A SURVEY OF FORM CREATION PROCESSES WITHIN THE EVOLUTION OF THE ORGANIC TRADITION IN ARCHITECTURE

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

IŞIL RUHİ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF ARCHITECTURE
IN
ARCHITECTURE

JUNE 2008

Approval of the thesis:

A SURVEY OF FORM CREATION PROCESSES WITHIN THE EVOLUTION OF THE ORGANIC TRADITION IN ARCHITECTURE

submitted by **IŞIL RUHİ** in partial fulfillment of the requirements for the degree **Master of Architecture in Architecture Department, Middle East Technical University** by,

Prof. Dr. Canan Özgen _______________
Dean, Graduate School of **Natural and Applied Sciences**

Assoc. Prof. Dr. Güven Arif Sargın _______________
Head of Department, **Architecture Department**

Assoc. Prof. Dr. Zeynep Mennan _______________
Supervisor, **Architecture Department, METU**

Examining Committee Members:

Assist. Prof. Dr. Arzu Gönenç Sorguç _______________
Architecture Department, METU

Assoc. Prof. Dr. Zeynep Mennan _______________
Architecture Department, METU

Assoc. Prof. Dr. Selahattin Önür _______________
Architecture Department, METU

Inst. Dr. Namık Günay Erkal _______________
Architecture Department, METU

Inst. Dr. Ülkü İnceköse _______________
Architecture Department, İzmir Institute of Technology

Date: 23 June 2008

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Işıl Ruhi

Signature:

ABSTRACT

A SURVEY OF FORM CREATION PROCESSES WITHIN THE EVOLUTION OF THE ORGANIC TRADITION IN ARCHITECTURE

Ruhi, Işıl
M. Arch., Department of Architecture
Supervisor: Assoc. Prof. Dr. Zeynep Mennan

June 2008, 122 pages

Beginning with the developments in biological sciences since the 1750s, many scientists have been exploring the characteristics of Nature and the living. These developments, not only enabled humans to understand the interrelations among natural beings, but also influenced and shaped an organic tradition of architectural design during modernity. In many contemporary computer-aided projects, organicity is still seen to hold a decisive though different role in formal processes, as well as acting as a guide in the design process.

The thesis explores the architectural design processes involved with the natural processes in form-making within the context of the computational paradigm. To this end, organic/genomic architecture examples are researched, proceeding through a historical analysis of the characteristics of the organic tradition in modern architecture, discussed and re-analyzed within the context of instances of contemporary organic projects in computer-aided design. Through the analysis of such projects and their properties, organicism is re-evaluated within the realm of computational design.

Keywords: Organicism, Organic Architecture, Evolutionary Architecture

ÖZ

MİMARİDE ORGANİK GELENEĞİN GELİŞİMİ İLE FORM OLUŞTURMA SÜREÇLERİ

Ruhi, Işıl
Yüksek Lisans, Mimarlık Bölümü
Tez Yöneticisi: Doç. Dr. Zeynep Mennan

Haziran 2008, 122 sayfa

18. yüzyılın ortalarında başlamak üzere, biyoloji alanındaki gelişmelerle beraber, doğanın özellikleri bilim adamları tarafından incelenmeye başlanmıştır. Bu gelişmeler doğadaki canlıların özelliklerinin anlaşılmasının ötesinde, aynı zamanda modern mimaride organik bir yaklaşımın oluşmasında etkili olmuştur. Organik yaklaşımın, günümüz bilgisayar destekli tasarımlarındaki form oluşumu sürecinde halen etkili olduğu ancak farklı bir yaklaşıma doğru yöneldiği, hatta tasarım sürecinde yol gösterici olduğu gözlenmektedir.

Tez, bilgisayar ortamında yapılan tasarımlarda, doğadaki form gelişimi sürecini temel alan mimari projeleri araştırmaktadır. Bu amaçla tez, modern mimari dönemindeki organik yaklaşımın özelliklerini göz önüne alarak, günümüz bilgisayar destekli ortamında ortaya konulan organik mimari örneklerinin tartışılmasını ve araştırılmasını amaçlamıştır. Her iki dönemde ortaya konulan projelerin tasarım süreçlerinin incelenmesi ile günümüz bilgisayar ortamındaki tasarımlarda organik anlayışı değerlendirilecektir.

Anahtar Kelimeler: Organik Mimari, Bilgisayar Destekli Tasarım

To my parents,
Şükriye and Emin Ruhi

ACKNOWLEDGMENTS

For me, this thesis is the meeting point of my deep interest both in biology and in architecture.

I am truly grateful to my advisor Assoc. Prof. Dr. Zeynep Mennan for introducing me to the computational paradigm in architecture. Her insightful understanding of the field became the departure point of my project. I especially value her guidance and her intellectual and emotional support throughout my thesis work especially at points and times where I needed to get on track.

I am very thankful to my jury committee members Assist. Prof. Dr. Arzu Gönenç Sorguç, Assoc. Prof. Dr. Selahattin Önür, Dr. Namık Günay Erkal and Dr. Ülkü İnceköse for their inspiring comments on this study.

A thesis looks like a journey taken on one's own, but it is actually one where you develop a fellowship with kind souls. Besides the rich intellectual environment created by my professors, I was lucky to be accompanied by the unfailing support of my msn architecture group, whose 'virtual' coffees and timely conversations during long nights were invaluable. Evrim Özlem Kale, Sinem Yardımcı, Ayşegül Akçay, Ali Aslankan and Cousin Cem, many thanks for being a part of this journey. Heartfelt thanks go to Itır Işın for being a pillar of true friendship ever since our high school days.

I do not have enough words to express my gratitude to my parents. This thesis is an opportunity to thank my father from the bottom of my heart for foreseeing that the best way for me would be the way of an architect. And my mother was always a harbor for little chats during my thesis work.

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CHAPTER 1

INTRODUCTION

Nature is the environment for every human settlement since early times and it constitutes one of the most influential sources of inspiration for architectural design with its forms, structure and several other aspects. The imitation of nature can be seen in many buildings and shelter designs. As a matter of fact, mimicking the organic process of Nature in architecture is neither a coincidence nor a contingency, but intentional. Throughout the history of architecture, we observe that the form making theories have explicitly borrowed several properties from the ways natural forms are generated. As our knowledge of natural systems developed, the understanding of the properties borrowed from Nature has also evolved; hence there is an increase in the variety of approaches to organic design. Furthermore, this variety is not just related to scientific -especially biological- experiments, but also to the technological improvements nourishing the architectural design practices, while introducing new construction techniques and materials.

By examining the role of Nature in architectural practice, and limiting itself to that of animate organic beings, this thesis mainly focuses on the “organic” design tradition in the early 20th century and in contemporary projects. Such a comparative survey of the organic tradition in two historical periods follows from the argument developed by Zeynep Mennan about a parallelism between the imitation of natural forms and natural growth that has led to the development of the modernist organic tradition and a revived interest in organicism reappearing in the contemporary complexity paradigm, especially with the new scientific innovations[1]: Zeynep Mennan observes that in many digitally produced projects, organicity is still seen to hold a decisive though different role in formal processes, as well as acting as a guide in the design process.[2] It can also be observed that in the two indicated time intervals, the architects follow a similar understanding in their organic approach in terms of the imitation of organic form generation processes. This similarity involves the thesis to re-evaluate the form creation processes pursued within these two periods in order to understand the consequences of the interaction of organicism and architecture.

1.1 Significance of the Study

To the best of my knowledge, the form-finding processes of the organic approaches in the 20th and 21st centuries stemming from the developments in the biological sciences have not been compared. Hence, the thesis attempts to reveal the design processes that the architects pursued with respect to changes in his/her approach to natural processes in architectural form-making. The thesis suggests that the design process is being altered by the usage of computer technologies from a form-finding process governed by the architect towards a form-finding process in the computer realm. Therefore, the study will reevaluate the prevalent attempt to emulate natural formal and growth processes and their implications in the realm of architecture by comparing the organic approaches in the two historical periods indicated above.

