authorship affect the architectural discipline? In order to answer these questions, the changes in the current technological and social situation of the architectural discipline have to be analyzed.

Accordingly, this chapter studies different modes of architectural authorship: the mode of architectural authorship that is accumulated in a single authority (Mode 1), in comparison to the distributed mode of architectural authorship (Mode 2), and the dissolution of authorship (Mode 3). The modes of architectural knowledge production are discussed accordingly in relation to knowledge communities, knowledge environments and interactions within the community and with its environment in order to lay the foundations for the architectural knowledge ecosystem. A knowledge community has to be defined and discussed by identifying its participants/constituents and the nature of their share of knowledge. Knowledge

¹¹⁴ Carpo, Mario. “Digital Darwinism: Mass Collaboration, Form-Finding, and The Dissolution of Authorship.” *Log*, vol. 26, 2012, pp. 97–105.

¹¹⁵ Even in the USA, the first copyright law passed in 1790 did not cover architecture. It was covering authors of books, maps and charts. Only in 1976, plans and drawings of buildings were included in copyright legislation. However, recently this legal structure is showing its restrictions because the layering in architectural discipline has been changed by digital technologies. In Europe, architectural works acquired internationally recognized copyright protections with the Berlin Act of 1908.

environments are studied from the technological, social and physical perspectives that aim to facilitate production, distribution and utilization.

3.1 Mode 1: Single Authorial Paradigm

The modern definition of architectural authorship is very recent compared to the existence of the act of building design. Bernard Rudofsky, on the occasion of the exhibition “Architecture without Architects” that took place in 1964, at the Museum of Modern Art, New York, mentioned that before architecture became an expert’s art, the act of building design was “a communal art, not produced by a few intellectuals or specialists but by the spontaneous and continuing activity of a whole people with a common heritage, acting under a community of experience.”¹¹⁶ Rudofsky asserts that this type of building design goes beyond fashion cycles and economic and aesthetic considerations, as it serves its purpose to perfection; and “it touches the far tougher and increasingly troublesome problem of how to live and let live, how to keep peace with one’s neighbors, both in the parochial and universal sense.”¹¹⁷

Until the 15th century, architecture was treated as a mechanical craft, buildings were designed and made by artisan workers on site, through stonemasonry, brickwork and woodwork.¹¹⁸ Buildings were constructed not designed nor planned: there were no required drawings, building plans or models.¹¹⁹ A master mason would develop a scheme and leave much of the buildings details to craftsmen.¹²⁰

The Renaissance approach to building required the design of the entire building made before construction, that brought about the birth of architectural authorship. Architects needed new design methods such as “the use of scale drawings and

¹¹⁶ Rudofsky, Bernard. *Architecture Without Architects: A Short Introduction to Non-Pedigreed Architecture*. Doubleday&Company, 1964.

¹¹⁷ Ibid.

¹¹⁸ Carpo, Mario. “The Art of Drawing.” *AD Special Issue: Drawing Architecture*, vol. 83, no. 5, 2013, pp. 128–133.

¹¹⁹ Kalay, Yehuda E. *Architecture’s New Media: Principles, Theories, and Methods of Computer-Aided Design*. The MIT Press, 2004.

¹²⁰ Ibid.

models and encode their newly formed body of knowledge.”¹²¹ Accordingly, the term “architect” started to be used as the “maker of drawings” and the architect started to be considered as a humanist author and a thinker instead of a craftsman or maker of buildings.¹²² Kalay notes that “professionals in charge of buildings’ projects moved away from the craft of making building and became theoreticians skilled in drawings and making models.”¹²³ This changed building design from a communal art to a single authorial art.

According to the single authorial definition, architecture “is conceived in the mind of its author, notated in drawings, then built by manual workers who must comply with the instructions they receive through drawings and models, and follow them without change”.¹²⁴ According to Mario Carpo, the single authorial act of design

“...was never really fully implemented, not even in the twentieth century, this paradigm has nevertheless inspired most of Western architecture for the last five centuries, and it is at the basis of the dominant legal framework that still regulates the global practice of the architectural profession... And this is the paradigm that recent developments in digital technologies are now phasing out.”¹²⁵

Single authorial paradigm has crossed paths and consolidated with many cultural technologies, such as the invention of printing, the invention of copyrights, the industrial revolution and the traditional design-bid-build model, which enhanced the labor division between designer and builder.¹²⁶ Modernism through emphasis in

¹²¹ Ibid.

¹²² Carpo, Mario. “Digital Indeterminism: The New Digital Commons and the Dissolution of Architectural Authorship.” *Architecture in Formation, On the Nature of Information in Digital Architecture*, edited by Pablo Lorenzo-Eiroa and Aaron Sprecher, Routledge, 2013, pp. 47–52.

¹²³ Kalay, *Architecture’s New Media: Principles, Theories, and Methods of Computer-Aided Design*.

¹²⁴ Carpo, “The Art of Drawing.”

¹²⁵ Carpo, Mario. *The Alphabet and the Algorithm*. The MIT Press, 2011.

¹²⁶ Ibid.

masters and postmodernism through emphasis on the star architect reinforced linear, hierarchical and master directed act of single authorial paradigm. Colletti relates that architects gained the position of being in the frontline of the whole building design process as heroic creators.¹²⁷ “In some cases, the signature of a particular individual is paramount to the whole building’s form, function, expression, aesthetic and materiality.”¹²⁸

3.1.1 Knowledge Ecosystem of Mode 1

Single authorial paradigm does not contribute to construction of a knowledge ecosystem framework due to the fact that openness for participation in the design process is very limited, and authorial power in the knowledge production is firmly centralized. Along with the start of the use of the architect in its modern definition, the desire was to establish impervious boundaries of knowledge for architecture as a discipline.¹²⁹ “The process of accumulation and transmission in space and time of architectural knowledge and theories”, that serves as a knowledge environment, happened through architectural treatises¹³⁰ and interaction in the architectural knowledge production was through the master- apprentice relationship.

In early manuscript copies of Vitruvius’s text, there was no clear definition of the architect, instead the knowledge required by the architect was emphasized. A clear definition for the architect was first provided by in Leon Battista Alberti’s

See also Carpo, “Digital Indeterminism: The New Digital Commons and the Dissolution of Architectural Authorship.”

¹²⁷ Colletti, Marjan. “Post-Digital Transdisciplinarity.” *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 74–81.

¹²⁸ *Ibid*, 80.

¹²⁹ Luscombe, Desley. *Inscribing the Architect: The Depiction of the Attributes of the Architect in Frontispieces to Sixteenth Century Italian Architectural Treatises*. University of Technology Sydney, 2004.

¹³⁰ Carpo, Mario. *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in The History of Architectural Theory*. The MIT Press, 2001.

manuscript, *De Re Aedificatoria*.¹³¹ As Desley Luscombe studies the attributes of the knowledge of the architect through architectural treatises she summarizes:

“The knowledge of the architect is born from the practice of the art and from reasoned thought brought to perfection by using the hands...the architect is concerned with his specific practices, the theoretical basis for their conceptualization and the explanation of these as built and discursive forms...Through his judgment he is able to verify those works which are brought to completion within the other Arts.”¹³²

Mario Carpo notes that most contemporary architects still vision themselves as lone creative geniuses, clinging to single authorial paradigm.¹³³ However, the current technological and social condition can be said to run against this single authorship paradigm. The digital age brought architecture a dramatic change in terms of definition of architectural authorship as Carpo highlights:

“The digitally enhanced horizontal integration of actors and agencies in the design and production process is already challenging the modern notion of the architect’s full authorial control and intellectual ownership of the end product.”¹³⁴

The first generation of digital design tools as CAD technologies was outlined for the first time in Sketchpad as part of Ivan Sutherland’s 1963 Ph.D. dissertation at MIT.¹³⁵ Sketchpad “describe(s) objects using analytical geometry with an associative data structure that enables dynamic editing, referencing and updating”.¹³⁶ The first generation CAD models had a common interest in connecting computation

¹³¹ Luscombe, *Inscribing the Architect: The Depiction of the Attributes of the Architect in Frontispieces to Sixteenth Century Italian Architectural Treatises*.

See also Alberti, Leon Battista. *De Re Aedificatoria*. 1485.

¹³² Luscombe, *Inscribing the Architect: The Depiction of the Attributes of the Architect in Frontispieces to Sixteenth Century Italian Architectural Treatises*.

¹³³ Carpo, Mario. “Digital Indeterminism: The New Digital Commons and the Dissolution of Architectural Authorship.”

¹³⁴ Carpo, *The Alphabet and the Algorithm*.

¹³⁵ Sutherland, Ivan E. *Sketchpad, A Man-Machine Graphical Communication System*. Massachusetts Institute of Technology, 1963.

¹³⁶ *Ibid*, 111.

to interaction, participation, and collaboration, which did not follow the logic of a single authored architectural mode.¹³⁷

On the other hand, the second wave of digital design tool technologies in the early 1980's, such as the ones in DWG formats, were less intelligent and capable than earlier models that were reduced to the structure of traditional hand drawings. They aimed to produce a standardized set of architectural scale drawings and models. They also followed the logic of single authorial paradigm and the conventions and terminology of drafting that was invented during the Renaissance.

However, in the late 1990s, the third generation of digital technologies for architecture emerged, diverging from the single authorial paradigm and the traditional conventions and terminology of architectural drawings and drafting. In the third generation models: "Designers are now no longer expected to produce a series of drawings, but rather a comprehensive model, the governing principle of which is the coming together of components to form an assembly of articulated rigid bodies."¹³⁸

3.1.2 Marking a Point of Departure from Single Authorial Paradigm

Divergence from the single authorial paradigm did not just come from developing digital technologies, but as a result of a combined socio-technologic and economic climate. Necessities of global, complex, multidisciplinary information and knowledge intensive design problems, digital technologies and big data management are redefining the roles of the parties involved in architectural design and their relationships with each other while colliding with the single authorial paradigm. On one hand, environmental, economic and social crises have resulted in energy problems, war, refugee migration and terrorism. On the other hand, developments in technology as well as in social and cultural theory have culminated in the emergence of new modes of energy, production, communication, and economic strategies such

¹³⁷ Negroponte, Nicholas. "Aspects of Living in an Architecture Machine." *Design Participation Proceedings of the Design Research Society's Conference*, 1972, pp. 63–67.

¹³⁸ Michalatos, "Design Signals: The Role of Software Architecture and Paradigms in Design Thinking and Practice."

as: maker culture, hacker culture, crowd funding, etc. These crises and emerging opportunities not only put an increasing pressure on architecture but also instigated critical discussions about the dispute of the social and public relevance of the architect, his/her role and strength, and changes in the way society looks at architecture. Architects are considered to be responsible for solving the big design challenges of our time.¹³⁹

Today's design problems are too complex to be solved by individuals or small design teams as available information exceeds the cognitive capacities of a single designer. Every day 2.5 quintillion bytes of data are created from sensors that are used to gather climate information, posts to social media sites, digital pictures and videos, cell phone GPS signals and many other.¹⁴⁰ We are experiencing how information technology and these large quantities of data are revolutionizing architecture and changing the structure of historical organization of labor in architecture.

Increasing complexity of design problems results in a huge unbalance between produced architectural labor, design information and the people who can access design in these conditions: good design becomes a luxury: Only 2% of the buildings in the world are designed by architects and 1% of the world population can hire an architect.¹⁴¹ Even in the case of the buildings designed by architects, the design usually fits the design criteria of the client, who is in most cases the investor rather than the final buyer or user of the building. Put another way, architects have been hired by the 1% to design buildings for the other 99% to live in and use.

Conversely, architectural competitions attract many entries, where only the winner is paid. In 2014, Guggenheim museum in Helsinki attracted 1,715 entries and outran the 2002 Grand Egyptian Museum competition with 1557 participants, however, the

¹³⁹ Ratti and Claudel, *Open Source Architecture*.

¹⁴⁰ Zikopoulos, Paul, et al. *Harness the Power of Big Data The IBM Big Data Platform*. The McGraw-Hill, 2013.

¹⁴¹ Parvin, Alastair. "Architecture (and the Other 99%): Open-Source Architecture and Design Commons." *AD The Architecture of Transgression*, vol. 83, no. 6, 2013, pp. 90–95.

Finnish City Council eventually rejected the proposal for the museum costing \$138 million.¹⁴² It is estimated that each project spent more or less 90 days with 3 architects in order to prepare their proposal. If each architect would be paid \$50 for a day, the total cost for the labor of all entries would make up \$23,152,500. In other words, Guggenheim was given a total of 3,704,400 unpaid hours spent for the proposals for a museum that was not going to be built.¹⁴³

The present arrangement of labor in architectural business model is very inefficient. Architectural authorship and division of labor could be better arranged and restructured in relation with emergent technologies.¹⁴⁴ Alastair Parvin, designer of Wikihouse¹⁴⁵, mentions that:

“Architecture operates on an inefficient quasi-artisanal business model, with unpaid interns working late into the night producing two-dimensional detail drawings, while next door another unpaid intern works on an almost identical detail; one that has been designed many times before by countless others, and probably better. It was simply never shared.”¹⁴⁶

¹⁴² Siegal, Nina. “Guggenheim Helsinki Museum Plans Are Rejected.” *The New York Times*, 2016, <https://www.nytimes.com/2016/11/30/arts/design/guggenheim-helsinki-museum-plans-are-rejected.html>. Accessed 30 June 2018.

¹⁴³ Ibid.

¹⁴⁴ Parvin, “Architecture (and the Other 99%): Open-Source Architecture and Design Commons.”

¹⁴⁵ WikiHouse is an open source project initiated in 2011 by Alastair Parvin, aiming to develop sustainable building systems which are shared openly for anyone to build upon and improve. Within the rules of the system, the design can be customized, allowing every house to respond to its user, site and context. From 3D models, a set of cutting files can be created for parts to be digitally manufactured using CNC machines. All the parts are numbered so they can be identified on site. CNC cut pieces are all snapped together, like IKEA furniture or like a life-size puzzle. Plywood, a widely available material, can be used in the construction. WikiHouse is built onto timber rails; this enables its compatibility with almost any foundation type or ground condition. The parts are assembled and the frames are raised by hand. The parts are connected using pegs and wedges, and the mallets are also cut with the kit. Only the screws and other basic do-it-yourself tools are needed. Depending on the size of the house, a team of amateurs can assemble the chassis in 1-3 days.

WikiHouse Foundation. *Wikihouse*. <https://wikihouse.cc/about>. Accessed 30 June 2018.

¹⁴⁶ Parvin, “Architecture (and the Other 99%): Open-Source Architecture and Design Commons.”

As it has been done in vernacular architecture for thousands of years, if we share our solutions, others can move on to the next one without re-doing old work. Lack of infrastructure for individuals to share disciplinary knowledge results in loss of productivity by triggering the “reinventing the wheel syndrome”.¹⁴⁷

The benefits of knowledge sharing are reciprocal. It effectively allows a whole market to move faster, by being its own research and design lab. This way, more people in the world could benefit from state of the art architectural solutions in terms of design, and could socially and environmentally benefit not only the ones that could hire architectural firms with research departments as big as an academic institution, but others as well.

Moreover, some other mainstream figures in the field are admitting the profession has lost its connection to the society and to the real needs of users. For instance, Frank Gehry said that “98% of everything that is built and designed today is pure shit. There’s no sense of design, no respect for humanity or for anything else.”¹⁴⁸ Similarly, at the closing keynote for the 2016 AIA convention, Rem Koolhaas mentioned architecture’s failure to adapt to the changing social and technical climates of today, highlighting that architecture has a serious communication problem.¹⁴⁹

Ben van Berkel added on to this discussion that “today’s climate calls for an architecture that is responsive to environmental, political, social, cultural and

¹⁴⁷ Pór, “Nurturing Systemic Wisdom Through Knowledge Ecology.”

¹⁴⁸ Shubow, Justin. “Architecture Continues to Implode: More Insiders Admit the Profession is Failing.” *Forbes*, 2015, <https://www.forbes.com/sites/justinshubow/2015/01/06/architecture-continues-to-implode-more-insiders-admit-the-profession-is-failing/#77da17ba4378>. Accessed 30 June 2018.

¹⁴⁹ WikiHouse Foundation. *Wikihouse*. <https://wikihouse.cc/about>. Accessed 30 June 2018.

Winston, Anna. “Architecture Has a Serious Problem with Communication Says Rem Koolhaas.” *Dezeen*, 2016, <https://www.dezeen.com/2016/05/24/rem-koolhaas-architecture-serious-problem-communication-oma-american-institute-architects-aia-convention/>. Accessed 30 June 2018.

economic requirements and as such there is call for an architecture that contains all possible layers of knowledge.”¹⁵⁰

In order to rethink the organization of knowledge and labor in architecture and in the architectural business model, we need to question some of the main aspects of the single authorial design paradigm. There is need for the inquiry into the ways to get more people involved in the design process, in order to save on valuable resources by sharing time, knowledge and experience.

Accordingly, this thesis suggests that nurturing an architectural knowledge ecology is needed for delivering more personalized, faster, inexpensive and more sustainable designs through emphasis on new modes of authorial paradigm that would dissolve further the traditional distinctions between producer and user of design knowledge.

3.2 Mode 2: Distributed Modes of Architectural Authorship

Both sociology of knowledge and cognitive science propose that cognition and knowledge are not confined to the individual mind. They are distributed across objects, individuals, artifacts, and tools in the environment.¹⁵¹ Distributed Cognition studies the interactions between individuals and the environment.¹⁵² Applying distributed cognition theories of knowledge to the architectural knowledge ecosystem, the type of knowledge production that will be referred as Mode 2 is going to define distributed modes of architectural authorship.