[1] This argument is developed in: Zeynep Mennan, "Des Formes Non Standard: Un 'Gestalt Switch,'" in *Architectures Non Standard*, eds. Fréderic Migayrou and Zeynep Mennan (Paris: Editions du Centre Pompidou, 2003), 34-41. See also: Zeynep Mennan, "Reversing Modernist Historiography: the Organicist Revival in Computational Architectures" (paper presented at IXth International DOCOMOMO Conference, "*Other*" Modernisms, METU, Ankara, Turkey, September 27-29, 2006).

[2] Ibid.

1.2 Terms Related with the Concept of Imitation of Nature

The terms that this thesis deals with, such as organic, organicity, organicism, and biomimicry, have to be briefly defined in order to understand the shifts within their meaning along with scientific improvements. The similarity between artificial things and natural things is defined with the term "organic"[3], but in architecture, organic is not an unequivocal term but one depending on the historical moment and also on different understandings within that historical moment.[4] It can refer to a variety of similarities, such as formal ones, sometimes to the process of natural growth, or even to an "organic unity", a notion which will be explained below. Since the meaning is elusive and variable, the study will emphasize the metaphorical connotations of these concepts. The thesis especially focuses on one of these organic metaphors, the process of 'unfolding from within'[5], which denotes the anticipated similarity between architectural form and organic being by emulating the natural growth process of Nature instead of the imitation of its forms. Hvattum gives the following definition in order to explain about this metaphor:

> Organic form, …, does not necessarily involve any likeness to the forms of nature. It evokes rather a principle of form itself, referring to an autonomous 'unfolding from within'. The organic metaphor entails an idea of a little totality which carries the reasons for its own change and development within itself.[6]

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[3] Günther Feuerstein, *Biomorphic Architecture: Human and animal forms in architecture* (Stuttgart: Menges, 2002), 7.

[4] Vittoria Di Palma, "Architecture and the Organic Metaphor," *The Journal of Architecture* 11, no. 4 (2006): 385, http://www.informaworld.com/10.1080/13602360601037644 (accessed July 4, 2008).

[5] Mari Hvattum, "'Unfolding From Within': modern architecture and the dream of organic totality," *The Journal of Architecture* 11, no. 4 (2006): 497, http://www.informaworld.com/ 10.1080/13602360601037941 (accessed July 4, 2008). See also: Colin St. John Wilson, "The Other Idea Architecture as a Practical Art," in *The Other Tradition of Modern Architecture, The Uncomplete Project* (London: Academy Editions, 1995), 49-78.

[6] Hvattum, "'Unfolding From Within,'" 497.

The origins of this metaphor will be traced while elaborating on the biological and mathematical innovations and their implications in architecture in the 20th century and further in the early 21st century.

This organic metaphor, which is especially referred during the early 20th century, comes into prominence after the inauguration of the science of life, that is, of biology as a discrete discipline in 1802.[7] This metaphor is not related with the imitation of the formal properties of Nature, because it insists on the necessity to emulate the natural growth process along with the correlation between parts and whole which generate an interdependent system formed by taking into account its needs to survive. The metaphor of internal organic growth -'unfolding from within'- is thus relevant to the idea of self-generation in Nature which is referred to while reviewing the ideas of architects working within the organicist trend in architectural form-finding during the early 20th century.[8]

There are also several terms derived from the word 'organic' that this thesis refers to, such as organicism and organicity. The definitions of the terms related with 'organic' are the results of studies on Nature and differ depending on the scientific knowledge of Nature. Definitions are given below without any detail to trace the prevalent meaning which is still current.

Actually, the influences of natural form, in terms of its organic metaphors, are widespread, notably in literary criticism. As will be mentioned in the study, the texts on the issue of organicism are prominent with their contributions to better define the basic characteristics of Nature that art should imitate. Abrams then gives the following definition of organicism as "the philosophy whose major categories are derived metaphorically from the attributes of living and growing

[7] Di Palma, "Architecture and the Organic Metaphor," 386.

[8] Detlef Mertins, introduction to *The Victory of the New Building Design*, by W.C. Behrendt, trans. Harry Francis Mallgrave (Los Angeles, Calif: J. Paul Getty Trust Publications, 2000), 1-60.

things."[9] In aesthetics, organicism is a doctrine, according to which in works of art, parts are unified interdependently to form the whole, and where the whole is different from the sum of the parts.[10] Besides the philosophy of art, this doctrine is also effective in biological sciences.[11] Philosophers, scientists, architects and artists contributing to this idea will be discussed in the thesis. It is the Abrams' philosophy that constitutes the basis of contemporary organic discourse. Briefly, organicism, as the thesis refers to, is a search for the imitation of nature in the artistic world, and its meaning is related to the natural law considered as nature's most fascinating property which has to be attained. Additionally, the term organicity, used to define the relationship between Nature and architecture as "the quality or state of being organic", will be used in this thesis with reference to Detlef Mertins, who points out that "becoming" is one of the essential characteristics of organic beings.[12]

Another term related with this thesis is "biomimicry," coined firstly by Janine Beynus in her book *Biomimicry: Innovation Inspired by Nature* (1997).[13] According to Beynus, "[b]iomimicry [from Greek *bios,* meaning life, and *mimesis*, meaning imitation] is a new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems."[14] This view suggests that in order to find solutions which best fit the problem, it is worthwhile to discover the natural properties which similarly have the potential to show a path to our own problems: It then insists on the idea to

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[9] M. H. Abrams cited in G. N. G. Orsini, "The Organic Concept in Aesthetics, *Comparative Literature* 21, no.1 (1969): 27, http://www.jstor.org/stable/1769367 (accessed May 23, 2008).

[10] Ibid.

[11] For biological definition see also, Scott F. Gilbert and Sahotra Sarkar, "Embracing Complexity: Organicism for the 21st Century," *Developmental Dynamics* 219, no. 1 (2000): 1-9, http://www3.interscience.wiley.com/cgi-bin/fulltext/72513248/PDFSTART (accessed December 20, 2006).

[12] Mertins, introduction to *The Victory of the New Building Design*, 50.

[13] Janine M. Beynus, *Biomimicry: Innovation Inspired by Nature*. (First published New York:William Morrow & Co., 1997; New York: Perennial, 2002).

[14] Ibid.

learn from Nature.[15] Therefore, biomimicry carries out researches on natural form generation processes and the appropriate use of materials.

Lastly, a term usually used while referring to an object whose form is comparable to an organic body has to be acknowledged: "biomorph" or its adjective "biomorphic." Although in several texts it is used as synonymous to organic, this term describes the formal resemblance between man-made objects and natural beings. In other words, as explained by Isabel Wünsche, "[f]ocusing on imagery rather than on natural laws, the term "biomorphic" sets limits and firmly places the topic in the realm of visuality without necessarily de-emphasizing its conceptual basis."[16] This idea, propounded by the artist as a source of inspiration, takes its root from an endeavor to give a soul to inorganic objects.[17] This inclination is reminiscent of anthropomorphism with reference to the organic structures. Biomorphic designs are closely bounded to the idea of free form development.[18][19]

All these terms introduced to designate the relationship between the appreciation of organic forms in architectural theory and practices are used throughout the thesis. The thesis interprets the architectural tendencies towards the imitation of nature, by tracing the architects' ideas through their writings and projects.

The thesis does not deal with the formal qualities of the architectural projects but examines the form creation process. As well known, architecture draws inspirations from many other disciplines, but the thesis deals with the consequences stemming from the imitation of nature with respect to the imitation of the form generation process of animate organic beings.

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[15] Ibid.

[16] Isabel Wünsche, "Biological Metaphors in 20th- Century Art and Design," *Ylem Journal* 23, no.8 (2003): 5, http://www.ylem.org/Journal/2003Iss08vol23.pdf (accessed December 15, 2006).

[17] Feuerstein, *Biomorphic Architecture*, 7.

[18] Ibid., 7- 12.

[19] For a selective iconography of biomorphisms during the early modern period, see: Fréderic Migayrou and Zeynep Mennan, eds., *Architectures Non Standard* (Paris: Editions du Centre Pompidou, 2003).

In chapter 2, the thesis makes an overview of the organic approaches during the Classical Period and the Renaissance Period. This overview attempts to depict the ancient understanding of organicism.

Chapter 3 first makes a survey of the organicism from the mid 18^{th} century until the early 20^{th} century which includes the biological developments in the 19^{th} century and the early 20^{th} century, as well as the ideas of the Romantic Movement on organicism. Second, the chapter relates the developments, which update the biological knowledge, to the architectural projects aiming to imitate the natural form generation processes in the early 20^{th} century, through the projects of Frank Lloyd Wright and Hugo Häring.

Chapter 4 first brings forth the biological innovations of the 20^{th} century which are related to the contemporary computational paradigm, and then examines the new design process undertaken in the digital paradigm.

CHAPTER 2

A SURVEY OF THE ORGANIC APPROACH UNTIL THE 18TH CENTURY

The organic metaphor has always been an integral part of architectural discourse -either explicitly or implicitly. Therefore introducing briefly the tendencies of the imitation of Nature until the 18th century will clarify the prevalent discourse on organicism. The survey traces back the origins of the imitation of nature in classical antiquity, and then extends to the Renaissance Period in order to underline the common points referred by the philosophers and the architects to define the characteristics of organic form along with the idea of imitation of nature. Revealing the organicism, these periods are emblematic on depicting the tie between the knowledge of Nature and the organic approach in art and architecture.

The history of the idea of the "organic" is grounded on the attempts to link art to Nature, and that link was firstly elaborated in the early classical antiquity.[1] Besides constituting the basis of organicism in terms of "organic unity" and "organic form," the understanding seems unchanged until the Renaissance[2] and thereafter, it exhibits various similarities with the assumptions made by the philosophers as well by the scientists of the early 18th century.

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[1] Anthony J. Close, "Commonplace Theories of Art and Nature in Classical Antiquity and in the Renaissance," *Journal of the History of Ideas* 30, no.4 (1969): 467-468, http://www.jstor.org/stable/2708606 (accessed May 4, 2008).

[2] Ibid., 482.

2.1 The Understanding of the 'Organic' in the Ancient Greek Philosophy

The origins of formal analogies between art and nature can be traced back to the philosophical and medical schools before Plato and Aristotle.[3] It cannot be precisely known by whom the generalizations concerning this relationship were first defined, but the notion that "art imitates nature" is identified as a commonplace for the educational discourse during the classical antiquity till contemporary period.[4] It is essential to cite here these commonplaces which "reveal a coherent conception of human culture and technology in relation to the natural world."[5] These commonplaces are identified by Close in the following manner:

> Their import is that human art generally is dependent on and ancillary to nature: dependent because it imitates the functions, processes, and appearance of the natural world, takes its laws and principles from nature, and makes use of its material; ancillary because it often cooperates with natural processes in helping them to attain full or normal development, and more generally because it fills in the deficiencies of man's natural state and environment.[6]

This broad conceptualization of "art imitates nature" is pivotal to understanding how the organic analogy gradually emerges, as it has two inter-related implications on Plato's and Aristotle's ideas in terms of architectural praxis. The first implication depends on their philosophical classification of the creative powers, among which the creative divine soul is considered as the ultimate one.[7] The second implication is on the notion of "organic unity" such that the artist

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[3] Ibid., 468.

[4] Ibid.

[5] Ibid., 468-469.

[6] Ibid., 469. Also see, Anthony J. Close, "Philosophical Theories of Art and Nature in Classical Antiquity," *Journal of the History of Ideas* 32, no.2 (1971): 163-164, http://www.jstor.org/stable/2708275 (accessed May 23, 2008).

[7] Close, "Philosophical Theories of Art and Nature in Classical Antiquity," 171.

"used living body (quite casually) as a model of organization and coherence in discussions of rhetoric and drama."[8]

The first implication should be divided into two different approaches, since the creative divine –'divine soul'- according to Plato[9] and Aristotle[10] is totally different. The first approach is dependent on the notion of 'Idea' introduced by Plato, who attributes no creative soul to art and considers art as a reflection of Ideas. According to Plato, there is an organic unity and continuity between art and nature on "the basis of their relationship to the Ideas."[11] Consequently, the interrelationship between the creative functions of art, nature, God is as follows: "…God creates from nothing, nature procreates (or imitates God), and art imitates nature."[12] Furthermore, within the so-called implication, there lies the division between soul and matter. Close explains the role of the divine soul according to Plato in the following manner:

> … the first creative power is divine soul, arguing from the universal priority of soul over matter. Since soul is essentially a rational faculty, such qualities as "reason" and "art" do not come after nature in the universal scheme, but precede it; or replace it altogether. In fact, the cosmos is the work of divine art; and nature, if it can be called a creative power at all, is a subordinate instrument of the divine principle of [divine soul].[13]

Along with the pivotal role of 'divine soul', or 'Idea', Plato, consistent with Aristotle, makes a classification of the mode of imitation, which varies according to types of art. Although Plato considers the aesthetic arts as a reflection of Ideas, they both accept that the art of architecture can "borrow nature's logical

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8 Mitchell Whitelaw, "The Abstract Organism: Towards a Prehistory for A-Life Art," *Leonardo* 34, no. 4 (2001): 345, http://www.jstor.org/stable/1577161 (accessed May 20, 2008).

9 Close, "Philosophical Theories of Art and Nature in Classical Antiquity," 164.

10 Close, "Commonplace Theories of Art and Nature in Classical Antiquity and in the Renaissance," 480.

11 Close, "Philosophical Theories of Art and Nature in Classical Antiquity," 167.

12 Ibid.

13 Ibid., 164.

modes of operation and adapt techniques from observing natural processes in order to achieve a result which nature itself could not achieve."[14] Plato considers the architect as an original maker of real things.[15] Consequently, the architect can learn from nature the ways to attain the perfect form, which is already defined in the world of "Ideas." In this case, it should especially be noted that in the aesthetic arts imitation is limited to being a representation of "nature."

The second approach related with the creative divine is set forth by Aristotle, who was a student of Plato. Although Aristotle agreed with the notion of "art imitates nature," one aspect concerning the link between matter and soul separates their approaches. According to his observations on embryos for the purpose of understanding the development of organic beings, Aristotle states that the early unstructured material, rather un-formed, (contained in the egg, for example) gradually acquires the final form.[16] This process towards the end identified as the epigenetic process of development, is guided by the 'soul,' which must be in the organic being since the beginning.[17] Aristotle defined this guiding 'soul' in the following manner: "It [the soul] causes the production… of another individual like it. Its essential nature already exists; … it only maintains its existence… The primary soul is that which is capable of reproducing the species."[18] The 'soul' as the principle which conducts the aim, goal, and end in itself has a "preexisting idea" of the final form.[19] Furthermore, this soul is formed by the combination of male and female semen. Thus, the process is internal. Aristotle divides the soul into categories such as vegetative, animal, and spiritual.[20] Plato, on the contrary, argued that the 'soul' is free of the organic being; that is, it is not contained within

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[14] Ibid., 174.

[15] Ibid., 166.