Distributed modes of architectural authorship can be addressed to allow for “fully maximizing the potential of the designer’s hitherto-underutilized cognitive

¹⁵⁰ UNStudio. *UNStudio to Launch Open Source Knowledge Sharing*. 2014, <https://www.unstudio.com/en/page/6630/unstudio-to-launch-open-source-knowledge-sharing>. Accessed 30 June 2018.

¹⁵¹ Hutchins, Edwin. “The Social Organization of Distributed Cognition.” *Perspectives on Socially Shared Cognition*, edited by Lauren B. Resnick et al., American Psychological Association, 1991, pp. 283–307.

¹⁵² Hutchins, Edwin. *Cognition in the Wild*. The MIT Press, 1995.

facilities”.¹⁵³ As consequences of new digital media and its effect on design and physical realization of buildings, the field of architecture has expanded and became more and more distributed.¹⁵⁴ This impact of transition to digital media challenges traditional authorship on two levels: firstly, by distributing design activity between various design actors: expert, non-experts, human and artifacts, that are across time and space; and secondly, by connecting design and fabrication more than it ever was.

Within the scope of this research, in agreement with distributed cognition theories, the distributed models of architecture are categorized as follows: 1) distribution between architects; 2) distribution between architects and professionals from other building design and fabrication disciplines; 3) distribution between architects and non-professionals; 4) distribution between human and artifacts.

3.2.1 Distribution between architects

As mentioned above, in contemporary architecture, design problems are also getting increasingly complex, sometimes even exceeding the cognitive capacities of single individuals. Mario Carpo highlights that “Building a multistory car park these days typically involve more digital technologies than were available to Frank Gehry’s office for the design of the Guggenheim Bilbao in the early 1990s.”¹⁵⁵ Due to the necessity to deal with the complexities of today’s design problems, some architectural firms have developed associated technology companies that deliver integrated solutions for a broad range of clients such as architects, engineers, contractors, builders, fabricators and owners working across the globe. For instance, Gehry Technologies is an AEC (architecture, engineering and construction) technology company providing leading edge integrated solutions to the industry’s

¹⁵³ Ross, Andrew. “Foreword.” *Building (in) the Future: Recasting Labor in Architecture*, edited by Peggy Deamer and Phillip G. Bernstein, Princeton Architectural Press, 2010.

¹⁵⁴ Chira, and et al. “An Ontological and Agent Based Approach to Knowledge Management within a Distributed Design Environment.”

¹⁵⁵ Carpo, Mario. “Introduction.” *AD Reader The Digital Turn in Architecture 1990-2010*, Wiley, 2013, pp. 8.

most challenging projects as a team that includes architects, engineers, builders, computer scientists, data scientists and management consultants, etc.¹⁵⁶

Some architectural firms preferred to develop their own research departments. For example, the research department of Foster + Partners led by Francis Aish is almost the size of an academic institution.¹⁵⁷ Many of the star architects employ hundreds of designers. More than 1000 designers are working for Foster + Partners and over 400 for Zaha Hadid Architects.¹⁵⁸ Even after the unexpected death of Zaha Hadid, in 2016, the Studio Zaha Hadid Architects continues to grow, to win competitions and to get new offers for new projects.¹⁵⁹

Many star architects have design studios with international branches. For example, OMA is a Rotterdam based architectural office with worldwide branches in Hong Kong, New York, Beijing, Doha, Dubai and Australia. Similarly, UNStudio is an Amsterdam based architectural office with branches in Shanghai and Hong Kong. Christopher Hight and Chris Perry exemplify architectural offices and research groups that use distributed modes of practice in the AD Special Issue on Collective Intelligence in Design, which was edited by themselves as:

“A number of design practices, as well as research groups, have started to learn from these models of distributed exchange and production, extending their logics to reconfigure the design office or research lab format by recasting it as an international, intergeographic, interinstitutional design-based file-sharing community. Professional design practices such as servo, OCEAN net, United Architects (UA) and Open Source Architecture (O-S-A), as well as various interinstitutional research groups that integrate both academic and professional forms of design knowledge (the MIT

¹⁵⁶ Gehry Technologies. <http://www.gehrytechnologies.com/>. Accessed 31 May 2018.

¹⁵⁷ Picon, Antoine. “From Authorship to Ownership: A Historical Perspective.” *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 36–41.

¹⁵⁸ Ibid.

¹⁵⁹ Hobson, Ben. “Patrik Schumacher Explains His Future Plans for Zaha Hadid Architects.” *Dezeen*, 2016, <https://www.dezeen.com/2016/07/19/video-interview-zaha-hadid-architects-future-business-plans-patrik-schumacher-movie/>. Accessed 30 June 2018.

Media Lab's OPENSTUDIO, RMIT's SIAL department, the Architectural Association's DRL, Cornell's Responsive Systems Group and the Columbia-based research practice CONTINUUM)."

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Design Studio of Chris Perry, *Servo*, is not just a design studio but also a research and design collaborative group that is decentralized across cities, bridging the US and the EU with focus on distribution between designers across various places and times. The organizational structure of *Servo* is not limited by the traditional forms of temporal and geographic space, thanks to network logics of responsive social and cultural communication infrastructures.¹⁶¹

Another outcome of the global distribution of design is that while the final product can be produced at site, designs and drawings can be produced at offshore locations. In other words, while manufacture is becoming local, design is becoming global due to the economic requisite of subcontracting on a global scale to cheaper locations. As a result of digital outsourcing in architecture, it is now possible and preferable to assign routine, repetitive and time consuming design tasks, such as drafting, rendering, modelling, to low wage offshore countries in order to reduce the cost.¹⁶²

In contemporary architecture, the single authorial paradigm will apparently be discontinued. Design projects that numerous architects work on collaboratively cannot be attributed anymore to one single architect. Accordingly, many researchers started to question the reason "architecture (is) still saddled with an authorial ambition apparently so at odds with the current technological and social situation".¹⁶³

¹⁶⁰ Hight and Perry "Introduction." *AD Collective Intelligence in Design*, pp.7.

¹⁶¹ Erdman, David, et al. "Responsive Exchange Environments." *Architectures Non Standard*, edited by Frederic Migayrou and Zeynep Mennan, Centre Pompidou, 2003.

¹⁶² Ross, "Foreword." *Building (in) the Future: Recasting Labor in Architecture*,

¹⁶³ Allen, Matthew. "Architecture's Struggle with Authorship." *Reviews in Cultural Theory*, vol. 5, no. 1, 2014, pp. 36–39.

3.2.1.1 Open Distribution Between Architects

Distribution of design between architects can occur as a number of architects working for one building design or in the form of open distribution of design knowledge between architects. This type of open distribution aims for the entire architecture industry to evolve together.

In 2013, UNStudio announced that they were releasing 27 articles containing research and architectural knowledge developed through their building practice in order to contribute to the building of a knowledge platform. Caroline Bos, co-founder of UNStudio, summarizes their purpose as: “Our primary goal is to improve our buildings through the creation of new dynamic ways of working and to develop expertise through knowledge-based strategies and working models.”¹⁶⁴ Ben van Berkel adds the following thoughts to Caroline Bos in relation to their motivation behind the suggestion of a knowledge platform:

“From the outset at UNStudio we have continually reexamined and reevaluated our practice, with the result that at certain key moments we have recognized the need for extensive reorganisation. Now, once again, the challenging climate within the profession today has in turn challenged us to take a close look and to rethink our organisational model with the ultimate aim of improving our architecture and ensuring its relevance within contemporary conditions. However, finding ourselves unable to locate a relevant model from within the profession, we became fascinated by the new initiatives put in place by online start-up companies - such as social networking firms - who have moved from an old economy to a far more innovative economy which celebrates communication, open exchange and co-creation. Believing that architecture can benefit greatly from adopting and adapting such an approach, in recent years we have set about the

¹⁶⁴ UNStudio. *UNStudio to Launch Open Source Knowledge Sharing.*

reorganization of our studio into an open knowledge-based practice.”

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The contribution of UNStudio is important due to the fact that they release the architectural thinking behind some of their work where traditionally only the final results, such as 3D renders and photographs in architectural journals and the Internet, would be available. This knowledge enables us to relate the architectural thinking and research behind the project, and contribute to other architects by enabling the use of such research for developing their own projects.

In 2016, Alejandro Aravena willingly unlocked the intellectual property rights of his four built social housing buildings, not only making the drawings available for download, but also by making them available to be used and modified in order to contribute to public knowledge. Aravena summarized his reasons as follows:

“Out of the 3 billion people living in cities today, 1 billion is under the line of poverty. By 2030 out of the 5 billion people that will be living in cities, 2 billion are going to be under the line of poverty. That means that we will have to build a 1 million people city per week with 10,000 dollars per family. Given the magnitude of the housing shortage, we won’t solve this problem unless we add people’s own resources and building capacity to that of governments and market. That is why we thought of putting in place an open system able to channel all the available forces at play. In that way people will be part of the solution and not part of the problem.”¹⁶⁶

Aravena embraces the copy paste function of architecture in order to contribute to public knowledge for dealing with the problem of sustainable and affordable housing. He perceives open systems and open source as a way to tackle this crisis, promoting public and social benefits of collaboration and information-sharing. Aravena’s initiative of opening four of his built projects is an important step towards

¹⁶⁵ Ibid.

¹⁶⁶ Aravena, Alejandro. *ABC of Incremental Housing*.
<http://www.elementalchile.cl/projects/abc-of-incremental-housing/>. Accessed 31 May 2018.

building a shared information ecology for architecture that has been followed by other individual projects.

The attitudes of these two architectural offices (Alejandro Aravena and UNStudio) towards openness of architectural information illustrate a redefinition of the notion of authorship following and followed by changing modes of production and distribution of knowledge.

3.2.2 Distribution Between Architects and Professionals from other Building Design and Fabrication Disciplines

Emerging digital technologies in architecture require a close link between many architects working on the same project, and also a close collaboration and interdisciplinary work of designers, engineers, builders, consultants and other building design professionals.¹⁶⁷ According to National Institute of Building Sciences, building design disciplines and related specialists covers: architect, architectural programming expert, acoustical engineer, building envelope specialist, civil engineer, cost estimating expert, demolition specialist, electrical engineer, fire protection engineer, historic preservation specialist and/or archeologist, HVAC and refrigerating engineer, information technologies engineer, interior designer, landscape architect, LEED® specialist, lighting designer, urban planner, project manager, plumbing engineering, seismic engineer, soils engineer, structural engineering, and waste management specialist.¹⁶⁸ This list could be developed with further specialization and more specific building cases.

The single authorship paradigm loses its relevance with all these building design professionals and specialists working on common projects with overlapping disciplinary boundaries, not only during the building design phase but also during the fabrication and construction process (Figure 1). The developing technologies are

¹⁶⁷ Bernstein, “Design Instruments of Service in the Era of Connection.”

¹⁶⁸ National Institute of Building Sciences. *Design Disciplines*.
<https://www.wbdg.org/design-disciplines>. Accessed 31 May 2018.

destroying the barriers between design and execution.¹⁶⁹ The traditional linear organization of design-bid-build is changing into integrated design and building process.¹⁷⁰ Connection of design and fabrication extends the professional stakeholders involved in architecture into a huge list composed of building design and fabrication disciplines that include experts as well. Accordingly, the architects are no longer perceived as the heroic building's main creators, as building design turns into a collaborative effort with an increasing number of other professionals and experts involved in the complex collective mode of designing.¹⁷¹

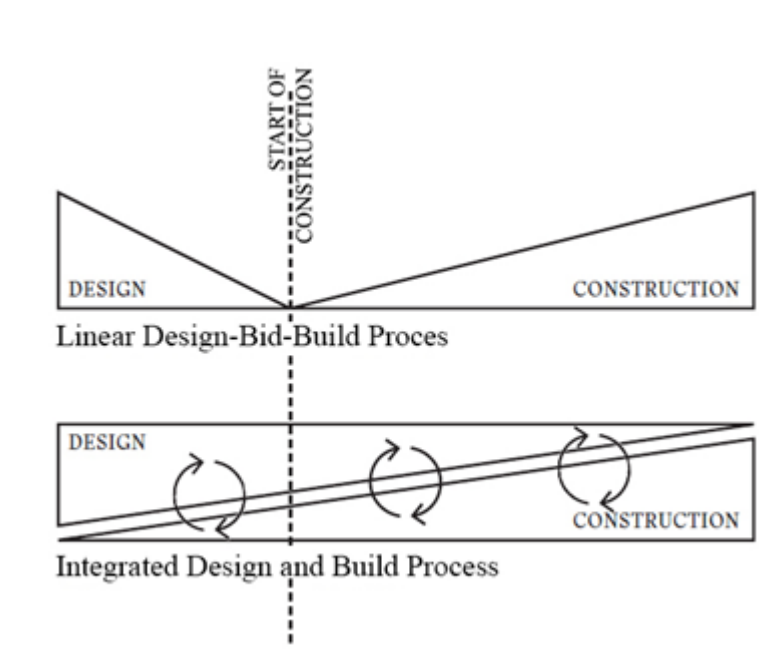


Figure 1. Channing relationship between design and construction

(Adapted from Andrachuk, James, et al. *Perspecta 47*. The MIT Press, 2014.)

3.2.3 Distribution Between Architects and Non-Professionals

The professional stakeholders involved in architecture such as architects in the era of connected design and construction are mentioned above. However, there is another

¹⁶⁹ Bernstein, “Design Instruments of Service in the Era of Connection.”

¹⁷⁰ Andrachuk, James, et al. *Perspecta 47*. The MIT Press, 2014.

See also Bernstein, “Design Instruments of Service in the Era of Connection.”

¹⁷¹ Bernstein, “Design Instruments of Service in the Era of Connection.”

very important group of stakeholders involved in the architectural design process who are out of domain of building design disciplines. The group of laymen, non-professional stakeholders include the owner, client, investor, final buyer, design customers and consumers.

These discussions related to indolent of the user in architectural design process first took place in the architectural discourse in the late 1960's, at the Design Participation Conference in 1971, which brought together designers, teachers and researches that shared similar interests in user participation.¹⁷² In this conference, Negroponte remarked that in the previous 5 years, the need and the idea of user participation had surfaced in the design field, both in education and practice; and the interest in participation was a consequence of the general feeling that architecture had been inadequate and unresponsive to the needs and desires of its users¹⁷³. Regarding user participation, he noted that the works presented in the conference appeared to point towards a democratization of decision-making.¹⁷⁴

3.2.4 Distribution Between Human and Artifacts

New construction techniques such as laser cutters, 3D printing, vacuum formers, robotic assembly and other CNC machines has started to be used more widely on a personal scale and on construction sites worldwide. Working with digital technologies enable architects to share building drawings and information easily. Moreover, for the case of computational designs, the code and information of building can be shared instantaneously while manufactured in situ using digital fabrication techniques. As the famous quotation of British economist John Maynard goes, “it is easier to ship recipes than cakes and biscuit.”¹⁷⁵ Free downloadable and adjustable designs that you can manufacture exist locally, from tangible goods, urban agriculture machines, houses (WikiHouse), and even manufacturing equipment (e.g.

¹⁷² Cross, N. (1972). Foreword. In *Design Participation Proceedings of the Design Research Society's Conference* (pp. 4–5).

¹⁷³ Negroponte, “Aspects of Living in an Architecture Machine.”

¹⁷⁴ Negroponte, Nicholas. *Soft Architecture Machines*. The MIT Press, 1976.

¹⁷⁵ Ratti and Claudel, *Open Source Architecture*.

you can download the code and print your 3D printer, *RepRap* which is a 3D printer that can be constructed with parts printed by another RepRap).

Design of downloadable and real size printable designs require attitudes, processes and procedures that cannot be met by the single authorial paradigm. As a result, the current era of digital deliverables challenge the single authorial paradigm where the service of the architect becomes digitalized information rather than a finished product.¹⁷⁶

Codified language, the language of 3D printers, robotic arms and all digital manufacturing tools, becomes a universal language between machines and humans all around the world. It is expected that in the next decade distributed design, together with localized manufacturing, will become more dominant. Wendy Wok, editor of the Special edition of AD on Open Source Architecture mentions that “Companies, large and small, are going to custom-make most things in small factories right in your neighborhood or city; goods will be picked up locally or distributed by a drone to the doorstep.”¹⁷⁷

3.2.5 Knowledge Ecosystem of Mode 2

Mode 2, i.e. the distributed mode of architectural authorship represents a breaking from the single authorial paradigm for the cultivation of a knowledge ecosystem. Distribution of the architectural knowledge production contributes to the formation of a knowledge community with a diversity of participants. Engagement in the knowledge community does not come only from the collaborative work of architects, but from other building design and fabrication professionals and non-professionals out of building disciplines as well. Moreover, the knowledge community is not only comprised of various expert and non-expert human agents but human made agents,

¹⁷⁶ Colletti, “Post-Digital Transdisciplinarity.”

¹⁷⁷ Fok, Wendy W. “Opening Up the Future of Open Source: From Open Innovation to the Internet of Things for the Built Environment.” *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 124.

tools and technologies, i.e. artifacts, as well. As Wendy Wok and Antoine Picon highlights:

“There can indeed be various authors behind a given building, from the individual who wrote a piece of software to the designer who used it to create an architectural model, and from this designer to his or her colleague who customized the model and got the resulting project built.”¹⁷⁸

In knowledge ecosystem framework of Mode 2, knowledge production expands from single mind into being distributed to diverse participants of knowledge community and also to interaction with artifacts. In this type of knowledge ecosystem, although the design is a distributed action, the architect is still the keystone species¹⁷⁹ of the knowledge community. The integrated design build process is mostly led by the architect, and accordingly it is also called as architect led design building process (Figure 2).