[16] Werner A. Müller, *Developmental Biology*, (New York: Springer- Verlag, 1997), 3.

[17] Jane Maienschein, "Epigenesis and Preformationism," in *The Stanford Encyclopedia of Philosophy* (Fall 2006 Edition), ed. Edward N. Zalta, http://plato.stanford.edu/ archives/fall2006/entries/epigenesis/ (accessed January 02, 2006).

[18] Müller, *Developmental Biology*, 4.

[19] Ibid., 3-4.

[20] Ibid., 4.

the material body. In this sense, Aristotle's idea, also known as the Aristotelian doctrine of epigenesist, connotes the immanence of nature. Close states that Aristotle's conception of the imitation of nature by the artists, can be summarized as follows: "… nature -the formal principle embodied in each living creature and giving it life, a power of evolution, and specific identity- embodies in superior degree the rational and purposive workmanship typical of human art."[21] This idea of purposiveness can be best understood according to the notion of "organic unity."

The second implication related with the conceptualization of "art imitates nature," is the notion of "organic unity", the classic definition of which is given by G. N. G. Orsini through the citations from Plato and Aristotle in the following manner[22]: "…in a poem, or any work of art, all the parts should be in keeping with each other and with the whole (Plato, *Phaedrus*, 245 C) in such a way that the alteration of one part causes the alteration of the whole (Aristotle, *Poetics*, Ch. VIII, 51a 32-35)."[23] Furthermore, Orsini, through deductions from Plato and Aristotle, states that it is "the problem of the One and Many" which identifies best the organic unity concept depicting the needed relationship between parts in order to form a single whole. In this manner "there is a multiplicity within unity."[24] Consequently, this relationship points out that the whole is something different from the sum of its parts which are interdependent. That is, there are no arbitrary relations between the parts. Although, Plato considers that kind of imitation as a "geometrical formula for modular integrity"[25], Aristotle suggests the importance of the "functional unity of the parts,"[26] defined as the reasoned unity of parts.

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[21] Close, "Commonplace Theories of Art and Nature in Classical Antiquity and in the Renaissance," 480.

[22] Classical definition means that it was formulated by ancient Greek philosophers and its meaning is still current. See Orsini, "The Organic Concept in Aesthetics," 3.

[23] Ibid.

[24] Ibid., 2.

[25] St. John Wilson, *The Other Tradition of Modern Architecture,* 72.

[26] Ibid.

Related with this aspect, Anthony J. Close, while pointing out the similarities between nature and art according to Aristotle, states that there is a common goal, the achievement of which is attained through a rational process in Nature. He adds that "in order to prove that nature has this tendency, Aristotle argues that methodological working towards an end is presupposed in any process of development which ends in a state of achievement."[27] This process, compared to the human endeavor, is teleological in the sense of attaining an end. Nature has this principle internally, just as the artist has the form of the work of art to be achieved in his mind. In this understanding, God, as the creator of nature, is assumed to have an intention for final form. Thus, art should imitate this purposiveness or functionality of Nature to achieve final form.[28] Considered as a practical art, architecture, according to their philosophy, served to another end by means of his purposes.[29]

Interest in the natural form generation process is grounded on the empirical observation of nature by architects, and philosophers. In this context, the analogy of process and organic unity, which is basically the outcome of a visual mediation, has influences on the issue of proportion in buildings. If the organic analogy regarded as essential by these philosophers during the design process of architecture should be attained, Plato's designer will attain it through a mathematical modular, that is, with respect to the natural proportions of the parts. On the other hand, Aristotle's designer will attain it by attending to it regarding the functional unity of parts. By consequence, they will all have the ultimate form of their design in their minds. In this sense, the spirit and matter can be said to be split from each other since the ultimate form is transcendental.

The proportion of the Greek temples built with respect to the Vitruvian tradition exemplifies this approach, which can be considered as 'organic' by relating

[27] Close, "Philosophical Theories of Art and Nature in Classical Antiquity," 171.

[28] Ibid.

[29] St. John Wilson, *The Other Tradition of Modern Architecture,* 41.

architecture to "nature-as-human body."[30] Behind all the organic metaphors, there lies the belief of an immanent law, which, besides guaranteeing the variety of forms, governs the appropriateness of natural forms to their function.[31] It is in this sense that the free forms that Nature presents were influential on the form creation process in architectural praxis.

Finally, it should be noted that the concept of organic unity still holds its importance in contemporary architecture. The experiments in biological sciences at the end of the 20th century introduced the concept of emergence, which attributes a similar understanding of organicism.[32]

2.2 The Understanding of the 'Organic' in the Renaissance Period

In the Renaissance period, the Aristotelian concept of organic unity –especially the notion of functionality– is seen to reappear in Leone Battista Alberti's ideas (1404-1472), which for the first time in architectural theory formulate an organic understanding appropriate to refer to architectural praxis.[33] There are several facts which paved the way for the reappearance of this concept, along with the continuity of the organic analogy. Firstly, translations of the books written during the classical antiquity helped to transmit the classical concepts to the Renaissance artists. Secondly, as Close explains, "the cultural and technological conditions to which they [ancient commonplaces] were relevant in antiquity were to remain little changed in certain fundamental respects until the mid-eighteenth

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[30] Susannah Hagan, *Taking Shape: A New contact between architecture and nature* (Oxford; Boston: Architectural Press, 2001), 29.

[31] Ibid., 18.

[32] Michael Weinstock, "Morphogenesis and the Mathematics of Emergence," in "Emergence: Morphogenetic Design Strategies," ed. Michael Hensel, Achim Menges and Michael Weinstock, special issue, *Architectural Design* 74, no. 3 (2004): 10- 11.

[33] Hagan, *Taking Shape*, 24. See also Caroline Van Eck, "Goethe and Alberti: Organic Unity in Nature and Architecture," *Structurist* 35/36, (1995/1996): 23, http://pao.chadwyck.co.uk//PDF/1215423356731.pdf (accessed October 20, 2006).

century."[34] This means that there are no paradigm shifts in the technological and cultural realms until the mid 18th century.

The relationship between art and nature during the Renaissance architectural praxis is fully explored in Book IX of Alberti's *De re aedificatoria* (On the Art of Building), which is "devoted to a definition of architectural beauty as *concinnitas*."[35] As a rhetorical term, which identifies an elusive concept, *concinnitas* is firstly introduced by Cicero in order to define a style, that is, "closely knit," "elegantly joined" or "skillfully put together."[36] According to Alberti and his contemporaries, this concept is a general ordering principle which provides the harmony between the parts and the whole, which have an interdependent relationship.[37] The *concinnitas* of Classical form described by Alberti refers to the concept of organic unity as a fulfillment of purpose.[38]

This principle propounds a dualistic approach regarding the organic analogy. The first approach is mathematical. It connotes a quantitative imitation; that is, the parts of buildings should represent a basic dimensional correlation between each other in order to attain the whole. This approach is best identified by Alberti in the following manner:

> Beauty is a form of sympathy and consonance of the parts within a body, according to definite number, outline and position, as dictated by *concinnitas*, the absolute and fundamental rule in Nature. This is the main object of the art of building, and source of her dignity, charm, authority, and worth.[39]

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[34] Close, "Commonplace Theories of Art and Nature in Classical Antiquity and in the Renaissance," 482.

[35] Van Eck, "Goethe and Alberti," 24.

[36] Ibid.

[37] Hagan, *Taking Shape,,* 25.

[38] St. John Wilson, *The Other Tradition of Modern Architecture*, 72.

[39] Alberti cited in Van Eck, "Goethe and Alberti," 24.