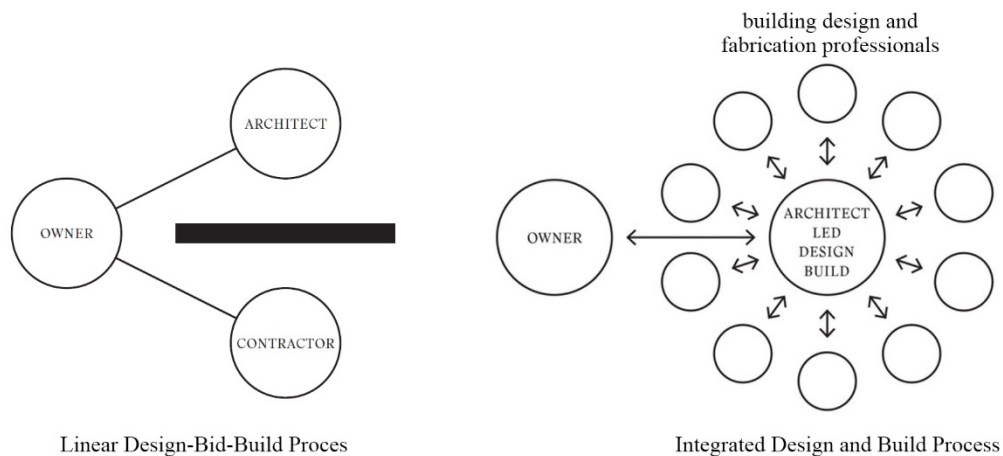


Figure 2. Changing role of architect

(Adapted from Andrachuk, James, et al. *Perspecta 47*. The MIT Press, 2014.)

¹⁷⁸ Fok, Wendy W., and Antoine Picon. “The Ownership Revolution.” *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 7.

¹⁷⁹ Keystone species is the species with a large effect, unique and crucial role on the ecosystem functions. The removal of the keystone species significantly alters the habitat around them even might result in the decay of the ecosystem.

Molles, *Ecology: Concepts and Applications*.

3.3 Mode 3: Dissolution of Architectural Authorship

Mode 3 type of architectural authorship involves the dissolution of authorship as a step further from its distribution. Mode 3 stands out as an umbrella terms that covers open source architecture, participatory design, user-centered design, citizen design, collaborative design, cooperative design, inclusive models of design and democratic design.

Compared to Mode 2, in Mode 3, the demarcation between design actors is more blurred. The dissolution of the boundaries between a diverse range of actors involved in the design process results in the loss of “absolute control, unconditional omniscience, and supreme authority.”¹⁸⁰ In the book *Building (in) the Future Recasting Labor in Architecture*, Peggy Deamer summarizes the changing roles of architects and other design professionals as below:

“The traditional definitions of designer, architect, and builder come under attack as the relationship of each to the other shifts. *Designer* is no longer equated with *architect*; fabricators, engineers, and software programmers can lay equal claim to authorial designation. The architect has access to all the economic/organizational parameters originally known only to the builder.”¹⁸¹

Kas Oosterhuis defines this kind of architecture as “a transaction environment running in real time” where collaboration occurs between design and engineering, between artists, architects and programmers, between the architectural practice and people from other disciplines like graphic artists, publishers, installation designers, with clients, citizens, users, accidental users, and even random passengers “either consciously as dedicated participator in the design process, or subconsciously as a passenger whose presence matters.”¹⁸²

¹⁸⁰ Ratti and Claudel, *Open Source Architecture*.

¹⁸¹ Deamer, Peggy. “Introduction.” *Building (in) the Future: Recasting Labor in Architecture*, edited by Peggy Deamer and Phillip G. Bernstein, Princeton Architectural Press, 2010.

¹⁸² Oosterhuis, Kas. *Hyperbodies: Toward an E-Motive Architecture*. Birkhäuser, 2003.

Crowdsourcing (user-generated content) is a perfect example for Mode 3 type of knowledge production, where participants subconsciously become a part of the process. Knowledge management and knowledge extraction from crowdsourced data for design is a growing paradigm. Crowdsourced data provides information related to user choices and opinions. Urban planners are recently using crowdsourced data to design better functioning cities; for instance, by retrieving GPS data from sports apps such as Strava¹⁸³ for planning non-motorized road networks.¹⁸⁴ From pre-design consulting to post-occupancy evaluations, the building design discipline is also starting to take advantage of crowdsourcing as well. Mode 3 expands the diversity of participants utilizing crowdsourced data as a form of participation.

The Turkish Pavilion at the 2018 Venice Biennale, *Vardiya* (the Shift), serves as a physical and digital environment for Mode 3 type of knowledge production. In line with Oosterhuis's definition, it consists in a transaction environment running in real time, where collaboration occurs between members of a knowledge community. The aim of *Vardiya* is to turn the Turkish Pavilion into an open space for communication, sharing ideas, encountering production and cultural exchange across borders.¹⁸⁵ The curator Kerem Piker explains: "Architecture is a field that is constantly expanding, transforming and renewing itself. As such, there is a need for environments where architectural knowledge is reproduced, shared and discussed, and the voices of new participants are heard."¹⁸⁶

The project initiated with an open call to architecture students around the world. According to their responses to some questions related to function in the biennale, 122 international architecture students from 16 countries were selected to participate in weekly shifts as active producers of the evolving exhibition content of the

¹⁸³ Strava is a mobile app that tracks athletic activity via satellite navigation and then uploads and shares such activities. It can be used for a number of sporting activities, the most popular activities tracked using the software are cycling and running.

¹⁸⁴ Jossé, Gregor, et al. "Knowledge Extraction from Crowdsourced Data for the Enrichment of Road Networks." *GeoInformatica*, vol. 21, no. 4, 2017, pp. 763–95.

¹⁸⁵ Piker, Kerem, et al. *Vardiya*. Yapı Kredi Publications, 2018

¹⁸⁶ Ibid.

pavilion.¹⁸⁷ Keynote lectures, digital meetings and other digital productions of the shift are available to the public online via *Vardiya*'s Youtube channel and blog.

The Turkish Pavilion aims to function beyond serving just as an exhibition space. The curators mention that as Venice Biennale is one of the most important informal learning arenas in architecture, they preferred to interpret the pavilion as an open learning and production space among students, academics, professionals, public and even random visitors of the pavilion. The pavilion (Figure 3) itself focuses on the production of knowledge rather than the final exhibited work where the process of knowledge production becomes the exhibited work.¹⁸⁸

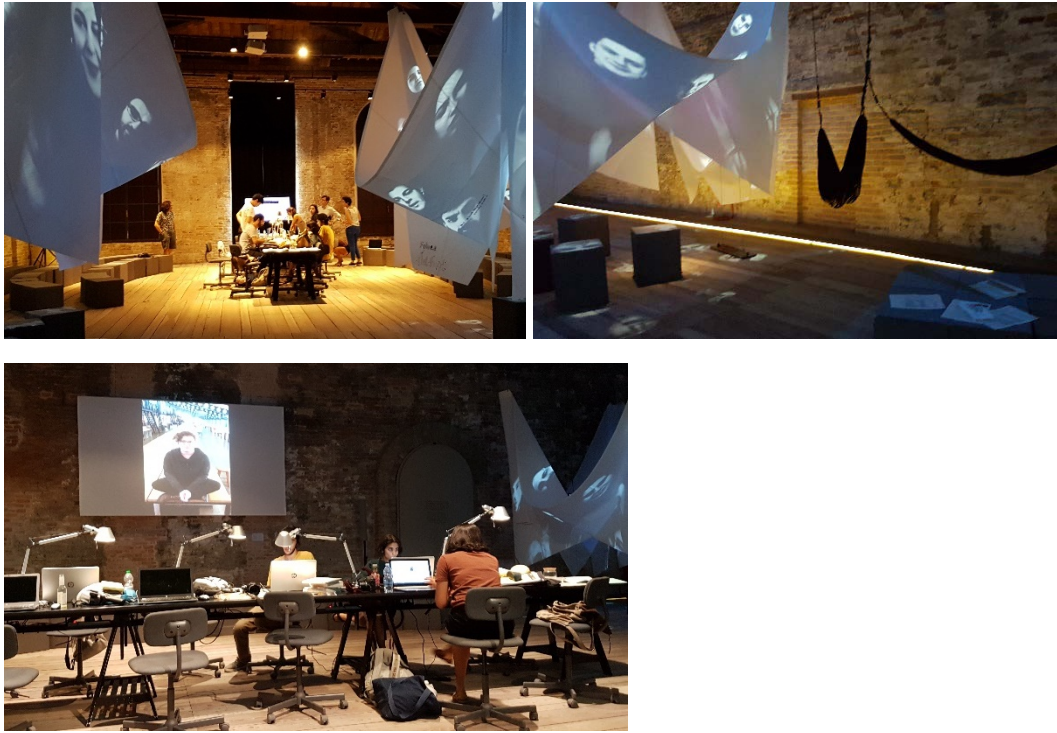


Figure 3. Vardiya (the Shift) the Turkish Pavilion at the 2018 Venice Biennale (Photograph Canan Albayrak Colaço)

¹⁸⁷ Ibid.

¹⁸⁸ Koçer, Derin. "Hiç Durmayan Bir Su; Buluşma, Karşılaşma, Üretme ve Mimarlık: Vardiya." *T24*, 2018, <http://t24.com.tr/haber/hic-durmuyan-bir-su-bulusma-karsilasma-uretme-ve-mimarlik-vardiya,657976>. Accessed 30 June 2018.

This type of dissolution of authorship in production of knowledge, intercepts with the knowledge ecosystem as defined in the previous chapter, both contributing to the diversity of participants in bringing in new types of knowledge and expertise to the process of shaping ideas, insights, and inspiration that cross fertilize and feed one another. As mentioned previously, the diversity of participants and the openness of the system contributes to the blurring of boundaries between disciplines and between knowledge producers and users, which is precisely the aim of Mode 3.

3.3.1 Knowledge Ecosystem of Mode 3

Mode 3 widens the knowledge community of architecture to everyone, where all parties are involved and stimulated to submit the best of their knowledge and experience, connected through information and knowledge flow.¹⁸⁹ The role of the architect in the knowledge community continues as keystone species (as in Mode) with a less dominant but a wider sphere of influence and professional action field as the diversity of participants involved in design increases.

According to Oosterhuis, the role of the modern architect is to sculpt the design data and to define rules and relations in the process that forms the project database.¹⁹⁰ The project data base has shells¹⁹¹ around it; direct access to the project database is blocked for some participants. The architect is the one who defines which of the participants of the design process would access to the project data base or decides whether to share it openly with other architects. The participants who have access to the project data base could change the design rules and relationships. Then again, participants who does not have access to the project data base could still change the

¹⁸⁹ Oosterhuis, *Hyperbodies: Toward an E-motive Architecture*.

¹⁹⁰ Ibid.

¹⁹¹ Oosterhuis's definition of the project data base being protected with shells around it, is reminiscent of Imre Lakatos's definition of a "protective belt" protecting the hardcore: According to Lakatos, each theory produced within a research programme contains a "hard core" consisting of assumptions which are unfalsifiable and irrefutable, further surrounded by a "protective belt" of auxiliary hypotheses. When a particular theory is refuted, the criticism is directed at the hypotheses in the "protective belt" and not to the "hard core". "Imre Lakatos." *Stanford Encyclopedia of Philosophy*.

parameters of the rules and communicate with the project data base through an interface.¹⁹²

Knowledge environments in Mode 3 support the distribution of data into connected brains and computers, spreading through the Internet, smart phones, laptops, tablets and other electronic wearable devices, thanks also to the unilaterality of languages mentioned above. The traditional architectural drawings and models evolve into a distributed being that is built up of many nodes similar to a neural network.¹⁹³ In this type of environment, design is not located at a fixed place in someone's head or computer but consists of many distributed parts.

3.4 Issues Related with the Dissolution of Authorship

3.4.1 Issue of Copy

In the previous sections, the benefits of digital technologies have been discussed in relation to the increased diversity of participants involved in the design process and its openness. Everything that is digital is potentially open to interaction, participation, easy distribution and replication, resulting in the dissolution of authorship.¹⁹⁴ However, there are important issues regarding this dissolution of authorship and the openness of the process regarding the limits between inspiration, copying, and pirating.

In the field of architectural design, this discussion peaked in 2013, when the building complex *Meiqian 22nd Century* (Figure 4) began being constructed in the southwestern Chinese city of Chongqing: its resemblance to Zaha Hadid's *Galaxy Soho complex* (Figure 5), which was being built in Beijing, was undisputable.¹⁹⁵ Zaha Hadid Architects told the press that "It is possible that the Chongqing pirates

¹⁹² Oosterhuis, *Hyperbodies: Toward an E-motive Architecture*.

¹⁹³ Ibid.

¹⁹⁴ Carpo, "Digital Indeterminism: The New Digital Commons and the Dissolution of Architectural Authorship".

¹⁹⁵ Platt, Kevin Holden. "Copycat Architects in China Take Aim at the Stars." *Spiegel Online*, 2012, <http://www.spiegel.de/international/zeitgeist/pirated-copy-of-design-by-star-architect-hadid-being-built-in-china-a-874390.html>. Accessed 30 June 2018.

got hold of some digital files or renderings of the project."¹⁹⁶ Due to the ease in the sharing of building drawings and information, the pirated copy of Hadid's building began being constructed even before the end of the construction of the original building.



Figure 4. Meiquan 22nd Century, unknown Architect 2012-2014

(Source: Fairs, Marcus. "Zaha Hadid Building Pirated in China." *Dezeen*, 2013, <https://www.dezeen.com/2013/01/02/zaha-hadid-building-pirated-in-china/>. Accessed 30 June 2018.)

TCA Think Tank. *Meiquan 22nd Century - Venice Biennale Fundamentals 2014*. 2014, <https://www.youtube.com/watch?v=hel6shNjEHM>. Accessed 30 June 2018.)



Figure 5. Wangjing Soho, Architect: Zaha Hadid, 2011-2014

(Source: Fairs, Marcus. "Zaha Hadid Building Pirated in China." *Dezeen*, 2013, <https://www.dezeen.com/2013/01/02/zaha-hadid-building-pirated-in-china/>. Accessed 30 June 2018.)

Zaha Hadid Architects. *Wangjing Soho*. <http://www.zaha-hadid.com/architecture/wangjing-soho/>. Accessed 30 June 2018)

¹⁹⁶ Ibid.

In contrast, developers of *Meiqian* denied they ever meant to copy, but only wanted to surpass.¹⁹⁷ The fact that the pirated building was being built faster than the original turned into a big challenge and race in construction quality and construction management, which eventually benefited both buildings.¹⁹⁸

Zaha Hadid did not file a lawsuit against¹⁹⁹ the so called “hacked, pirated, copied” building; instead, she mentioned that she had a philosophical stance on the replication of her designs and it could be quite exciting to see future generations of these clone buildings displaying innovative mutations.²⁰⁰ Indeed, there are few intellectual property lawsuits in architecture, because architects are actually aware of the fact that pure authenticity is impossible to achieve. As Umberto Eco said, “books always speak of other books, and every story tells a story that has already been told”²⁰¹, design is also always a response to other designs. For the same reason, many of the world’s most innovative architects have not filed patents such as Zaha Hadid Architects and Foster + Partners.²⁰² Many buildings that belong to the same style or same era show many design properties common to each other. This fact is also highlighted in Rem Koolhaas’s ‘*Elements*’ exhibition at the 2014 *Venice Architecture Biennale*²⁰³ that “architecture has become nothing more than a

¹⁹⁷ Ruy, David. “Serving, Owning, Authoring.” *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 16–25.

¹⁹⁸ Platt, “Copycat Architects in China Take Aim at the Stars.”

¹⁹⁹ Kashem, Nadia. “A Tale of Two Buildings: A Case of Architectural Copyright Infringement in China.” *Fordham Art Law Society*, 2015, <https://fordhamartlawsociety.com/2015/10/30/a-tale-of-two-buildings-a-case-of-architectural-copyright-infringement-in-china/#ampshare=https://fordhamartlawsociety.com/2015/10/30/a-tale-of-two-buildings-a-case-of-architectural-copyright-infringement-in-chi>. Accessed 30 June 2018.

²⁰⁰ Platt, “Copycat Architects in China Take Aim at the Stars.”

²⁰¹ Eco, Umberto. *The Name of the Rose*. 1983

²⁰² Garcia, M. (2016). Architectural Patents and Open-Source Architectures. *AD Digital Property: Open-Source Architecture*, 86(5), 92–99.

²⁰³ Ruy, D. (2016). Serving, Owning, Authoring. *AD Digital Property: Open-Source Architecture*, 86(5), 16–25.

compilation of technologies, manufactured parts and other smaller designed objects.”²⁰⁴ In different cities of the world, resembling forms of buildings can be encountered, as shown below (Figure 6-10).



Figure 6. Galaxy Soho, Beijing, China, Zaha Hadid, 2009-2012

(Source: Zaha Hadid Architects. *Galaxy Soho*. <http://www.zaha-hadid.com/architecture/galaxy-soho/>. Accessed 30 June 2018.)



Figure 7. Education Execution Agency and Tax Office, Groningen, The Netherlands, UNStudio, 2006-2011

(Source: UNStudio. “Duo and Tax Offices.” *Archello*, <https://archello.com/project/education-and-tax-offices#story-1>. Accessed 30 June 2018.)



Figure 8. Youth Towers Arlozorov, Tel Aviv, Israel, MYS Architects 2011

²⁰⁴ Ruy, D. (2016). Serving, Owning, Authoring. *AD Digital Property: Open-Source Architecture*, 86(5), 16–25.

(Source: *Arlozorov Towers*. 2012, <https://www.youtube.com/watch?v=jBOEi6Kzws>. Accessed 30 June 2018.)



Figure 9. Absolute Towers, Ontario, Canada, MAD Architects, 2012

(Source: Frearson, Amy. “Absolute Towers by MAD.” *Dezeen*, 2012, <https://www.dezeen.com/2012/12/12/absolute-towers-by-mad/>. Accessed 30 June 2018.)



Figure 10. Radisson Blu Hotel&Residence, Maputo, Mozambique, DSA Architects International, 2013

(Source: Metrum Project Management. *Projectos e Investimentos*. <https://www.metrum.co.za/portfolio/horizon-fenix-projectos-e-investimentos-lda-maputo-mozambique/>. Accessed 30 June 2018.)

Instead of filing for patent or opening lawsuits in order to claim copyright, some architects are opening their design knowledge for public use, as mentioned in the previous section. On the other hand, some architects prefer to fill patents for their designs in order to protect their copyrights (Figure 11). However, due to the limited lifespan of patents and copyrights (for patents this is generally 20 years), filing for patents might not be sufficient. After the expiration of the patent protecting iconic

designs, other architects could use these design with expired patents as generic forms.²⁰⁵



U.S. Patent Aug. 25, 2015 Sheet 5 of 10 US 9,113,702 B2

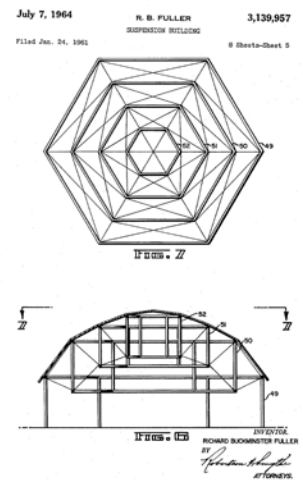
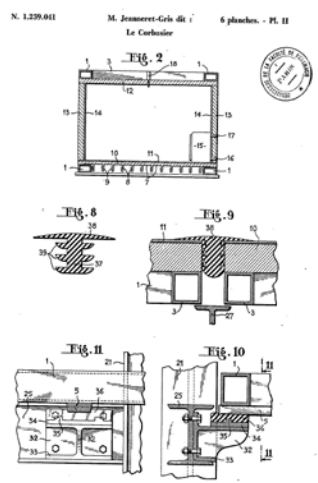
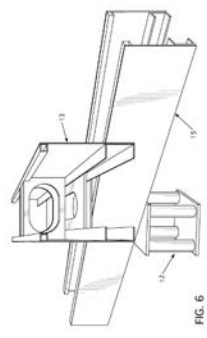


Figure 11. Examples of Patents filed by architects.

(Source: United States Patent and Trademark Office.
<http://pdfpiw.uspto.gov/.piw?docid=09113702&SectionNum=1&IDKey=629FDBF02317&HomeUrl=http://patft.uspto.gov/netahtml/PTO/patimg.htm>. Accessed 30 June 2018.

British Library. *Architectural Patents*.
<http://britishlibrary.typepad.co.uk/patentsblog/2009/03/the-patents>. Accessed 30 June 2018.)

²⁰⁵Generic products become available after the patent protections of original developer expire, For instance a generic drug is an equivalent to a brand-name product in dosage, strength, route of administration, quality, performance, and intended use, but does not carry the brand name. In other words, other pharmaceutical companies than the original producer could release the same drug under different brand names.

From another perspective, “Patented architectures can also seek crowdsourced forms of funding, for example through Kickstarter (or other crowdfunding platforms²⁰⁶) and architects could revert patents to the public earlier, making them more open source, faster.”²⁰⁷

Obviously, current legal systems are showing restrictions and more research in providing a more up-to-date legal structure regarding the distribution and/or dissolution of architectural authorship is needed. The fine lining between fair and unfair use of architectural knowledge, stealing and inspiration gets thinner in today’s realm of the open source movement and the networked society being governed by no one.

The problems of ownership, legislation and ethic use in the case of the dissolution of architectural authorship require a deeper critical analysis. Mark Garcia makes a prediction for the future of as:

“This current transition from file-based versioning systems to databases thus brings to the foreword questions regarding distributed and shared authorship. The architectural historians of the future will be able to access digital models of buildings to see the contributions of all of the underpaid interns and graduates who committed changes at 4am, and the continuous refinement of every single niche of the design – and perhaps some credit will finally be given to the various consultants and engineers whose important roles are generally unacknowledged.”²⁰⁸

²⁰⁶ Crowdfunding started as an alternative financial method to funding projects online by raising small amounts of money from a large number of people. It has become a loaded term, meaning much more than just raising money from the public. Crowdfunding could be used to gather donations for nonprofit purposes. These are referred to as “online fundraising,” “social media fundraising” or “peer-to-peer fundraising.” Crowdfunding can also be used for raising money for enterprises, start-up or any other profit oriented project as well.

Thorpe, Devin. “What Is Crowdfunding?” *Forbes*, 2018, <https://www.forbes.com/sites/devinthorpe/2018/06/25/what-is-crowdfunding/#4414882065c5>. Accessed 30 June 2018.

²⁰⁷ Garcia, Mark. “Architectural Patents and Open-Source Architectures.” *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 99.

²⁰⁸ *Ibid*, 113.

Keeping in mind that distribution and dissolution of authorship are newly emerging paradigms in architecture one should not hasten to draw early conclusions on this topic, but give the architectural discipline time to respond and to react to these paradigm changes. Perhaps, as Garcia envisions, new developing technologies would open new ways regarding the problems of ownership, legislation, ethic and fair use of architectural knowledge in relation to the dissolution of architectural authorship.

The following chapter aims to address a main problematic related with open source and the dissolution of authorship through a detailed study of specific example projects to discuss whether they trigger distributed creativity or hinder discovery and original design research.

3.4.2 Total Dissolution of Authorship in Architectural Practice

In the previous sections, the single authorial paradigm (Mode 1) and the dissolution of architectural authorship (Mode 3) were presented as two extreme ends of authorship in architecture. In the age of information and networked societies, architectural design does not follow the single authorial paradigm; yet, it has also not shown total dissolution (unlike some open source works in other disciplines), as discussed in chapter 2. Mario Carpo concludes that with the exception of a handful of avant-garde experiments, the participatory turn of the open source movement has not yet happened in architecture.²⁰⁹

In the architecture discipline, there is resistance to the total dissolution of authorship and to open source architecture. Firstly, as mentioned in the previous section, there are issues regarding ownership, authorial rights, definition of (un)fair use, and accreditation; moreover, there is uncertainty about “how open-source processes will be fully realized with the introduction of new practice and payment models”.²¹⁰ Secondly, the problematic of the claimed equality/equivalence of expert and

²⁰⁹ Carpo, Mario. *The Second Digital Turn: Design Beyond Intelligence*. The MIT Press, 2017.

²¹⁰ Ratti, Carlo, and Matthew Claudel. “A/B Architecture: Publicly Augmented Design.” *AD Digital Property: Open-Source Architecture*, vol. 86, no. 5, 2016, pp. 42–47.

non-expert knowledge needs to be discussed. Carlo Ratti raises these questions regarding the dissolution of authorship and open source architecture:

“A specific tension at the core of the discipline, is whether the future occupants of buildings (or anyone else, for that matter), with no professional training, can be confronted with decisions that involve complex structural, regulatory or mechanical knowledge? Can a practice that is predominantly technical be made accessible to laypeople, to the point that their contributions are productive? In short, can an open-source process be effectively implemented in the field of architecture? ... As the built environment merges with networks, platforms and advanced fabrication tools, can we realise a contemporary open-source architecture? How will the role of architects and their output change in light of open design practices for the digital age?”²¹¹

The problematic of the equality claim between expert and non-expert knowledge is solved by the project data bases with protective shells, as proposed by Oosterhuis, blocking direct access to the database for certain participants.²¹²

Another argument against the dissolution of authorship and open source architecture is that, in open source, the work is always an unfinished object that calls anyone to improve it. The end product of architecture is, in most cases, a finished object: how is it going to be possible for the whole knowledge community of architecture to alter architectural objects in real time?

The next chapter deliberates this discussion by a detailed analysis of study-case projects from milestone conferences and exhibitions in relation to how designers tackle these issues regarding the dissolution of architectural authorship.

²¹¹ Ibid, 44.

²¹² Oosterhuis, *Hyperbodies: Toward an E-motive Architecture*.

3.4.3 The Need for a Common Language

As stated in the previous chapter, biological ecosystems and knowledge ecosystems thrive, respectively, on the diversity of species and on the diversity of its community of knowledge producers by the coming together of participants with a wide range of varied shared skills, knowledge, expertise and insight that cross fertilize and feed one another. In the previous section, the gradual expansion from single to distributed and finally to dissolution of architectural authorship with participation of a diversity of knowledge producers was discussed in detail in the process of development of an architectural knowledge ecosystem.

In knowledge ecosystems, including architectural knowledge ecosystems, participants represent a combined diversity of perceptions or perspectives in the same way that actors in the life-world perceive a problem and the factors in various different ways.²¹³ The first step for the integration of various participants, experts and non-experts is to acknowledge the diversity of perspectives and create a shared understanding.²¹⁴ Lack of mutual understanding and limitations of “not speaking the same language” are the main methodological challenges of transdisciplinary research.

Exchange of data and information is not adequate to assure mutual understanding and to support effective collaboration among actors of the knowledge ecosystem.²¹⁵ A common set of values is needed in order to unify diverse participants into a knowledge community. Members of the community need to share a common language where the vocabulary of the language represents a shared understanding.²¹⁶ A common language is the key component of distributed cognition and creativity.

²¹³ Pohl, Christian, and Gertrude Hirsch Hadorn. “Methodological Challenges of Transdisciplinary Research.” *Natures Sciences Sociétés*, vol. 16, 2008, pp. 111–21.

²¹⁴ Ibid.

²¹⁵ Carrara and et al. “An Ontology-Based Knowledge Representation Model for Cross-Disciplinary Building Design A General Template.”

²¹⁶ Bahrami and Evans, *Super-Flexibility for Knowledge Enterprise A Toolkit for Dynamic Adaptation*.

See also Tunçer and Sariyildiz, “Facilitating Architectural Communities of Practice.”

Knowledge has to be formalized, managed and shared in order to achieve distributed cognition across individuals, artifacts, time and space.²¹⁷

The need for a common language as a methodological requirement for a knowledge ecosystem creates a paradoxical situation. On one hand, the necessity for a common language in order to create a shared understanding between the diversity of participants is quite evident. On the other hand, there are undeniable adverse outcomes of the use of a common language in relation to the diversity of participants for the sake of removing language barriers.²¹⁸

Language is not only a means for communicating, it is also identity.²¹⁹ Language is a specific way of construction of meaning: the language that a person speaks is the language with which the person identifies. Accordingly, it can be asked whether a world with no language differences would lose its diversity.²²⁰ Moreover, it is a cognitive fact that the language we speak affects our perceptions of the world, shapes our thoughts and the way we think.²²¹ Would a common language that serves as a meeting point result in a diversity of participants who lose some degree of perspective and insights diversity? How would an architectural knowledge ecosystem deal with this paradox? Ezio Manzini defines the characteristics of design research and design knowledge of network and knowledge based society as:

“Design research is an activity that aims to produce knowledge useful to those who design: design knowledge that designers and non-designers (individuals, communities, institutions, companies) can use in their processes of designing and co-designing... It (the design knowledge) must be explicit, discussable, transferable, and accumulable. It must be

²¹⁷ Carrara and et al. “An Ontology-Based Knowledge Representation Model for Cross-Disciplinary Building Design A General Template.

²¹⁸ Kamman, William F. “The Problem of a Universal Language.” *The Modern Language Journal*, vol. 26, no. 3, 1942, pp. 177–82..

²¹⁹ Lanehart, Sonja L. “The Language of Identity.” *Journal of English Linguistics*, vol. 24, no. 4, 1996, pp. 322–31.

²²⁰ Ibid.

²²¹ Boroditsky, Lera. “How Language Shapes Thought.” *Scientific American*, vol. 304, no. 2, 2011, pp. 62–65.

knowledge that can be clearly expressed by whoever produces it, discussed by anyone who is interested, applied by other designers, and it must become the starting point that allows other researchers to produce further knowledge.”²²²

This type of transparentiation of design knowledge is possible by means of formalization and naturalization.²²³ The next chapter discusses in detail the use of formal languages in relation to cultivation of architectural knowledge ecosystem through example projects selected from milestone conferences and architectural exhibitions. This empirical research will bring light to the paradoxical questions related to the use of a common language and diversity of participants and perspectives in the case of architecture.

²²² Manzini, Ezio. “New Design Knowledge.” *Design Studies*, vol. 30, no. 1, 2009, pp. 5.

²²³ Mennan, Zeynep. “Mind the Gap: Reconciling Formalism and Intuitionism in Computational Design Research.” *Footprint, Delft Architecture Theory Journal*, vol. 15, 2014, pp. 33–42.

CHAPTER 4

GENEALOGY OF AN ARCHITECTURAL KNOWLEDGE ECOSYSTEM THROUGH THE USE OF FORMAL METHODS

The impact of the shifts in the distribution of knowledge production, from a centralized towards socially distributed paradigm in the architectural discipline; its resistance to the total dissolution of authorship; and issues to be resolved in relation to the cultivation of an architectural knowledge ecosystem have been listed in the previous chapter. This chapter addresses the architectural discipline's response to these issues and how innovative design models and solutions designers have come up with help overcome authorship challenges regarding the dissolution of architectural authorship. This research aims to answer this question by a genealogical study of landmark exhibitions and conferences that indicate a leap towards the cultivation of an architectural knowledge ecosystem. Design models and projects selected from these conferences and exhibitions are instantiated and studied in detail. In addition, the use of formal language and formal methods in architecture is analyzed in relation to the paradoxical situation regarding the use of a common language by a diversity of participants and perspectives.

4.1 A Common Formal Language for the Dissolution of Authorship

The use of formal methods and formal languages “is a concept very well established in computer and information sciences and technologies, and means roughly the use of theoretically driven techniques, expressed in languages stemmed from mathematics.”²²⁴ In the 17th century, the use of the concept of formal languages and theories related to formal methods began leaping from mathematics (number theory,

²²⁴ Viana, David Leite, et al. “Introduction Formal Methods in Architecture and Urbanism.” *Formal Methods in Architecture and Urbanism*, edited by David Leite Viana et al., Cambridge Scholars Publishing, 2018.

calculus, logic, set theory and later developments such as modern algebras, language theory, and category theory) to other fields, such as linguistics and art.²²⁵

The use of formal methods has several uses in many disciplines and human activities. However, today the main use of formalization is to ensure perfect communication between the acting human and artifact agents from different disciplines and expertise levels.²²⁶ Accordingly, formalization has the great advantage to bring together diverse actors of knowledge ecosystem. As formalized language becomes the universal language, it creates continuity and communication between the various actors in the building design field.

4.1.1 The Use of Formal Methods and Language in Architecture

The use of formal methods and language in architecture requires a different way of thinking design from the traditional approaches. As Zeynep Mennan highlights:

“Numerical notations expressed in a formal language have already gained a privileged place in current design research due to their efficiency in reducing complexity, equally fostered by the multi-disciplinary nature of such design research which requires the accessibility of formal representations across different fields and disciplines.”²²⁷

The use of formal methods has posed design as a procedure which depends on defining relationships and the willingness and ability of the designer to consider the relationship-definition phase as an integral part of a broader design process. It requires the designer to take a step back from the activity of design and focus on the logic that binds the design together. This process of relationship creation requires a

²²⁵ Ibid.

²²⁶ Ibid.

²²⁷ Mennan, “Mind the Gap: Reconciling Formalism and Intuitionism in Computational Design Research.”, pp. 36.

formal notation and introduces itself as an additional concept that had not previously been considered as part of design thinking.²²⁸

Formal methods can be implied at a number of levels. The first level consists in what can be called as lightweight formal methods, which is a mixed use of formal and non-formal languages. Therefore, it does not require full formalization. The highest level of formal methods, referred as heavyweight occurs when the full formalization process can be fully computer-read.²²⁹ For architects who do not have abilities or who do not want nor have interest in directly using formal languages such as coding, “there still exists this secondary exposure to the logics of numerical representations and software development”.²³⁰ Most platforms that are based on formal languages also provide a visual interface for architects.

In the architectural discipline, the design of the systems that consist of elements combined with rules are also referred as computational design.²³¹ Computational design as method of formalization in architectural design, took off in the 1960's, and already became a well-established design method.²³² Ideas related to the utilization of computational design to increase participation in architectural design have been in the research agenda for more than half a decade. The ideas related to the widening of the single authorial paradigm in architecture were proposed for the first time as the main theme of a conference in 1971: the “*Design Participation Conference*” which brought together researchers with shared interests in utilizing new approaches for increasing participation in the design process²³³. In his conference paper, Nicholas Negroponte mentioned that:

²²⁸ Woodbury, Robert. *Elements of Parametric Design*. Routledge, 2010.

²²⁹ Almeida, José Bacelar, et al. “An Overview of Formal Methods Tools and Techniques.” *Rigorous Software Development*, Springer, 2011, pp. 15–44.