Although Alberti's definition of the organic unity is regarded as a modular proportion among the parts, the principle explicitly calls for a qualitative imitation of nature. This is the second approach of Alberti to organic unity, which supposes the regulative law generating "beauty based on skillful and elegant connection."[40] It is this law dependent on the purposive unity of the parts, and the construction method exhibited by nature that the architect should follow. According to Van Eck, by stating purpose, Alberti admits that the seen proportions within nature are not a coincidence; it is a consequence of a fundamental aspect of *concinnitas.*[41] The quantitative character is generated by means of the qualitative aspect. The principle connotes a process identifying the generation of forms, where the process and the purposive unity of the interdependent working parts ensures the unity of the whole.

Regarding the principle of *concinnitas*, it is correct to state that the general rule active in the organic being on the formation of its forms begins to get explored by the artists and the architects. The awareness concerning this rule, as will be discussed later, has many common points with the organic principles of the 19th century which are developed in view of the scientific developments. But, we have to note here that the idea in the tradition of Renaissance that "the building was required to make a certain impression on a spectator"[42] was a dominant one. Following this idea, although the organicism was seen as decisive in Alberti, the architectural forms were proportional and statically ordered regardless of the human use, or the environment.[43]

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[40] Alberti cited in ibid., 25.

[41] Ibid.

[42] Richard P. Adams, "Architecture and the Romantic Tradition: Coleridge to Wright," *American Quartetly* 9, no. 1(1957): 46-62, http://www.jstor.org/stable/2710068 (accessed May 4, 2008).

[43] Ibid.

CHAPTER 3

RE-CONCEPTUALIZATION OF THE ORGANIC APPROACH UNTIL THE EARLY 20TH CENTURY

While the organic metaphor encompasses also the imitation of organic forms in architecture, the present chapter attempts to trace the organicism which is a consequence of the enthusiasm felt for the self-generation of organic complex forms –that is, the natural laws– in order to scrutinize the philosophers', architects' and scientists' interpretation of organic form. Thus the survey aims to reveal a variety of analogies of process which attempt to learn from Nature's own form generation process.

In the first part of this chapter, a brief look into the architectural discourse of the 19th century enables us to understand why the organic approach resurfaced following the shifts within the Enlightenment and Industrial Periods. Investigating the endeavor to unify art and nature by means of imitation of natural properties necessitates a review of the biological developments, along with their impact on the Romantic Movement of the 19th century. Within this specific moment, introducing an important shift indicated by Immanuel Kant aims to point out to the radical changes in the ways nature is investigated. In this sense, the survey attempts to delineate the understanding of organic form accompanied with its analogy in the architectural realm. The major architectural theories concerned with the organic analogy give clues as to how the organic form, that is Nature, has been conceived and how it became one of the central interests within the architectural design of the early 20th century. Thereafter, in the second part, this study will ground the interest in the form creation process of nature, through the projects of Frank Lloyd Wright and Hugo Häring.

3.1 A Survey of the Organic Approach until the Early 20th Century

Beginning with the Enlightenment Period until the early twentieth century, a variety of influential shifts within cultural, political, economic, and technological fields gradually invoked the architects to re-conceptualize the characteristics of their own discipline. Regarding all these changes, it is possible to talk of a "paradigm shift" in architectural design praxis, because a "paradigm shift" is characterized by the changes of "some of the field's most elementary theoretical generalizations as well as many of its paradigm methods and applications."[1] The search for organicity in architecture is related with this paradigm shift. In this chapter, some of the major shifts which occurred at the 19th and 20th centuries due to the Enlightenment and Industrialization Period will be pointed out for the purpose of tracing the drives effective on the resurfacing of the organic approach.

3.1.1 The Shifts within the 19th and 20th Centuries: Industrial Revolution

The architectural projects designed during the late 19th and the early 20th centuries address the problematic of social change, which is accompanied with the new cultural, political, economic, technological conditions brought about by the consequences of industrial revolution.

The 19th century was identified with the emergence of a new society, the separation of the craft from the production process, with mass production in factories, and owing to the new transportation systems, the enlargement of working areas that underpinned the formation of the global market economy.[2] Previous social orders were swept away by the relocation of new working groups

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[1] Thomas S. Kuhn. *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: The University of Chicago Press, 1970).

[2] Mertins, introduction to *The Victory of the New Building Design*, 2.

(that is, labor) into the metropolis.[3] The relationship between designers, workers, manufacturers, and distributors were dismantled. With especially the development of transport and communication networks, the notion of time totally changed.[4]

The three best-known challenges that the architectural realm faced were: "The qualitatively new requirements in architectural design, the new materials and construction techniques, and the subjugation of architecture to new functional, above all economic, imperatives." [5] The first challenge refers to the new types of buildings, such as the railway station, the factory, the department store, and the exhibition hall. The second correlates especially with one of the main problematics of this century as the new materials demand new construction techniques, and by consequence, introduce new architectural forms. Another imperative of the second challenge relates to the products of the machines, which pose a dual problem, first with their new "standard" forms, and second, with their production process.[6] The third challenge also correlates with the two former problems. The rise of mass markets –accompanied with the advertising and mass fashion– and the construction techniques of that period actually demand the standardization of forms, which were economically preferable.[7]

Regarding all these effects, it is accurate to state that changes in social life have totally altered not only the way we live, but also the way we experience space and time.[8] The way the architects design is thereby affected. In this sense, new definitions needed to be in accord with all these new developments along with

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[3] Ibid., 15.

[4] Jürgen Habermas, "Modern and Postmodern Architecture," in *Critical Theory and Public Life*, ed. John Forester (Cambridge, Mass.: MIT Press, 1988), 320.

[5] Ibid., 319.

[6] Ibid., 320.

[7] Mennan, "Reversing Modernist Historiography: the Organicist Revival in Computational Architectures."

[8] Marshall Berman, "Introduction: Modernity-Yesterday, Today and Tomorrow," in *All That is Solid Melts into Air: The Experience of Modernity* (London: Verso, 1983), 15-36.

the new norms of everyday life.[9] The scope of the present survey is limited to the ways architectural design looked into nature for a firm basis.

3.1.2 The Evolution of the Biological Developments Effective on Architectural Praxis until the Early 20th Century

The understanding of the organic derived from the empirical observation of nature, which is especially a visual appreciation, is altered with the first attempts in the mid 17th century to discover the inner logic of Nature. The historical review of the biological and mathematical sciences dating back to the 1750s, accompanied with the ideas of romantic writers of that period, demonstrate how the analogy of organic form, that is organicism, gradually evolved in the realm of architecture.

The following review will briefly illustrate how the awareness of self-generation - especially the concept of "unfolding from within" and process according to which natural forms gain shape comes into prominence in the realm of architecture. Accompanied with the search of a form generation process, the attempts to classify the species during 18th and 19th centuries presented an important metaphor in terms of a historicized sense of style which is directly related to the architectural discourse of that period.[10] This new understanding of style will be referred to in terms of its effectiveness on the unification of art and nature. Furthermore, how the notion of "organic functionalism" surfaced in the 20th century organic tradition will be clarified. Within this review, it should be noted that although there was deep interest in the developments in biological sciences, architects were especially interested in the works of the following scientists: George Cuvier, Johann Wolfgang von Goethe, and Ernst Haeckel. Moreover, the architectural theories in the two continents were grounded on the romantic

[9] Mertins, introduction to *The Victory of the New Building Design*, 15.

[10] Amy Kulper, "Of stylised species and specious styles," *The Journal of Architecture* 11, no. 4 (2006): 391-392, http://www.informaworld.com/10.1080/13602360601037693 (accessed July 4, 2008).

writers' ideas on organic forms, such as: Coleridge, Schlegel in Europe, and Emerson in America. In this sense, the important remarks of the European scientists on the characteristics of organic beings and their correlation with the romantic tradition –widespread also in America, especially in literature – will be reviewed as the basis of the ongoing debates on the unity of art and nature.