²³⁰ Michalatos, Panagiotis. “Design Signals: The Role of Software Architecture and Paradigms in Design Thinking and Practice.”

²³¹ Menges, Achim, and Sean Ahlquist. *Computational Design Thinking: Computation Design Thinking*. Wiley, 2011.

²³² Ibid.

²³³ Cross, Nigel. “Foreword.” *Design Participation Proceedings of the Design Research Society's Conference*, 1972, pp. 4–5.

“Two apparently untreated movements have marked the development of theory of architecture in the past five years- that of participation and that of computation. In one case, we are talking about providing users of physical environments with a higher level of input to the criteria for design as well as to the design itself. In other case we are dealing with computers that aid the designer. One obvious convergence for these two growing lines of research occurs by making the user in participation be the designer in computation.... I will call concurrence of participation and computation, responsive architecture; to be vigorously distinguished from flexible architecture, manipulative architecture or (even) adaptable architecture.”²³⁴

In addition to Nicholas Negroponte, some other participants of the conference included Yona Friedman, Charles Eastman, William Mitchell and Christopher Jones, whose works have pioneered the research track of design rationalization and the process of making architectural design process more transparent, which ultimately is important in increasing participation in the design process and fostering the cultivation of an architectural knowledge ecosystem.

4.2 The Selected Conferences and Exhibitions

The following sections aim to form a genealogical study of exhibitions and conferences marking a leap towards the cultivation of an architectural knowledge ecosystem. This will be achieved through detailed examination of selected case-study projects that are parallel to the issues and problems that have been highlighted in the previous chapters, related to the total dissolution of authorship and the cultivation of an architectural knowledge ecosystem.

The example projects are selected up from the 1970's until today (2018), ranging almost five decades, which constitute the scope of inquiry.

²³⁴ Negroponte, “Aspects of Living in an Architecture Machine.”

4.2.1 Design Participation Conference (1971)

The *Conference on Design Methods* (1962), held in London, laid the origins of The Design Research Society, which was founded in the UK in 1966. The Design Research Society enabled a group of people who had shared interests in new approaches to the design process to come together. The society held its first international conference on Design Participation in Manchester, 1971.²³⁵ The proceedings of the Design Research Society's conference were edited by Nigel Cross.²³⁶

In this conference, Negroponte remarked that in the previous 5 years the need and the idea of user participation had surfaced in the design field, both in education and practice; and that the interest in participation was a consequence of the general feeling that architecture had been inadequate and unresponsive to the needs and desires of its users.²³⁷ Regarding user participation, the works presented in the conference appeared to point towards a democratization of decision-making.²³⁸

The conference brought together architects, urban planners, architectural critics, artists and scientists, whose interests in blurring the distinction between designer and user overlapped. These contributors covered a wide range of multidisciplinary topics grouped by Nigel Cross in his edition of the proceedings as: social technology, participation in design and planning, adaptable environments, computer aids and design methods.²³⁹

The outcome of the conference has brought forth discussions of do-it-yourself, democratization, adaptable environments, user-responsiveness and personalization to the architectural discourse, with the common agreement on the fact that the

²³⁵ International Conference “*Design Participation*” at Manchester University, 1971, UK. Conference proceedings edited by Nigel Cross.

²³⁶ Cross, “Foreword.” *Design Participation Proceedings of the Design Research Society’s Conference*.

²³⁷ Negroponte, “Aspects of Living in an Architecture Machine.”

²³⁸ Negroponte, *Soft Architecture Machines*.

²³⁹ Cross, Nigel. “Here Comes Everyman.” *Design Participation Proceedings of the Design Research Society’s Conference*, 1972, pp. 11–13.

traditional planning and design process were ceasing to achieve desired goals and were becoming obsolete. Accordingly, new design methods and models were proposed by the contributors for a reorientation of knowledge and power between stakeholders during the design process, a real transfer of power on design decisions, and a redefinition of the relationship between architecture and its user.²⁴⁰ At the *Design Participation Conference*, Reyner Banham made the following remark:

“One begins to have the feeling that participatory design is, in Donald Schön’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. But the presence of 250 souls at this conference is a fair indication that it is not quite a dead issue yet...Do-it-yourself is the only real design participation. When resources are in the hands of ‘the people’ and ‘the people’ invent their own rules for the game, then I think design participation is getting somewhere.”²⁴¹

The research questions Reyner Banham has raised challenged professional expertise and the concept of professionalism. He used the term ‘do-it-yourself’ within architectural discourse, referring to a concept of participatory design that takes advantage of new technologies in order to achieve personalization.

Herein, the *Design Participation Conference* has been chosen as a milestone for the cultivation of an architectural knowledge ecosystem due its importance in raising the need for architectural design to connect with society and suggesting increased user participation in the design process. The general contribution of the conference was important to highlight that traditional architectural tools, such as drawings and plans, are not sufficient for an efficient integration of non-expert actors in the design process and to achieve a shared language between diverse design parties. Increased user participation requires a new language beyond traditional design and representations methods, calling for a rethinking of the role of technology.

²⁴⁰ Ibid.

²⁴¹ Banham, “Alternative Networks for the Alternative Culture.”

In this chapter, the design models suggested by Charles Eastman (Adaptive Conditional Architecture, Yona Friedman (Flatwriter), and Nicholas Negroponte (Design Amplifiers) are selected to be studied in detail. Many design models presented in the conference proposed the use of formal languages and computation to increase user participation. However, these three design models were specifically chosen because each one represents a different approach in user-design model interaction. Almost five decades afterwards, these proposed designs models (Adaptive Conditional Architecture, Flatwriter, and Design Amplifiers) are still at the focus of recent research agendas in formalization and computational architecture.²⁴²

Friedman, Eastman, Negroponte and their contemporaries had produced their models as technological imaginaries of the 60's and 70's as speculative computational rendering of future design models.²⁴³ However, the available computational power and tools of the time were not adequate to actualize these computational envisions. Only after another decade, the digital technologies, software and hardware systems required to actualize and materialize those imaginaries would start to become available. The research of John Frazer would develop and actualize these ideas of pioneers related to utilization of computation for further distribution of design process among numerous actors and ultimately among a knowledge ecosystem.²⁴⁴

4.2.2 An Evolutionary Architecture (1995)

The “*An Evolutionary Architecture*” Exhibition was held in 1995 at the Architectural Association, London.²⁴⁵ John Frazer edited the “*An Evolutionary Architecture*” book to coincide with the exhibition.²⁴⁶ Frazer explains the content of

²⁴² Vardouli, “Who Designs? Technological Mediation in Participatory Design.”

²⁴³ Ibid.

²⁴⁴ Frazer, *An Evolutionary Architecture*.

²⁴⁵ Exhibition “*An Evolutionary Architecture*” at the Architectural Association, 1995, London, UK.

²⁴⁶ Frazer, *An Evolutionary Architecture*.

the exhibition and book as “the first attempt to publish an overall description of the objectives and achievements of work which began more than thirty years ago, when I arrived at the Architectural Association as a student, and continues still in the AA’s Diploma Unit 11.”²⁴⁷

The exhibition is named “*An Evolutionary Architecture*” in order to indicate the biological and scientific analogies and to introduce concepts such as the principles of morphogenesis, genetic coding and biodiversity in architecture. An Evolutionary Architecture utilizes natural science and the developing theories of cybernetics, complexity and chaos. In this perspective, architectural form evolves from natural forces, especially including those of society.²⁴⁸ In other words, it’s not only structural, material and environmental types of input that shape design, but social ones as well.

According to Frazer, in post-industrialization, profound cultural and technical changes are reshaping our understanding of the world, with great impact on many fields, including architecture. Frazer mentions that the era is characterized by a shift of perception, from a universe of objects to one of relationships, as follows:

“In industrial design the all-embracing concept of mass production for a homogeneous international market has given way to a search for a new flexibility in design and manufacture. The distinguishing characteristic of this approach is that it focuses on the dynamic processes of user experience rather than on physical form...Design is now 'beyond the object'.”²⁴⁹ With this goes a shift from specialisation to generalisation, from the self-conscious to the unselfconscious, from linear relationships to complex webs. Our emerging new worldview is characterised as decentralised, desynchronised, diverse, simultaneous,

²⁴⁷ Ibid.

²⁴⁸ Ibid.

²⁴⁹ Ibid.

anarchic, customerised ... Key concepts are information, sustainability, participation, emergent properties ...”²⁵⁰

The new approaches mentioned by Frazer induce some changes in the traditional working methods of architects. He suggests that architects need to be better prepared to incorporate the concept of client- and user-participation in the process, and ultimately “a rich genetic pool of ideas” can be achieved in architectural design process.²⁵¹

The role of the architect in this process is not the design of final form, but instead the design of the evolution process. The new role of architects becomes to design the inner logic rather than the external form by means of generative rules; Conversely, handling the design of the final form to other actors does not diminish the architect’s role in the overall design process: it enhances the role of the architect, which develops into engaging with more actors in design, both human and non-human, and “to seed far more generations of new designs than could be individually supervised, and to achieve a level of sophistication and complexity far beyond the economics of normal office practice.”²⁵² For such purposes, Frazer mentions the need for the development of tools other than traditional ones as follows:

“Our present search to go beyond the 'blueprint' in architecture and to formulate a coded set of responsive instructions (what we call a genetic language of architecture) may yield a more appropriate metaphor... Throughout this project it has been necessary to design and develop our own tools: our own computer software, our own computer languages and, in some cases, our own prototype computer hardware.”²⁵³

Accordingly, instead of transferring design concepts via blueprints and drawings, “the concepts are described in a genetic language which produces a code script of

²⁵⁰ Frazer, John. “The Architectural Relevance of Cyberspace.” *The Digital Turn in Architecture 1992-2012*, edited by Mario Carpo, Wiley, 2013, pp. 49–52.

²⁵¹ Frazer, *An Evolutionary Architecture*.

²⁵² *Ibid.*

²⁵³ *Ibid.*

instructions for form generation”.²⁵⁴ This kind of expressions of architectural concepts as generative rules enable their evolution and development to be accelerated and tested by computer models. Since numerous evolutionary steps can be generated very fast, the emergent forms sometimes can be unexpected.

Frazer uses an analogy to genetic code for the concept of the evolutionary architecture model. The new role of the architect, as mentioned above, is to design a “genetic” code comprising the information of the design system with elements and rules for how to combine them. This “genotype” does not constitute the final product, but supplies the instructions that describe the process of building the “phenotype”. Rather than the architect, other actors in the design process generate the final form by assigning fixed values for “genotype”.²⁵⁵

The discussion about the genotype-phenotype differentiation is further developed in the “*Non Standard Architectures*” Exhibition as that between norm and form, specifically in Bernard Cache’s arguments on the condition of the object and his development of the concept of ‘objectile’.²⁵⁶ The narratives genotype / phenotype, norm / form and object/objectile contribute to the same idea of a new design model in which architectural authorship is split between more agents, “on one side, the designers of the general function; on the other, its final customisers, or interactors”.²⁵⁷

4.2.3 Non Standard Architectures (2003-2004)

The international architectural exhibition “*Architectures Non Standard*” (Non Standard Architectures) took place between 2002 and 2003 at the Centre Pompidou, Paris. The exhibition was curated by Frederic Migayrou and Zeynep Mennan.²⁵⁸

²⁵⁴ Ibid.

²⁵⁵ Ibid.

²⁵⁶ Cache, Bernard. *Earth Moves the Furnishing of Territories*. The MIT Press, 1995.

²⁵⁷ Carpo, “Introduction.” *AD Reader The Digital Turn in Architecture*

²⁵⁸ International exhibition “*Architectures Non Standard*” at the Centre Pompidou, 2003-2004, Paris, France. Curators: Frédéric Migayrou, Zeynep Mennan.

Mennan notes that the exhibition “has been named after a mathematical analysis and through the bias of multiple external fields into which this latter extends”²⁵⁹ and that the term “non-standard” indicates “epistemological, perceptual, geometric/mathematical and technological” distinctions.²⁶⁰ It represents a new paradigm in the architectural context with extensive use of computational design technologies and use of formal language.²⁶¹ Standardization is associated with sameness, uniformity and thereby impersonality and individual being eliminated in the process. Alternatively, non-standard is related to the non-identical, the varied and the heterogeneous, and thus to personalization, the individual, the subjective and the intuitive.

The closed design processes have become progressively transparent as the use of formal/computational languages in design increases. As mentioned above, the use of formal methodologies in architecture requires a different way of design thinking from traditional approaches, as it requires the designer to take a step back from the activity of design and to focus on defining parts, relationships and the logic that binds the design together. Mennan highlights: “The formalist methodologies used in computational design research ease the understanding and control of complex forms and enable their production by extending the interface from standardization to non standardization.”²⁶² Accordingly, formalist methodologies enable design to be more open to participation of various agents including non-designer actors.²⁶³

Works of twelve international architectural firms (Asymptote, dECOi Architects, DR_D, Greg Lynn FORM, KOL/MAC Studio, Kovac Architecture, NOX, Objectile, Oosterhuis.nl, R&Sie, Servo and UN studio) were presented together with selected 272 images of works of art and science, buildings and designs that curators considered as precursors of the “non-standard”. From the exhibited designs, the works of Bernard Cache (Objectile) and Kas Oosterhuis (Distributed Being) which

²⁵⁹ Mennan, Zeynep. “The Question of Non Standard Form.” *METU JFA*, vol. 25, no. 2, 2008, pp. 172.

²⁶⁰ *Ibid*, 171.

²⁶¹ *Ibid*.

²⁶² *Ibid*, 172.

²⁶³ *Ibid*.

exhibit participatory design characteristics, are selected in the context of this thesis for a discussion that will follow in later sections of this chapter.²⁶⁴

The works of these architects were presented through prototypes, physical models and drawings along with a digital model. Visitors were allowed to experiment directly with the design tools to produce these “non-standard” forms through interaction with the design models by assigning variables to their attributions. As a result, the visitor of the exhibition could also become the designer of the form/object/phenotype, who personalizes and customizes the norm/objectile/genotype. Mennan describes this as: “A new notion of form, gives rise to the notion of fluctuating norm, one which is in constant redefinition in an open ended series formed by the non-determinacy of a formal catalogue.”²⁶⁵ The variability allowed the interaction of visitor operates through with the limits of norm.

4.2.4 Naturalizing Architecture (2013-2014)

The international exhibition *Naturalizing Architecture* was curated by Marie-Ange Brayer and Frédéric Migayrou, as the 9th *ArchiLab* exhibition.²⁶⁶ The exhibition took place between 2013 and 2014 at the FRAC Centre, Orléans, France, that covered the exhibition and related symposium series under three main topics: architecture as ecosystem, formalization and material behaviors. The projects of over forty architects, designers and artists were brought together in the exhibition. The exhibition covered prototype models, digital shows and screenings and experimental pavilions, along with interactive environments with which the visitors could engage.

The exhibited projects shared a common interest in the theories and methodologies of nature oriented scientific fields of biology, computer science, engineering, and

²⁶⁴ Servo and UN Studio who has participated in the exhibition has mentioned in the context of the previous chapter.

²⁶⁵ Ibid, 173.

²⁶⁶ International exhibition “*Naturalizing Architecture*” at the FRAC Centre, 2013-2014, Orléans, France. Curators: Marie-Ange Brayer and Frédéric Migayrou.

mathematics.²⁶⁷ In the interview for AD Magazine, Frédéric Migayrou states that the *Naturalizing Architecture* exhibition focuses on the discussion of how

“architecture now overlaps with the sources of molecular biology, even in processes of replication, transcription and translation of genetic material. In this way, architects can introduce complex models based on processes involving the self-generation of matter and incorporating programmatic, social, material and environmental variables. Control of these processes turns hybridization into a new architectural order.”²⁶⁸

In the context of the exhibition, *Naturalizing Architecture* represents a narrower perspective that does not cover the meaning attributed to naturalization in epistemology, defining the term only as a closer relationship of architecture with natural sciences and natural environment than engaging with issues of formalization. Mennan states that the issue of complexity management sustains and promotes naturalization and formalization as two main operational forms related with research within the analytico-cognitive sphere.²⁶⁹ Referring to Jean-Michel Salanskis, who explains that the “natural is generally defined as that which has the power of evoking a scientific language of reference,” Mennan continues: “Naturalization accounts for an objectification of cognitive and spiritual processes, expressed in an ever-growing accuracy of translation into a universal and semantic free numerical language, contributing to the unilateralization of formal languages”.²⁷⁰ On the other hand, in the exhibition catalogue Rivka Oxman notes that in the exhibition, naturalization is a term used

²⁶⁷ Oxman, Rivka. “Naturalizing Design: In Pursuit of Tectonic Materiality.” *Naturalizing Architecture Archilab 2013*, edited by Marie-Ange Brayer and Frédéric Migayrou, 2013, pp. 106–21.

²⁶⁸ Basulto, David. “AD Interviews: Marie-Ange Brayer & Frédéric Migayrou / 9th ArchiLab, Naturalizing Architecture.” *Archdaily*, 2013, <https://www.archdaily.com/430175/ad-interviews-marie-ange-brayer-and-frederic-migayrou-9th-archilab-naturalizing-architecture>

²⁶⁹ Mennan, “Mind the Gap: Reconciling Formalism and Intuitionism in Computational Design Research.”

²⁷⁰ *Ibid.*

“to define a syndrome of diverse design phenomena that derive from our ability to digitally model and fabricate based upon processes similar to the phenomena of natural environment. In analogy to the way that nature behaves, naturalization is also predicated upon the ability to integrate morphogenesis and emergence into a linked informed holistic design process.”²⁷¹

Naturalizing Architecture exhibition and related symposium series are valid for the context of this thesis, in their contribution of use of formal methods, especially computational approaches for the dissolution and distribution of the authorship. From the exhibited event works, *METAfolly* by *ecoLogicStudio* and *Bloom: Distributed Urban Game* by *Biothing* are going to be discussed further in relation to enhanced distribution and interaction.

4.3 The Selected Projects

4.3.1 Interaction Types

4.3.1.1 Adaptive Conditional Architecture by Charles Eastman

In the *Design Participation* conference, Charles Eastman mentioned that even though many quantitative and qualitative measures are taken into account during the design process, in many cases the final designs, still would “not respond to future changes of context or evolutions in the users’ activities”.²⁷² For this reason, Eastman proposed an “*Adaptive-Conditional Architecture*” as a split of architectural authorship between multiple agents. *Adaptive-Conditional Architecture* is a design model aiming to accomplish a measure of fit between function and environment, with a focus on three principal issues: designing for anonymous users, designing for unpredictable behavior in new environments and designing for activity patterns

²⁷¹ Oxman, Rivka. “Naturalizing Design: In Pursuit of Tectonic Materiality.”

²⁷² Vardouli, “Who Designs? Technological Mediation in Participatory Design.”

which change over time.²⁷³ The contribution of adaptive conditional architecture to design participation is the proposal of a design system that would adapt to individual requirements of anonymous users and functions, instead of designing an environment for a single user. *Adaptive-Conditional Architecture* exploits the development of software techniques that would allow hardware of architecture to become responsive to users and, accordingly, to offer personalized environments for users.²⁷⁴

The major principle of *Adaptive-Conditional Architecture* is in rethinking design in order to take advantage of the role of technology and computation via sensing devices, decision algorithms, change mechanisms and control setting features.²⁷⁵ These four mechanisms enable Eastman's design model to sense the changes in the user's environment and respond accordingly. However, this system is not designed to send any feedback to the user nor environment. Accordingly, Eastman's *Adaptive-Conditional Architecture* design model is an example of linear interaction between user and design model (Figure 12).

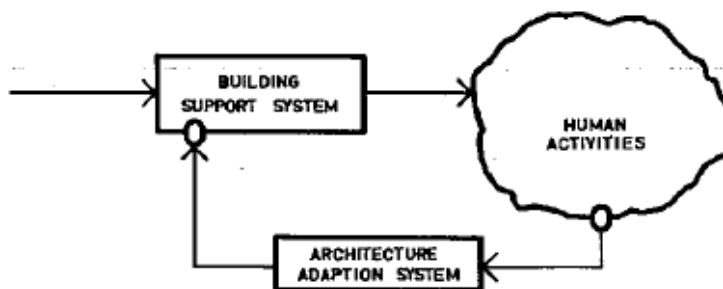


Figure 12. Elements of the Adaptive-Conditional Architecture

(Source: Eastman, Charles. "Adaptive-Conditional Architecture." *Design Participation Proceedings of the Design Research Society's Conference*, 1972, pp. 54)

²⁷³ Eastman, Charles. "Adaptive-Conditional Architecture." *Design Participation Proceedings of the Design Research Society's Conference*, 1972, pp. 51–57.

²⁷⁴ Ibid.

²⁷⁵ Cross, "Here Comes Everyman."

4.3.1.2 Flatwriter by Yona Friedman

Yona Friedman had been experimenting with the ideas about the distribution of architectural authorship, design participation and design democratization for over a decade before the *Design Participation Conference*. Friedman's proposal for housing shortage in France during the late 1950's was a "*Spatial City*". A systematic mega-grid (Figure 13) that reflects Friedman's vision that everyone has an individual part to play in design decision-making and that designs should allow for the free will of the individual inhabitant.²⁷⁶



Figure 13. Spatial City

(Source: MOMA. *Spatial City* by Yona Friedman.
<https://www.moma.org/collection/works/800>. Accessed 30 June 2018.)

Friedman's contribution in the Design Participation was related to the proposals he raised in his book *Pour Une Architecture Scientifique*.²⁷⁷ Friedman published "*Pour Une Architecture Scientifique*", where he set out the idea of the "*Flatwriter*", two years after Herbert Simon published his highly influential book "*Sciences of Artificial*" (1969) and while five years earlier Christopher Alexander had developed his arguments for logic and objectivity in design in his book "*Notes on the Synthesis of Form*" (1964). Only in 1975 "*Pour Une Architecture Scientifique*" was published

²⁷⁶ MOMA. *Spatial City* by Yona Friedman.
<https://www.moma.org/collection/works/800>. Accessed 30 June 2018.

²⁷⁷ Friedman, Yona. *Pour Une Architecture Scientifique*. 1971.

in English with the title “*Towards a Scientific Architecture*”.²⁷⁸ His conference presentation, “*Information Processes for Participatory Design*”, highlighted the importance of replacing the single user by masses of people, and he suggested *Flatwriter* as a design model.

Flatwriter is a repertory system based on a complete list of possible space divisions, linkages and labeling; and a warning system to inform the client about the advantages and disadvantages of linkages.²⁷⁹ *Flatwriter* gives the user freedom to choose any possible assemblage and eliminates the professional designer from the design process. However, the role of the designer is not totally eliminated, instead it shifts from being responsible for the finalization of the design to that of the rule maker, the one who prepares the repertory.²⁸⁰

The main difference between Eastman’s *Adaptive-Conditional Architecture* model and Friedman’s *Flatwriter* model, is that *Flatwriter* is not only allowed to react, but also to interact with the user by means of the warning system that provides a feedback to the user from the design model (Figure 14). Accordingly, the *Flatwriter* design model is an example of circular interaction between user and the design model.

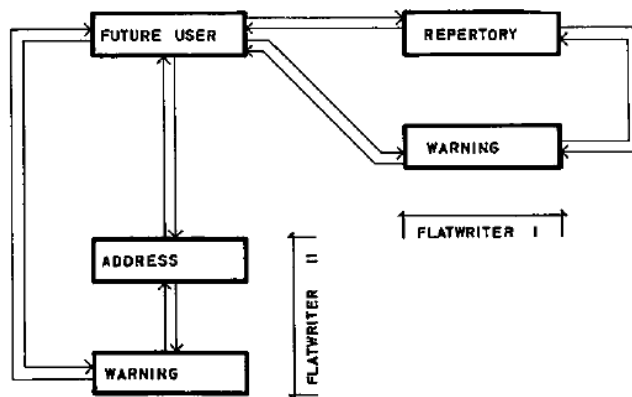


Figure 14. Warning system in Flatwriter

(Source: Friedman, Yona. “Information Processes for Participatory Design.” *Design Participation Proceedings of the Design Research Society’s Conference*, 1971, pp. 49).

²⁷⁸ Friedman, Yona. *Towards a Scientific Architecture*. The MIT Press, 1975.

²⁷⁹ Friedman, Yona. “Information Processes for Participatory Design.” *Design Participation Proceedings of the Design Research Society’s Conference*, 1971, pp. 45–50.

²⁸⁰ Ibid.

4.3.1.3 Design Amplifiers by Nicholas Negroponte

In 1967, Nicholas Negroponte founded MIT's *Architecture Machine Group*, with Leon Groisser, as a laboratory of architecture, engineering and computing. Aspects of *Architecture Machine Group* include attributing physical environment knowledge, common sense, intelligence and other aspects that are necessary to make the built environment responsive. The group's work was focused on the envisioning of computational machines as active partners in the design process by incorporating ideas from Gordon Pask's conversation theory (related in chapter 2) and artificial intelligence.²⁸¹

"*Design Amplifiers*" design model is a proposal for a computational machine enabling users to create their own designs. In the *Design Participation Conference*, Negroponte presented his paper titled "*Aspects of Living in an Architecture Machine*".²⁸² This paper does not talk directly about *Design Amplifiers*, but instead lays the foundation for the ideas of user empowerment during the design process. In 1975, Negroponte presented the *Design Amplifiers* in his book *Soft architecture machines*.²⁸³ The main idea behind *Design Amplifiers* is very similar to Friedman's "Flatwriter" that works as a repertoire for a non-expert user.

Negroponte's *Design Amplifiers* differs however from Friedman's *Flatwriter* in the way it interacts with the user. Negroponte believed a learning period is necessary for design participation software. He identifies the three aspects of intelligence behind *Design Amplifiers* as recognizing, responding and learning, and discusses alternative examples achieved through computation.²⁸⁴ Accordingly, the interaction type between user and the design model in *Design Amplifiers* is an example of circular interaction that involves learning.

In Eastman's *Adaptive-Conditional Architecture* and Friedman's *Flatwriter*, the user interaction with the design model is based on eliminating user's subjectivity through

²⁸¹ Negroponte, Nicholas. *The Architecture Machine: Toward a More Human Environment*. The MIT Press, 1970.

²⁸² Negroponte, "Aspects of Living in an Architecture Machine."

²⁸³ Negroponte, *Soft Architecture Machines*.

²⁸⁴ Ibid.

mechanizing the user interventions to the model.²⁸⁵ In this sense, the design model is limited to act as a support rather than a co-design agent. Yet, Negroponte's "*Design Amplifiers*" had intentions to humanize machine so that the design model could learn, react and converse with the user.²⁸⁶ This type of interaction between the model and the user enables the design model to act as a co-design partner.

4.3.2 Computational Realizations of Earlier Technologic Envisions

As mentioned above, during the 60's and 70's, Eastman, Friedman, Negroponte and their contemporaries had produced their models as computational envisions.²⁸⁷ The digital technologies, the required software and hardware systems to actualize and materialize those imaginaries would only become available after another decade. The research of John Frazer would develop and actualize these ideas of pioneers, specifically Cedric Price and Walter Segal, related to the utilization of computation for further distribution of design process among numerous actors.²⁸⁸

Cedric Price had been working on ideas related to challenging professional expertise and dissolution of architectural authorship, together with Paul Barker, Peter Hall and Reyner Banham who had also presented these ideas in the 1971 *Design Participation Conference*.²⁸⁹ They published '*Non-Plan: an experiment in freedom*' in 1969 in the *New Society* magazine.²⁹⁰ They were concerned with the fact that architects and planners had been imposing their own aesthetic choices on users, who might prefer other choices of their own. Thus, they suggest the *Non-Plan* project as a design experiment as a real transfer of power in the design process.

At the time, *Non-Plan* was criticized not only for being very provocative but also for its user empowerment, which could possibly be contentious to the established order

²⁸⁵ Vardouli, "Who Designs? Technological Mediation in Participatory Design."

²⁸⁶ Ibid.

²⁸⁷ Ibid.

²⁸⁸ Frazer, *An Evolutionary Architecture*.

²⁸⁹ Banham, "Alternative Networks for The Alternative Culture

²⁹⁰ Banham, Reyner, et al. "Non Plan: An Experiment in Freedom." *New Society*, no. 335, 1969.

and controlled uniformity of the built environment.²⁹¹ However, the ideas of *Non-Plan* were a breakthrough because of the involvement of people during the design of their environments, empowering them during the planning process and letting them shape the environment they want to live and work in.²⁹² Cedric Price also worked on other architectural design models fostering user participation in the architectural design process such as the *Generator Project*. He got in touch with John Frazer as a computer consultant for computational realization of his ideas related to distribution of architectural authorship.²⁹³

4.3.2.1 Generator Project

In 1978 Cedric Price contacted John Frazer to work with his team as computer consultants on the Generator project. The project was commissioned by Howard Gilman for a site in Florida to provide a facility to host visiting artists and performances such as dance, theater.²⁹⁴ Cedric Price's proposal for the Gilman was a series of rectangular prisms that could be moved on a permanent grid of foundation and combined to create temporary spaces for housing, rehearsal, performance and other functions (Figure 15). The project was designed as a kit of parts that could be rearranged to meet the changing requirements of the client.

²⁹¹ Hughes, Jonathan, and Simon Sadler. *Non-Plan: Essays on Freedom, Participation and Change in Modern Architecture and Urbanism*. Routledge, 2000.

²⁹² Banham and et al. "Non Plan: An Experiment in Freedom."

²⁹³ Frazer, J. (1995). *An Evolutionary Architecture*. Architectural Association Publication.

²⁹⁴ MOMA. (n.d.). Cedric Price Generator Project. Retrieved June 30, 2018, from https://www.moma.org/collection/works/895?artist_id=7986&locale=en&page=1&sov_referrer=artist



Figure 15. Generator Project design concepts, perspective sketch and axonometric of model

(Source: MOMA. *Cedric Price Generator Project*.

https://www.moma.org/collection/works/895?artist_id=7986&locale=en&page=1&sov_referrer=artist Accessed 30 June.

2018 https://www.moma.org/collection/works/879?artist_id=7986&locale=en&page=1&sov_referrer=artist Accessed 30 June.

2018 https://www.moma.org/collection/works/104701?artist_id=7986&locale=en&page=1&sov_referrer=artist Accessed 30 June 2018.)

John Frazer produced a computer algorithm to organize the layout of the site in response to changing requirements. Accordingly, the computer enables the client, visitor, or user to design a new layout to for changing functional requirements. The model of interaction between user-design of the *Generator* is similar to Negroponte's *Design Amplifiers* such that the design model could react, learn and converse with the user. Frazer mentions that

“We intended the Generator to learn from the alterations it made to its own organization, and coach itself to make better suggestions. Ultimately, the building itself might be better able to determine its arrangement for the users' benefit than the users themselves. This principle is now employed in environmental control systems with a learning capability... This would have created an 'intelligent' building which controlled its own organization in response to use....”²⁹⁵

Accordingly, the computational model of the *Generator Project* would act as a co-design partner that encourages the visitor to continually refine and improve his or her design and suggest alternative arrangements (Figure 16).



Figure 16. Generator Project computer interface

(Source: MOMA. *Cedric Price Generator Project*.

https://www.moma.org/collection/works/870?artist_id=7986&locale=en&page=1&sov_referer=artist Accessed 30 June 2018

https://www.moma.org/collection/works/1076?artist_id=7986&locale=en&page=1&sov_referer=artist Accessed 30 June 2018.)

4.3.2.2 Segal Method

In the late 70's, as a response to the London's housing crisis, Lewisham council brought a vacant site into use for housing for self-builders in South London. The first project, *Phase One*, started in 1979, and the success brought the need for a second

²⁹⁵ Frazer, *An Evolutionary Architecture*.

phase that started in 1984. In total, twenty-seven families were given a piece of a plot to construct their own houses.

Walter Segal was commissioned to direct the self-build scheme and he laid the set of principles for the self-builders. He developed an adaptable timber frame housing method (Figure 17) that is easy to manipulate so that self-builders could be self-designers as well. This method, referred to as the *Segal Method*, had implications that reached beyond the simple construction of Lewisham council houses: It could produce many types of houses, one and two story buildings with flat or pitched roof, courtyards, split levels and double height space.²⁹⁶

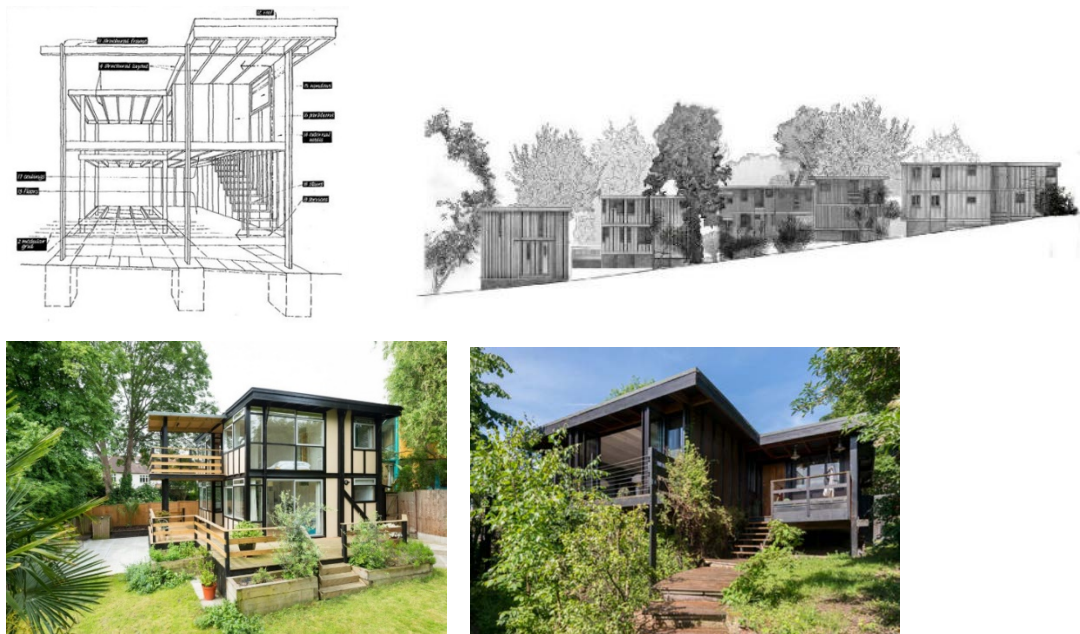


Figure 17. Lewisham houses general arrangement, section, two built houses

(Source: Broome, Jon. "Segal Method." *Architects' Journal*, vol. 189, no. 25, 1988.

Global Studio Praxis. *Walter Segal Self-Build Houses*.

<https://studioglobalpraxis.wordpress.com/studio-actions/postcards/walter-segal-self-build-housessegal-close-and-walters-way/> Accessed 30 June 2018.

On the Market: Walter Segal-Designed Modernist Property.