According to Peter Collins, the attempts beginning in the 1750s to classify organic beings with the intention to clarify the generation of forms in Nature constitute the origins of organic analogy in modern architectural theories.[11] By that time, according to Helmur Müller-Sievers, the Aristotelian doctrine of epigenesis had been recently reintroduced by the modern sciences and had become one of the central issues that was to be dealt with over decades.[12] This doctrine, by allowing for an objective presentation of nature, enabled "organic" to "bec[o]me the ultimate praise in philosophical and aesthetic judgment in the period of the epigenetic turn, a status the word has not lost since."[13] Therefore, understanding how the biological sciences evolved within this period is necessary.

Explaining natural phenomena through mathematical and physical laws was the dominant rule in biological sciences in the 1750s. As a consequence, the lack of a proper scientific method was one of the major problems of the natural sciences. This problem was first identified by Immanuel Kant (1724-1804), who especially in his book *Analysis of the Concept of Purpose,* identified the need to redefine the boundary between biology and mathematical sciences through a convenient system with proper methods and principles in order to attain an "autonomy" of biology.[14] With such a new "autonomy," he aimed to redefine the notion of

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[11] Peter Collins, "Biological Analogy," in *Changing Ideals in Modern Architecture, 1750-1950* (London: Faber and Faber, 1965), 149.

[12] Helmut Müller-Sievers cited in Detlef Mertins, "Bioconstructivism," in *Nox : machining architecture*, by Lars Spuybroek (New York: Thames & Hudson, 2004), 361.

[13] Helmut Müller-Sievers, *Self-generation: biology, philosophy, and literature around 1800* (Stanford: Stanford University Press, 1997), 4.

[14] Ernst Cassirer, *The Problem of Knowledge* (New Haven: Yale University Press, 1950), 118-120.

organic systems from his own teleological concept presented in his book *Critique of Judgment* (1790).[15] All deductions from this review will be based on scholars' understandings of Kant's ideas on the creation of knowledge in art and science.

In his book the *Critique of Judgment*, Kant was concerned with one of the main questions enabling to understand the inner workings of nature. Hvattum summarizes it as follows: "What is it that justifies us in seeing nature as a whole that assumes the form of logical system?"[16] Along with his answer to this question and his definition of pure reason, Kant aimed to formulate the way we understand nature through empirical data. Kant declared that due to our nature of understanding, we are able to attribute a lawfulness and purposiveness in nature.[17] It is our cognition of nature which assumes that nature is purposive. In this sense, the lawfulness is seen as a formal purposiveness of nature which enables us to investigate nature.[18]

Kant propounds two forms of order in knowledge: The concept of causality and purpose.[19] On these concepts and on the system of nature, Cassirer states that:

> Causality has to do with the knowledge of the objective temporal successions of events, the order of change, whereas the concept of purpose has to do with the *structure* of those empirical objects that are called living organisms…It is enough if we recognize a special kind of being –that of "natural forms" – and understand it in its systematic order as a unified self-contained structure…It [biology] considers nature under aspect of a whole so formed that it determines the properties of its various parts.[20]

[15] Mari Hvattum, *Gottfried Semper and the Problem of Historicism* (Cambridge: Cambridge University Press, 2004), 130.

[16] Ibid.

[17] Ibid.

[18] Ibid., 131.

[19] Cassirer, *The Problem of Knowledge*, 121.

[20] Ibid.

Cassirer notes that Kant, by defining the concept of purpose, referred to inner methodological reason, that is, the regulative of the system effective on the formation of a mathematical natural science.[21] Kant's approach to purposiveness is not related with "any utilitarian purpose that nature may serve."[22] This immanent purposiveness is not simply used to judge organic systems, as Kant put forth that it is in accord with every organized being called as 'natural purposes,' such as works of art. Cassirer cites Kant's element of purposiveness as: "An organized product of nature is that in which all is reciprocally end and means."[23] According to Kant, parts are interrelated through a system with reference to the whole, and the whole with reference to the part generate the organisms.[24] By consequence, Kant stated that it would not be possible to understand the inner principle within nature "merely through the mechanical principles of nature."[25] In this sense, he underlined one of the most important characteristics of nature that is self-referentiality, which was referred to several times in the history of biology, art, and the sciences.

With these concepts in mind, Kant pointed out the way for the study of nature, which firstly presupposes to conceive nature as a whole acting according to law.[26] Kant states that the scientist should relentlessly observe natural phenomena in order to sense and discover the law which lies underneath. Afterwards he tries to prove empirically that law through experiences.[27] In this sense, Kant tried to demonstrate the way to the objective natural sciences from its own natural characteristics.[28] This philosophy underpinned his successors,

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[21] Ibid.

[22] Hvattum, *Gottfried Semper and the Problem of Historicism*, 131.

[23] Kant cited in Cassirer, *The Problem of Knowledge*, 120.

[24] Hvattum, *Gottfried Semper and the Problem of Historicism*, 132.

[25] Cassirer, *The Problem of Knowledge*, 122.

[26] Ibid., 126.

[27] Ibid., 127.

[28] Ibid., 123-136.

totally changed the conception of the organic wholes, and enabled to define the organic world not as a substantial or static system but a relational one.[29]

The researchers, along their way to understand the method according to which nature generates, concentrated on the following scientific problems: the classification of organic beings, the process effective on the generation of organic form, and the evolution which provides the variety of organic forms.[30] As all these problems are interdependent, the theories propounded by any scientist of that period have conceived them as a whole.

Taken chronologically, two books are significant, as they are the preliminary attempts to explain the appearance of new organisms. The first one is Carolus Linnaeus' (1707- 1778)[31] *Plantarum* (l753) "in which the entire vegetable kingdom was classified binominally according to the disposition of the female reproductive organs, or 'styles,'"[32] and the second Georges-Louis Leclerc, Comte de Buffon's (1707- 1788)[33] book, *Histoire Naturelle* (l749), which attempted to "incorporate all biological phenomena into a general interpretation of the laws governing the universe."[34] Linnaeus' compilation was gathered through arbitrarily chosen characteristics, that is, the modes of the reproductive systems of organic beings. It envisaged a statically ordered classification which is formed from the simple towards the complex. While rejecting Linnaeus' system, Buffon's conviction was

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[29] Mari Hvattum, "'Unfolding from within,'" 499.

[30] Stephen Jay Gould, "D'Arcy Thompson and the Science of Form," *New Literary History* 2, no.2, Form and Its Alternatives (1971): 231-235, http://www.jstor.org/stable/ 468601 (accessed May 3, 2008).

[31] Linnaeus was a Swedish botanist, who was the first to specify the principles for "defining genera and species of organisms and to create a uniform system for naming them." *Encyclopaedia Britannica Online*, s.v. "Linnaeus, Carolus," http://search.eb.com/eb/article-9048407 (accessed January 3, 2007).

[32] Collins, "Biological Analogy," 149.

[33] Comte de Buffon was a French naturalist who is especially known for his multi-volume work on the classification of the animal kingdom and minerals. His work attemted to unify the knowledge on natural history within "a generally intelligible form." *Encyclopaedia Britannica Online*, s.v. "Buffon, Georges-Louis Leclerc, count de," http://search.eb.com/eb/article-9017945 (accessed January 3, 2007).