<https://www.wowhaus.co.uk/tag/walter-segal/>. Accessed 30 June 2018.)

John Frazer and his team developed an interactive machine-readable modelling kit for the computation of the *Segal Method*. The model enabled the self-designers to

²⁹⁶ Broome, J. (1988). Segal method. *Architects' Journal*, 189(25).

arrange the components in the physical model on an electronic panel. Every design element, such as 128 different types of panels, doors, windows, is labeled with an eight-bit code. This allowed a digital processor to automatically scan the model and identify all the parts and their locations so that it can automatically generate the plan of the building. In addition to these, the computational model could interpret the plan to produce area calculations, schedules, drawings and three-dimensional views.

²⁹⁷

By using this computational physical model (Figure 18), a self-builder with no knowledge of architecture could not only create buildable designs according to Segal's method, but also design alternatives and quickly evaluate them in relation to some aspects, such as cost.²⁹⁸ In 1982, the working computational model was completed. Even though Walter Segal, as the original derring of the system, was very excited about the model, his sudden death prevented the design model to be further experimented.²⁹⁹ Frazer explains this aspect of the model as:

“We had some of Segal’s ideas literally preserved in silicon and could have continued with the project after his death. On this occasion we decided not to, but it is an interesting notion that architects' ideas could be made permanently available in this way. Quite unlike a design 'in the style of', it would allow others to create projects using the actual generating programs used by deceased architects - a bizarre prospect given the strangeness of using these programs when the architect is alive. The Segal project showed us that there was real potential for client and user-involvement in design and a new potential for immortality for the architect.”³⁰⁰

In other words, the most important aspect of the computational model of *Segal Method* is that it incorporated Walter Segal's design rules and much more of his

²⁹⁷ Frazer, *An Evolutionary Architecture*.

²⁹⁸ Ibid.

²⁹⁹ Ibid.

³⁰⁰ Ibid.

expertise. As a result, people without any knowledge of architecture or computers could design a house by building a simple model.³⁰¹

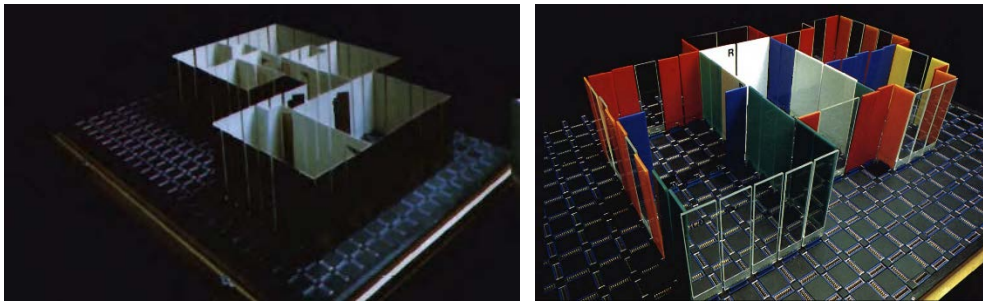


Figure 18. Segal Method self-builder computer interface

(Source: Frazer, John. *An Evolutionary Architecture*. Architectural Association Publication, 1995.)

The 27 Lewisham houses were self- designed and self-built using the *Segal Method*. The fact that they were self-designed and self-built didn't result in randomness or anarchy. They all contributed to forming a meaningful whole. The role of the architect, Walter Segal, in this process was not the design of final form, but instead the design of the method that would enable everyone to design and build their own houses. As mentioned in the previous subsection, the role of architects becomes to design the inner logic rather than the external form by means of defining design rules. Frazer defines this new role of the architect, as designing a “genetic” code comprising the information of the design system with elements and rules for how to combine them. This “genotype” does not constitute the final product, but supplies the instructions that describe the process of building the “phenotype”.

4.3.3 Design of Norm versus Form

The discussion about the genotype-phenotype differentiation is further developed in the “Non Standard Architectures Exhibition” as norm-form, specifically, Bernard Cache's Object-Objectile arguments.

³⁰¹ Ibid.

4.3.3.1 Objectile by Bernard Cache

The term “objectile”, besides being the name of the architectural firm by Bernard Cache and Patrick Beaucé, defines a new type of object. This definition is created by Bernard Cache and further developed by Gilles Deleuze, in his book “*The Fold: Leibniz and the Baroque*”.³⁰² Deleuze lays foundations of the notion of objectile on the ideas of Leibniz related to the definition of families of curves depending upon one or several parameters. The final object is not defined by an essential form rather it is framed by parameters.³⁰³ Deleuze notes that

“The new status of the object no longer refers its condition to a spatial mold—in other words, to a relation of form-matter—but to a temporal modulation that implies as much the beginnings of a continuous variation of matter as a continuous development of form”³⁰⁴

According to Gilles Deleuze's and Bernard Cache's definitions, Objectile, a new kind of technical object, is not really an "object" but rather an "objectile" in Aristotelian terms: a generic, non-specific object that is no longer designed but calculated.³⁰⁵ Carpo defines the objectile as:

“An objectile is a family or a class of objects that are individually different but all similar, because they all share the same generative algorithm: the same code or mathematical function, or the same genotypic DNA, as it were. In technical terms, an objectile is an open-ended algorithm, or a generative, incomplete notation; and this necessarily means that every final incarnation of an objectile into an individual object requires the intervention of some additional agency that may be other than, and even unrelated to, the objectile's designer.”³⁰⁶

³⁰² Deleuze, Gilles. *The Fold: Leibniz and the Baroque*. The Athlone Press Ltd, 1993.

³⁰³ Ibid.

³⁰⁴ Ibid.

³⁰⁵ Cache, *Earth Moves the Furnishing of Territories*.

³⁰⁶ Carpo, “Authors, Agents, Agencies and the Digital Public.”

In this matter, the difference between genotype and phenotype, norm and form is the same as objectile and object. Objectile comprises not the information of the final form but rather that of the design system with elements and rules for how to combine them; and the object is the final product when fixed values are defined to the attributes of the objectile.

As a result, this type of duality between objectile and object creates two classes of authors: the designer of the objectile and the designer of the object. The role of final designer can be carried by the end-user, customer or client, who personalizes and customizes the general program to make it fit his desires.³⁰⁷ These two authorial roles are separate and independent from one another. The author of the objectile is the author of the modifiable source code. The end-user is the author of the usable artifact assigning values to parameters and turning the generic object into a specific one.³⁰⁸

Tables Projectives is a project that was realized by Bernard Cache and Patrick Beaucé in 2003, as a table design. This project is important to illustrate the logic of Objectile and the notion of differentiated authors of editable source code (objectile, genotype) and final artifact (object, phenotype). “Tables Projective” are designed as nonstandard objects, which are calculated in modelling software and industrially produced using CNC machines. The design and manufacturing of different shapes in the same series from the same source code is achieved by the modification of the design parameters that allowed the mass customization. Anyone could go online to change the parameter values that controlled the geometry of the tables simply by manipulating the sliders, and would be able to immediately see the effects of the changes.³⁰⁹

³⁰⁷ Ibid.

³⁰⁸ Ibid.

³⁰⁹ Kolarevic, Branko. “From Mass Customisation to Design ‘Democratisation.’” *AD Mass-Customised Cities*, vol. 85, no. 6, 2015, pp. 48–53.

Tables Projectives was exhibited for the first time as a part of the “*Non Standard Architecture Exhibition*”.³¹⁰ It was originally planned that the visitors would design their own version of the *Tables Projectives* using the digital model by assigning their preferred values to the attributions. They could experiment with different design alternatives and observe the changes as the results of assigning different values to the attributions (Figure 19). After finalizing their design, in the end of their visit of the exhibition, the *Tables Projectives* version they designed would be already manufactured and be ready for them to be shipped home thanks to a seamless process that directly connected design to fabrication.



Figure 19. Tables Projectives

(Source: Carpo, Mario. “Pattern Recognition.” *ARCH'IT*, 2006, http://architettura.it/extended/20060305/index_en.htm. Accessed 30 June 2018)

In the *Tables Projectives* project, the visitors - the designers of the object - were able to modify the designs with the limitation set by the original author, or in other words, the designer of the object. For instance, the allowed modifications were limited by the ones that would not change the center of the gravity of the final table design. They were also not able to modify the defining rules set by Cache and Beaucé. As mentioned in the previous chapter, Kas Oosterhuis named this type of design model as project data bases with protective shells. The participants could modify the design

³¹⁰ International exhibition “*Architectures Non Standard*” at the Centre Pompidou, 2003-2004, Paris, France. Curators: Frédéric Migayrou, Zeynep Mennan.

code within the set parameters by the original author with direct access to the database being blocked.³¹¹

4.3.3.2 Distributed Being by Kas Oosterhuis

ONL is the name of the architectural studio founded in 1989 by Kas Oosterhuis and Ilona Lenard. In their mission statement, Kas Oosterhuis highlights that buildings are subject to a digital revolution with a rise in a strong belief in collaborative design and engineering. Architecture and art no longer have a static final image due to the fact that project databases are a part of global networks, and the final behavior and shape is the outcome of multitude of data from these project databases. Accordingly, designing changes its notion from designing the end product to designing the project database.³¹² Oosterhuis defines the nature of this project database as a distributed being:

“What is the nature of a project database? Brian Eno wrote a song titled Distributed Being [from the album Nerve Net (experimental, electronic, jazz album) with Robert Fripp 1992]. That is exactly what a project database is: a distributed being... A project database is a being in evolution. It is not a static thing; it transforms after each input... These transformations are triggered by different actors, by different stakeholders in the design process, by the clients, by external circumstances, by the experts, by a new piece of software, by passengers, by the changing circumstances of the weather... (as a result) you may start thinking of a project as a distributed being.”³¹³

Oosterhuis also makes an emphasis on the fact that the concept of distributed being, with regard to collaborative design, ultimately constitutes a powerful tool for direct democracy. In the process of direct democracy, participators are not only experts, but

³¹¹ Oosterhuis, *Hyperbodies: Toward an E-motive Architecture*.

³¹² Ibid.

³¹³ Ibid.

also the clients, citizens, friends, accidental users and passengers. Everyone can become a participator in the design process.³¹⁴ Consequently, the distributed project is an open source architecture. The source code is free for the stakeholders to view, use, change and adapt.³¹⁵

Variomatic House is a housing project that is designed by ONL in 1999, as an example to what they call as distributed being. This project offers a web based parametric design tool for the future client. The *Variomatic House* (Figure 20) is presented as a 3D model on the web, where clients can make changes in the geometry in real-time. As a result, the clients become the co-designers of their house. The source code of the Variomatic has been created at the ONL domain and all possible configurations are built in the computers of the clients via web. Thus, the Variomatic is a distributed being and a multitude of homes created from one source code.³¹⁶



Figure 20. Variomatic House

(Source: Oosterhuis, Kas. *Hyperbodies: Toward an E-Motive Architecture*. Birkhäuser, 2003.)

The Muscle NSA (Figure 21) is a working prototype developed by Oosterhuis. It was exhibited in the context of the *Non Standard Architecture Exhibition*.³¹⁷ The

³¹⁴ Ibid.

³¹⁵ Ibid.

³¹⁶ Ibid.

³¹⁷ International exhibition “*Architectures Non Standard*” at the Centre Pompidou, 2003-2004, Paris, France. Curators: Frédéric Migayrou, Zeynep Mennan.

prototype had the capacity to change its shape by contracting and relaxing through its pneumatic muscles, after which it has been named. It was built to develop the concept for a data-driven architecture that could change shape and content in real-time, such that it could act as a distributed being responsive to the data input by various participants. Oosterhuis notes that “Programmable buildings can reconfigure themselves mentally and physically... (and they) change shape by contracting and relaxing industrial muscles”.³¹⁸ He adds that

“The Muscle NSA never stops calculating the positions of its flocking nodes, based on input values from both the participants and from environmental forces acting upon the structure. The behaviour of the control nodes has become a running process, which keeps running when it has been built. The Muscle NSA keeps reconfiguring itself, and produces complexity and unpredictability in real-time.”³¹⁹



Figure 21. Muscle NSA

(Source: Glynn, Ruairi. “Muscle.” *UCL Interactive Architecture Lab*, 2006, <http://www.interactivearchitecture.org/muscle-hrg-and-onl.html>. Accessed 30 June 2018.)

³¹⁸ Oosterhuis, *Hyperbodies: Toward an E-motive Architecture*.

³¹⁹ Oosterhuis, Kas. “Muscle NSA: A Basis for a True Paradigm Shift in Architecture.” *Hyperbody*, <http://www.hyperbody.nl/research/projects/muscle-nsa/>. Accessed 30 June 2018.

4.3.3 Enhanced Distribution and Interaction

4.3.3.1 METAfolly by ecoLogicStudio

The *ecoLogicStudio* is an architectural and urban design studio co-founded by Claudia Pasquero and Marco Poletto. Studio defines their method as combining systemic thinking, bio and sociologic research, parametric design and prototyping. Besides working on building projects, ecoLogicStudio also participated in important international exhibitions. They participated in the *Naturalizing Architecture* exhibition with a pavilion design called *METAfolly*.³²⁰

Their studio and the pavilion design for this exhibition were influenced by Gregory Bateson's book *Steps to an Ecology of Mind*. According to Bateson, language is created by different types of systems and subsystems, which could be rational systems following rules of logic or irrational systems such as meta-communication.³²¹ Meta-communication is about how a piece of information is meant to be interpreted. The real meaning that is conveyed may be different, contradictory, and even opposite to what is said such as in irony. Accordingly, it is playful and intuitive rather than pure logic.³²²

The architects explained the name choice for the pavilion as: *METAfolly* aims to form "a dialogue with the user enabling the development of a form of meta-language based on material experience, patterns recognition as well as a real-time meta-conversation... It revisits the architectural "folly" type as a synthetic organism." *METAfolly* is designed as a contemporary interpretation of architectural folly, specially *grotto* type where architecture is used as a medium that aims to form a relationship between humans and the natural environment.

The prototype built for *Naturalizing Architecture* exhibition was around 2,55 x 2,60 meters, including a spherical shape with alternative access points to the inside of the

³²⁰ International exhibition "*Naturalizing Architecture*" at the FRAC Centre, 2013-2014, Orléans, France. Curators: Marie-Ange Brayer and Frédéric Migayrou.

³²¹ Bateson, Gregory. *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology*. Jason Aronson Inc., 1987. Accessed 30 June 2018.

³²² Ibid.

structure that allowed access to kids and adults. The pavilion had sensors to capture the user's presence up to an area of 12 x 12 meters.³²³ For this specific exhibition, the behavior of the pavilion was set to mimic the swarm behavior of crickets in a field. However, the computational design process enables the pavilion to be set with other type of behaviors different than mimicking crickets. The behavior set for *Naturalizing Architecture* is explained as:

“When no interaction was present speakers would loop in a random sequence; human presence would increase looping time proportional to distance so that closer speakers would turn quiet for a long time; speed of movement and other parameters would then determine the delay before the speaker would resume normal looping time. Overall the swarm would always escape you but with ever-changing behaviour and sound patterns... The visitor then hears the response and acts accordingly; his/her reaction is then registered and fed back; the loop continues until no more visitors are within the sensitive zone or too many of them overload the system. Multiple behaviors can be tested with simple adjustments to the interaction code..”³²⁴

In *METAfolly*, the interaction between the physical environment, the sonic environment and the visitor is more complex than just a response mechanism or interactive environment. The visitors and the sonic environment are almost conversing through the physical environment and digital model that enables remote and virtual control of the *METAfolly*.³²⁵ In this case, not the design of the physical environment, but the design of the sonic environment is a distributed design by means of computation; and digital and physical models serves as media that enable the user/visitor to control the design of the sonic environment (Figure 22). In other words, even though *METAfolly* is a material system, it aims to work as a

³²³ ecoLogic Studio. *METAfolly*. 2013,
<http://www.ecologicstudio.com/v2/project.php?idcat=3&idsubcat=4&idproj=120>.
Accessed 30 June 2018.

³²⁴ Ibid.

³²⁵ Ibid.

communication system with a focus on enabling a conversation between the digital and physical model and the user/visitor.



Figure 22. METAfolly pavilion, virtual control user interface and motherboard

(Source: ecoLogic Studio. *METAfolly*. 2013, <http://www.ecologicstudio.com/v2/project.php?idcat=3&idsubcat=4&idproj=120>. Accessed 30 June 2018.)

4.3.3.2 Bloom: Distributed Urban Game by Biothing

Biothing is the design research lab founded by Alisa Andrasek, functioning as a transdisciplinary laboratory, transcending disciplinary borders of design, biology, mathematics, and genetics.³²⁶ Andrasek's works have been exhibited at the Centre Pompidou and at the FRAC-Centre, Orléans. She developed *Bloom: Distributed Urban Game* in collaboration with José Sanchez. The main idea was to challenge participatory design by transforming architecture into a social process utilizing crowd-sourcing contexts, with the objective of achieving not just a pavilion, but an interactive urban game of series of follies.³²⁷

Bloom: Distributed Urban Game is commissioned as part of London's 2012 Olympic celebrations. Along with four different locations in London, it was

³²⁶ FRAC. *Biothing* (Alisa Andrasek). http://www.frac-centre.fr/_en/art-and-architecture-collection/biothing-316.html?authID=255. Accessed 30 June 2018.