[34] Collins, "Biological Analogy," 149.

towards "a dynamic whole" of the nature.[35] He claimed the existence of an animate, organic matter existent within all the animal and vegetable substances, which is active on their nourishment, their development, and their reproduction.[36] This organic matter comes equally from the male and the female sexes.[37] This philosophy of creation proffers for the first time in history an active inner principle and the idea of evolution.[38] Müller-Sievers explains that Buffon's idea of inner principle, later elaborated by Caspar Friedrich Wolff (1733-1794)[39] and then by Friedrich Blumenbach (1752-1840)[40], is prominent in terms of suggesting a new theory of self-generation of Nature.[41] Self-generation of the organic structure was generated through an emergent inner principle.[42] These theories explained that the organic form generation process was conducted through the inner-self of the organic being.[43]

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[35] Maurice Mandelbaum, "The Scientific Background of Evolutionary Theory in Biology," *Journal of the History of Ideas* 18, no. 3 (1957): 345, http://www.jstor.org/stable/2707797 (accessed May 9, 2008).

[36] Müller-Sievers, *Self-generation: biology, philosophy, and literature around 1800,* 32.

[37] Ibid., 31-34.

[38] Collins, "Biological Analogy," 149.

[39] Wolff was a German anatomist and physiologist. He is one of the founders of modern embryology. "In his *Theoria generationis* (1759) he reintroduced the theory of epigenesis [formation of the bodily form gradually from a germ containing primitive homogeneous material] to replace the then current theory of preformation [a simple bodily form with its organs is already existent in the germ and unfolds to form the adult]." *The Columbia Encyclopedia Online,* s.v. "Wolff, Caspar Friedrich," http://www.bartleby.com/65/wo/Wolff-Ca.html (accessed January 3, 2007).

[40] Johann Friedrich Blumenbach was a German physiologist and comparative anatomist, who is considered as the father of physical anthropology with his classification of the races of mankind. He showed the importance of comparative anatomy for the humankind. He divided the mankind into five families through his reseaches on measurement of craniums. *Encyclopaedia Britannica Online*, s.v. "Blumenbach, Johann Friedrich," http://search.eb.com/eb/article-9015787 (accessed January 3, 2007).

[41] Mertins, "Bioconstructivism," 361.

[42] Timothy Lenoir, "Kant, Blumenbach, and Vital Materialism in German Biology," *Isis* 71, no. 1 (1980): 83, http://www.jstor.org/stable/230314 (accessed May 2, 2008).

[43] Mertins, "Bioconstructivism," 361.

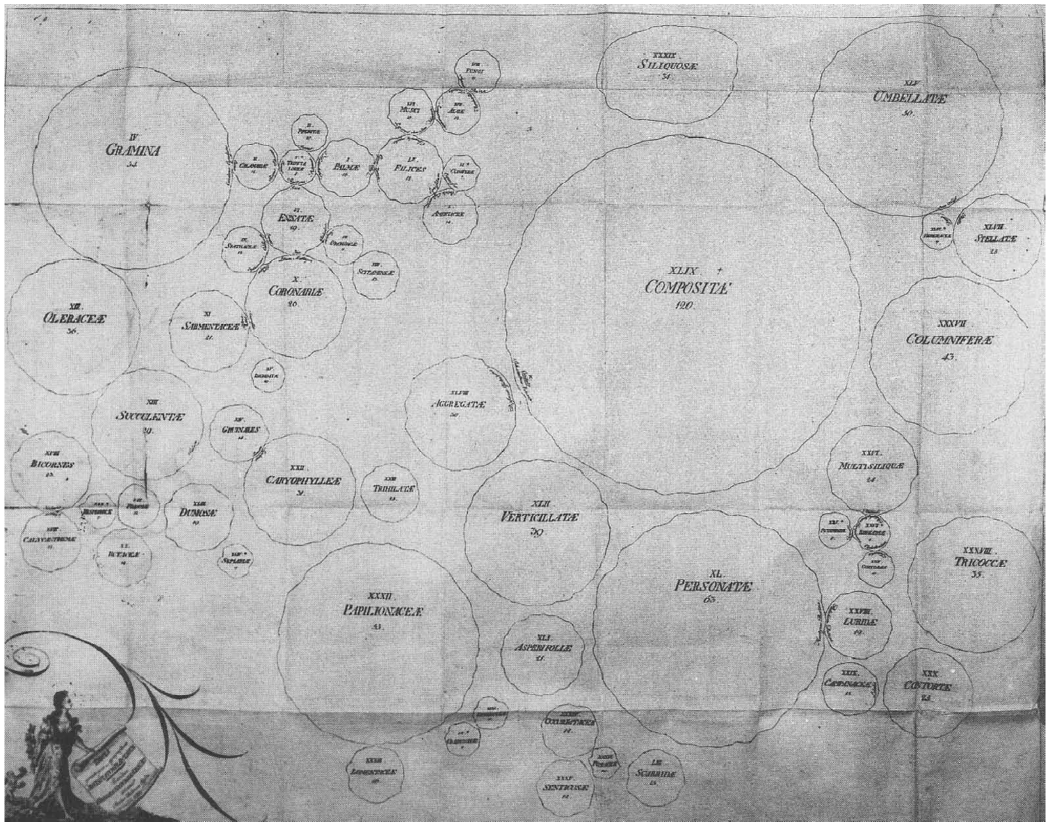

Figure 3.1: Linnaean Map of affinities between plants.

Paul Emmons, "Embodying networks: bubble diagrams and the image of modern organicism," *The Journal of Architecture* 11, no. 4 (2006): 444.

After the 1750s, remarks on the natural form generation continued to develop the idea of evolution. As a disciple of Buffon and the inventor of the term biology in its modern sense, Jean-Baptiste Lamarck (1744- 1829) had a pivotal role owing to his influence on his successors with his analysis of the problem of species.[44] His hypotheses regarding the genealogical factor as a sufficient factor to separate the species through the capacity of organic beings to produce its descendants and the impact of the environment on evolution through transmutation should be

[44] His full name is Jean-Baptiste-Pierre-Antoine de Monet, Chevalier de Lamarck. He is a French biologist, who is known for his studies on heredity. He suggested that acquired traits can be transfered to the offspring , this idea forms the basis of Lamarckism. *Encyclopaedia Britannica Online*, s.v. "Lamarck, Jean-Baptiste de Monet, Chevalier de," http://search.eb.com/eb/article-9028345 (accessed January 3, 2007).

highlighted in this sense. [45] Lamarck remarked that the determinant factors of the organ or bodily form are related with the environment and the habits according to which the ancestor of that organic being has lived.[46]

After explaining the emergence of the importance of environment along with the relevance between the function performed and the form of organic beings, it is important to refer to the principle of correlation introduced by George Cuvier (1769-1832)[47] in 1812, which created a shift in biological sciences in the classification of organic beings according to the function they performed. Cuvier's principle should be considered as a shift in architecture, as it will be seen later that many of his arguments are developed also within architectural discourses searching for the way to an organic architecture. His whole work, accompanied with his personal character and his ability to appeal to a vast audience, had been influential for nearly a quarter of a century on European scientifics.[48]

Cassirer states that, influenced by Kant's philosophy, Cuvier advocated a view of nature dependent on empirical research. He therefore concentrated on morphology, while having in mind the so-called concept of organic unity, that is, the coherence of whole and part as the essence of nature.[49] Being in conflict with

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[45] Mandelbaum, "The Scientific Background of Evolutionary Theory in Biology," 350.

[46] Ibid. See also Collins, "Biological Analogy," 150.

[47] His full name is Georgesléopold-chrêtien-frédéric-dagobert, Baron Cuvier. He is a "French zoologist and statesman, who established the sciences of comparative anatomy and paleontology." His collaboration with Étienne Geoffroy Saint-Hilaire until the publication of their study of mamalian classification ended by opening an important debate on the formation of organic beings. His principle of the "correlation of parts" published in his book *Leçons d'anatomie comparée* (Lessons on Comparative Anatomy). Controversial with the idea of Lamarckian evolution, he stated that the species had not changed since the Creation. Cuvier classified animals into four group according to their anatomical organization. Forms within the same group is attained through the modification of one anatomical type. He "broke away from the 18th-century idea that all living things were arranged in a continuous series from the simplest up to man." His works are considered as the transition from the 18th century view of nature, to the last half of 19th century. *Encyclopaedia Britannica Online*, s.v. "Cuvier, George, Baron," http://search.eb.com/eb/article-9028345 (accessed January 3, 2007).