³²⁷ Andrasek, Alisa, and José Sanchez. *Bartlett Design Research Folios: Bloom Distributed Urban Game*. 2012.

exhibited at the *FRAC Centre* as well.³²⁸ *Bloom* is a modular construction system built by identical pieces that has three alternative possible connection points to be combined with the next piece. Selection of different connection points enables standardized units to generate a different formation.³²⁹

An initial pavilion/structure/folly is constructed at the location by the designers. These follies not only demonstrate the possibilities of the system, but also act as an invitation for interaction and participation. Public was encouraged to change the form of the structure by removing or adding pieces. Removed pieces could be used to initiate the growth of a new folly.³³⁰ Hence, *Bloom* utilizes a crowd-sourced approach for the assembly and creation of pavilions with different forms (Figure 23). Without the interaction of the crowd, the pieces cannot do anything. The pavilion can only emerge as a collective and distributed work of public by putting thousands of pieces together.³³¹ Moreover, *Bloom* aims to trigger the learning process. Andrasek and Sanchez mention that

“The public would learn about patterns and structure by figuring out what structures could stand and how to achieve specific sequences. Collective interaction was expected from the number of units that would be available to the public at every time. The units were proposed to become a token of participation, allowing the public to take them home as a souvenir, adding to concepts of dissipation and entropy of the piece.”³³²

60.000 identical copies of the piece are manufactured from a plastic injection mold for the pavilions.³³³ These units have embedded information encoded into them. As the designers of *Bloom* note, “No matter how randomly participants connect the

³²⁸ International exhibition “*Naturalizing Architecture*” at the *FRAC Centre*, 2013-2014, Orléans, France. Curators: Marie-Ange Brayer and Frédéric Migayrou.

³²⁹ Andrasek and Sanchez *Bartlett Design Research Folios: Bloom Distributed Urban Game*.

³³⁰ *Ibid.*

³³¹ Andrasek, Alisa, and Jose Sanchez. “BLOOM.” *Fabricate: Negotiating Design & Making*, edited by Fabio Gramazio et al., UCL Press, 2014, pp. 98–103.

³³² *Ibid.*

³³³ *Ibid.*

cells, they will always exhibit recognisable behaviours... Future emergent behaviours are pre-seeded into the system by encoding information within the anatomy of a cell.”³³⁴ Even though the distributedly constructed pavilions seem to be random, they are not. Since they are built from a single unit offering alternative ways to be connected with the next unit, there are numerous possible alternatives when many of the pieces come together. Nevertheless, these possible combinations are all computationally predictable, since they are all based on the same geometric system of the aggregation of a standardized unit. A software that could simulate possible geometries in order to test different patterns of growth and structurally stable formations that provided input for the final design of the unit was developed.³³⁵



Figure 23. Different configurations of Bloom Pavilion

(Source: Furuto, Alison. “BLOOM - A Crowd Sourced Garden.” *Archdaily*, 2012, <https://www.archdaily.com/269012/bloom-a-crowd-sourced-garden-alisa-andrasek-and-jose-sanchez>. Accessed 30 June 2018.)

Within the context of the present discussions, the *Bloom* pavilion has an important place due to its being an instance of crowd sourcing in a realized project. The public was encouraged to interact and participate in the building pavilions without any deterministic design control, such as providing pre-planned drawings or a fixed state of design. Yet, their constitutions were not totally random, as mentioned above. The variability and diversity of the constructed pavilions proved that the *Bloom* system allowed adequate room for the contribution and imagination of the public.

³³⁴ Andrasek and Sanchez *Bartlett Design Research Folios: Bloom Distributed Urban Game*.

³³⁵ *Ibid.*

4.4 Revisiting Issues Related with the Dissolution of Authorship

This chapter studied in detail nine design models and projects with the common characteristic of opening the architectural design process to diverse actors by using formal languages. These projects were selected from four landmark conferences and exhibitions. Even though only one of these events had the distribution of architectural authorship as its primary focus (*Design Participation Conference*), the others provided a lot of input into the issue as well: These three examples displayed a close relationship between participation and the use of formal methods, from the inclusion of the user into the design process to the invitation of participation and interaction to crowds.

The use of formal language and formal methods in architecture contributes to the distribution of authorship, by disposing of the idea of meaning pertaining to a first person perspective³³⁶ (the designer's perspective) and opening it to a diversity of participants. Zeynep Mennan notes that "The opposition of formal and natural languages constitutes the very interface where the question of meaning is problematized: in natural languages, meaning is appropriated by the reader, whereas formal languages dispose of the reader and the question of meaning".³³⁷

In the previous chapter the paradoxical relationship related to the use of a common language and loss of diversity of participants and perspectives were mentioned. However, after studying the use of formal languages in architectural discipline, it is safe to conclude that in the architectural discipline such paradoxical losses do not have a reflection in architectural design. On the other hand, formal languages are mostly addressed as a solution to achieve an increase in diversity of participation and openness of the architectural design. Other detected patterns and similarities found from the study of the design models will be developed as characteristics of a knowledge ecosystem for architecture in the conclusions.

³³⁶ Mennan, "Mind the Gap: Reconciling Formalism and Intuitionism in Computational Design Research."

³³⁷ Mennan, Zeynep. "From Number to Meaning: Prospects For a Quantitative Hermeneutics at Istiklal." *In Architecture in Turkey Around 2000: Issues in Discourse and Practice.*, edited by Tansel Korkmaz, Chamber of Architects of Turkey, 2005, pp. 125.

CHAPTER 5

CONCLUSION

The present thesis conceptualized and discussed the prospects of an architectural knowledge ecosystem, starting with the definition of a knowledge ecosystem from a biological perspective and developing into an architectural knowledge ecosystem framework through a discussion of the dissolution and distribution of architectural authorship.

Nine design models and projects have been studied in detail, selected from four landmark conferences and exhibitions sharing the common characteristic of opening the architectural design process to diverse actors by using formal languages. Research has been based on observations from design theory (distributed creativity, distributed cognition), working methods of architectural firms and emerging methodologies in the building design field (changing trends from the traditional design-bid-build model to an architect-led integrated design and building process) and case studies from selected design projects that emphasize the opening of the architectural design process to diverse actors. From observations in these diverse areas, the research aimed to detect patterns and similarities that define the characteristics of a knowledge ecosystem for architecture. These patterns and common characteristics have been used to infer general conclusions, which are mentioned below in detail.

5.1 Open Source Architecture versus Architectural Knowledge Ecosystem

Open Source has been the main starting point of this research as the working model for social constructivism. As detailed in the second chapter, Open Source provided important inputs for this research, since by its very nature, it utilizes a diversity of participants and openness for social production of knowledge. In order to increase participation, the source code is being shared openly to be used, changed,

augmented, and developed by others. In this type of collective work, where contributions of numerous people are gathered, authorship reaches a full dissolution. Dissolution of authorship through access to the source code is one of the fundamental principles that expanded open source into a paradigm changing movement.³³⁸

However, the translation and interpretation of open source principles from software space to architectural space is seen to present several challenges. It is difficult, or even impossible, to apply all open source principles to architecture. In architectural design, the projects that opened their source code to the public have been limited to a handful of avant-garde experiments.

The instances studied in relation to open distribution (see chapter 3) such as UNStudio's knowledge platforms and Aravena sharing his design freely with the public, consist of two exciting initiatives presenting an open source working principle for architecture.³³⁹ However, in the years following these proposals, it became apparent that their impact had been limited. In the UNStudio platform, some articles were shared containing a few detail drawings, calculations and explanations but a reluctance in sharing their drawings and parametric models was observed. Their contribution is also limited to being an institutional platform instead of being an interactive online knowledge platform bringing together users to contribute for knowledge production. Despite its importance in releasing the architectural thinking behind some of their work, their contribution does not involve the share of the source code.

Moreover, even though two years have passed since Aravena freely shared with the public all the necessary drawings for the design and construction of his four social houses, no one has yet attempted to utilize these for real construction projects. Arguably, in architecture, even making the drawings available for download and free use, is not equivalent to sharing the source code as in software considering that each

³³⁸ Free Software Foundation. *What Is Free Software?* <https://www.gnu.org/philosophy/free-sw.en.html>. Accessed 30 June 2018.

³³⁹ UNStudio. *UNStudio to Launch Open Source Knowledge Sharing*
See also Aravena, *ABC of Incremental Housing*

architectural design is specific in terms of site, climate, user, client, construction technology etc. Nonetheless, Aravena's designs leave some openness for user intervention and it is discussable whether they really involve user participation or adaptability to changing sites, user requirements, or diverse functions.

Another issue related with open source and the total dissolution of authorship in architecture is the fact is that in this type of knowledge production the limits between inspiration, copying, and pirating are unclear. Open source works not always contribute to the production of new knowledge and originality, and unethical uses and abuse of knowledge may arise, as discussed in cases of pirated buildings in Chapter 3. The discourse of open source architecture makes these limits even more ambiguous while not providing for a clear solution regarding the issues arising from the dissolution of authorship.

On the other hand, from the study of design models with a focus on increased participation in the previous chapter, it is observed that none of these projects freely opened their source code to users or to other architects. In fact, it is suggested that the source code has to be protected and direct access to the project source code is blocked for some participants. In the above-mentioned case studies, it is suggested that anyone other than the architect has restricted access to the source code. While these projects used formal methods and languages facilitating participation and action through a common language, authorization has been limited so that parameters could be changed but not the main rules that define the project.

Open source discourse has therefore been a good starting point for opening architectural design to more participants though distributed authorship in architecture, but it should be highlighted that, due to the specified reasons discussed, it does not necessarily translate into architecture, as architecture has its own resistance and reluctance to go open source and a line of development in this direction is seemingly not to be expected in the near future.

There are major differences between the software discipline, from which open source has originated, and architecture. As discussed above, both freely sharing source code and the total dissolution of authorship are essential in open source. However, they

cannot find a direct translation to the architectural discipline. Moreover, the software discipline is a pragmatic discipline. Many coders share the same problems where interchanging some lines of code is the shared solution. This type of patchwork of copy-pasted and shared code does not allow for the quest of original authorship, and it is a representative example of the total dissolution of authorship.

Conversely, every architectural problem is very specific and architecture is not a purely pragmatic discipline. For architecture, the share of knowledge and creative contribution are required instead of the copying and sharing of the functional portions of the code. Accordingly, rather than being limited to the discussion of open source architecture, the present thesis presented a knowledge ecosystem as a new conceptual and programmatic agenda for promoting increased participation and openness in architectural design.

5.2 Knowledge Ecosystem: Knowledge Community, Environment and Interactions

The framework for an architectural knowledge ecosystem has been constructed based both on theory, examples from practice and critique related to the distribution of architectural authorship in three subfields: knowledge community, environments and the interactions between these.

The architectural knowledge ecosystem framework has its focus on the diversity of participants and openness of the system. As discussed throughout the thesis, architectural design within this framework is treated as distributed action between architects, professionals from other building design and fabrication disciplines, non-professionals and even non-human agents. These constitute the knowledge community for the architectural knowledge ecosystem.

In the knowledge community, authors are diversified: these authors can be named as designers of norm and designers of form, as exemplified in all of the nine projects studied herein. The authorial role of the architect is not yet totally dissolved, but this type of knowledge ecosystem blurs the existing distinctions between designer and user. The author of the norm is the author of the modifiable source code. The non-

professional actor is the author of form; in other words, he is the author of the usable artifact assigning values to parameters and turning the generic object into a specific one.

Accordingly, the architect's authorial powers become less dominant but spread to a wider sphere of influence and professional action field as the diversity of participants involved in the design increase. The aims of such design models are not the design of a phenotype/form/object, but the design of genotype/norm/object itself. Thereby, design offers an unfinished object that calls for participants to improve it.

The use of formal language and formal methods is proved to be operational in opening the architectural process to diverse participants. Formal language has been proposed as a common language to unify the diverse actors of this ecosystem. Accordingly, design models that utilize formal languages have been proposed as environments that nourish this ecosystem.

Design models which involve systems that could not only react to the input but interact (circular interaction types), are proven to be more convenient for nourishing a knowledge ecosystem where the actors of the system are active participants of the system. Systems involving learning are preferable, since this type of interaction works as a conversing and learning platform of knowledge production and sharing.

The role of non-experts used to remain in the receiving end of the design process, with very limited amount of information and authority handed down to them.³⁴⁰ Grounding on the populism of professionalism, non-professional knowledge and its contribution to design have always been treated as less valuable than expert knowledge.³⁴¹ This approach has been challenged by searching for new approaches to participatory design since the 1971 *Design Participation* conference, setting the ground for the participatory paradigm in architecture

The main contribution of the knowledge ecosystem framework to the architectural discipline is that it presents an updated version of participatory design according to

³⁴⁰ Cross, "Here Comes Everyman."

³⁴¹ Banham, "Alternative Networks for The Alternative Culture."

the opportunities our current world presents and demands. The framework developed herein aims to increase the actors involved in the design process, with a focus on non-professionals and even non-human actors. This inclusive approach to architectural authorship offers diversified knowledge and epistemic diversity, the main goals of the architectural knowledge ecosystem conceptualized in the present thesis.

As discussed above, architecture is not to be expected to go open source. Yet, this does not mean that architecture can totally exclude open source. Not only the epistemic grounding of open source (social constructivism of knowledge) but also the outcomes of open source (crowdsourcing, peer to peer platforms, new economic models, etc.) are shaping the world. The architectural discipline cannot exclude itself from these paradigm changes.

The creative effects of including different points of view are already changing the architectural design discipline, as seen in the examples discussed throughout this thesis. In the near future, it is expected that the use of formal methods and languages would develop more to answer the demands of a growing diversity of participants. Within this prospect, the architectural design discipline would start to harvest the benefits of the cultivation of an architectural knowledge ecosystem.

The main output of this research is the definition of a knowledge ecosystem for architecture, which presents a new perspective towards current changes in the architectural discipline as a result of increased connection and sharing of information in society. The possible benefits cultivating an architectural knowledge ecosystem have been listed above. However, the background study and discussions of this research cover a variety of other contributions along the current proposal for a knowledge ecosystem framework.

The present thesis discusses in detail different modes of knowledge production and authorship in architectural practice. This discussion traces out the current saturation in the distribution of knowledge in architecture. The shifting roles of different actors involved in the design process and the relationships between them are categorized. By doing this a resurging of the participatory paradigm is outlined in an updated

form, parallel to new epistemologies in social theory and new technologies of the information age.

This research had as its motivation the definition of a knowledge system for architecture. To accomplish this purpose, the work has been grounded on social constructivism, and evolutionary epistemology has been chosen as a methodological approach. Consequently, a biological analogy for the proposal of a knowledge ecosystem has become inevitable. Throughout the thesis, the terminology borrowed from biology has been used and adapted to the architectural discipline, which resulted in the definition of an architectural knowledge ecosystem.

The outcomes and contributions herein prove that this approach provides a new perspective to understand the relationship between authorship and knowledge production in the current state of the architectural discipline. However, it should also be highlighted that different perspectives could have been proposed as well, based on different approaches and methodologies of social theory. For instance, the actor-network theory handles knowledge systems as shifting networks and relationships rather than ecosystems and interactions.

Preference was given to a social construction of knowledge together with a biological analogy to knowledge production through evolutionary epistemology over other approaches and perspectives. This was an informed decision made at the beginning of this research process, to suggest a new and original contribution to the field of architecture.

Some other fields of social theory, which have already been studied from within the architectural discipline already started being used in architectural discourse with attributions that fall outside the scope of this research. For instance, the actor-network theory seems to be covering similar discussions according to a different constructivist approach based on defining human and non-human elements and the respective interactions. The application of the actor-network theory in architecture also suggests that architecture should be socially shaped and proposes to look at

buildings as technological artefacts.³⁴² Accordingly, this theory is applied in architecture with a specific focus on studying the relationships between buildings and society.³⁴³ In order to prevent overlapping attributions, the knowledge ecosystems framework is suggested as a new way of dealing with current changes in the architectural discipline.

The claim and nature of this thesis has required a transdisciplinary research approach that spans different disciplines (knowledge management; biology, memetics evolutionary epistemology; distributed cognition; open source software, computer science; and mainly architecture). There are some existing potential challenges and limitations of this type of transdisciplinary research that may have affected the research process. For instance, different disciplines use different terminologies or sometimes use the same terminology to refer to different meanings. Analogies borrowed from other disciplines need to be adapted to the new theoretical framework.

Finally it should be highlighted that, within the timeframe of this thesis, the number of selected projects that were added to the discussion of this thesis was limited to nine. These were very carefully selected from milestone conferences and exhibitions that represent each a different aspect of the topics covered in the thesis. The theory could be further developed and completed by the addition of other examples.

³⁴² Fallan, Kjetil. "Architecture in Action: Traveling with Actor-Network Theory in the Land of Architectural Research." *Architectural Theory Review*, vol. 13, no. 1, 2008, pp. 80–96.

³⁴³ Ibid.

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PUBLICATIONS

- 2018 Colaço, C. A., & Acartürk, C. (2018). Visual Behaviour During Perception of Architectural Drawings: Differences Between Architects and Non-architects. In J. Gero (Ed.), *Design Computing and Cognition '18*. Springer.
- 2018 Colaço, C. A., & Colaço, R. (2018). Z-Tolerance: Three-Dimensional Abstract Representations of the Migration Issues in Europe. In D. L. Viana, F. Morais, & J. V. Vaz (Eds.), *4th International Symposium Formal Methods in Architecture*. Cambridge Scholars.
- 2011 Colaço, C. A., & Tunçer, B. (2011). Performative Architecture as a Guideline for Transformation: Defense Line of Amsterdam. In *29th eCAADe*.
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WORK EXPERIENCE

- 2011-Present Architect, Designer international experience in Portugal, Mozambique, and Turkey.

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- 2015 International Competition Entry Project, Open Gap Innatur 3
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