[48] Paula Young Lee, "The meaning of molluscs: Leonce Reynaud an the Cuvier-Geofffroy Debate of 1830, Paris," *The Journal of Architecture* 3 (1998): 215-222, http://www.informaworld.com/10.1080/136023698374189 (accessed July 4, 2008).

[49] Cassirer, *The Problem of Knowledge*, 128-129.

Lamarck's view of classification, who considered it a product of human thought, Cuvier stated that the genealogical element is not hypothetical but can be proven through empirical data, which are based on the structural relationships between parts instead of laws of process.[50] As remarked by Cuvier, these relationships define the laws of nature and are dependent on fundamental types, or in his words, the "four principle forms and four general plans [vertebrates, mollusks, articulates, and radiates] … after which all animals appear to have been modeled."[51] These irreducible plans can show several differences depending on their development and addition of some parts, but the "essence of the plan" is still constant.[52] Lee notes that "because function determined structure, both form and function were fixed."[53] Introducing the influence of the performed function on the shape of natural forms, Cuvier stated that "every modification of a function entailed the modification of an organ."[54] He considered the organic being as a whole derived from interdependently combined parts. Due to his belief on the fixity of the plans, his types are static; they can vary according to environmental effects. Cuvier even combined his view with an architectural metaphor: "the composition of a house is the number of apartments of chambers found there; its plan is the reciprocal distribution of these apartments and chamber."[55] In this sense, Cuvier has been considered as a last biologist to maintain that nature does not evolve.[56]

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[50] Ibid. See also Mandelbaum, "The Scientific Background of Evolutionary Theory in Biology," 350.

[51] Cuvier cited in Lee, "The meaning of molluscs," 213-214,

[52] Ibid., 214.

[53] Ibid.

[54] Collins, "Biological Analogy," 151. See also, St John Wilson, *The Other Tradition of Modern Architecture*, 72.

[55] Cuvier cited in Lee, "The meaning of molluscs," 215. In the same article, Lee articulates that the design of Cuvier's own house as an extension to the museum is made by himself, regarding his theory of correlation.

[56] Hvattum, *Gottfried Semper and the Problem of Historicism*, 124.

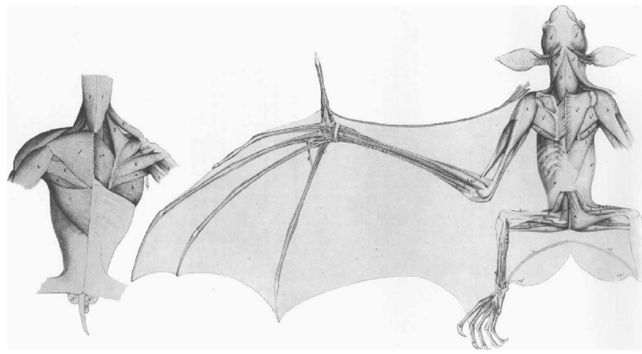

Figure 3.2: Georges Cuvier, dissection drawing of a bat.

Mari Hvattum, "'Unfolding From Within': modern architecture and the dream of organic totality," *The Journal of Architecture* 11, no. 4 (2006): 500, http://www.informaworld.com/ 10.1080/13602360601037941 (accessed July 4, 2008).

One of the main contributions to the theory of evolution was made by Charles Darwin (1809- 1882) through his theory of "Natural Selection." Opposing Lamarck, who had already claimed that the changes are transferred through the heredity to the offspring, in his book, *On Origin of Species* (1859), Darwin claimed that evolution is a selection of existing forms, which means the elimination of the obsolescent forms by Nature. Arbitrariness and accidental formal changes in nature cause a change in species because the non-functional forms never survive.[57] Darwin's theory, while rejecting the fixity of forms in favor of a dynamic principle of nature, underscored also the idea that 'function follows form.'[58] Although there is no written reference to show the relevance of this theory to the organic tradition of the 20^{th} century, it is possible to state that it showed the importance of environmental properties on natural forms.[59]

Regarding the consequences of these developments in the biological sciences, the major shift within the understanding of the organic form when compared to the classical and Renaissance period, is acknowledged by Hagan as "the

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[57] Collins, "Biological Analogy," 153.

[58] Ibid., 154.

[59] Ibid.

difference between the religious ‘top-down’ model of nature, and the Darwinian ‘bottom-up model”:

> In the first, order flows from the mind of God down through the Great Chain of being to the lowliest one-celled organisms. There is a unity in creation because it flows from a single source. In Darwin’s model, order arises from one-celled organisms. They evolve into more complex life forms in a state of mutual dependence. The unity lies in the interconnectedness of this bottom-up proliferation.[60]

Research on the theory of evolution and the self-generation process of nature, which will be explained later following the ideas of the well known scientists such as Ernst Haeckel, and Raoul Francé, continued to be the central problem of the biological sciences after Cuvier. But it is important to cast here the architectural responses to the above-mentioned developments, accompanied with the romantic tradition of the 18th and 19th centuries, which are interrelated with the new understanding of an organic architecture.

3.1.3 Redefinition of the Organic Form

As mentioned above, the unification of art and nature was central throughout the history of art, and by consequence, architecture. The artistic theory of the 1800s with respect to the improvements dealing with the qualities of natural forms in biological sciences is redefined with a significant impact on conceptions of organicism in architecture.

Johann Wolfgang von Goethe (1749-1832), considered as one of the leading figures of organic thought in art, took into account his interpretations of classical Greek art, which is in accord with the natural laws of their period. Goethe tried to formulate the idea that the laws governing the natural form generation process

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[60] Hagan, *Taking Shape: A New contact between architecture and nature*, 18.

and the development of species can be also applicable to art.[61] Regarding his study on morphology, which established an autonomous scientific research for biological studies, he aimed to understand the natural development from itself, with nature's own properties, through its own parts working dependently with the whole, that is, without referring to outer world.[62] He acknowledged the importance for the artist to study nature in order to grasp the "inside out" process on which form is dependent, a process for which he introduced the term "morphology."[63] While focusing on the formal properties of nature, Goethe emphasized its dynamic developmental characteristics. M. A. Báez explains Goethe's contribution to the understanding of organic development in the following manner:

> [Goethe] envisioned nature's creations as "patterned graduations" within a much larger harmonious "moving order." He tried to resolve the conflicting dichotomy between substance and form, the whole and its parts or mechanistic reductionism and holism through a conceptual synthesis of both. He searched for nature's primordial interrelated context. In the field of Botany, for example, he searched for the primordial plant that would contain the basic organizational blueprint from which all other parts would be derived.[64]

For Goethe, then, the formal process of organic bodies would definitely be related with the intrinsic and extrinsic conditions, without a need for the vital forces.[65] Thus, this process generates the variety of natural forms regarding the environmental conditions.[66] This formal development, identified both for art and

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[61] Van Eck, "Goethe and Alberti," 20.

[62] Kulper, "Of stylised species and specious styles," 393.

[63] Ibid.

[64] M. A. Báez, "Text-tiles of in-formation: Drawing inspiration from the nature of things," in *Design and Nature, Comparing Design in Nature with Science and Engineering*, ed. C.A Brebbia, L.J Sucharov and P. Pascalo (Southampton, Boston: WIT Press, 2002), 259.

[65] Kulper, "Of stylised species and specious styles," 393.

[66] Van Eck, "Goethe and Alberti," 22.

nature, is dependent on purposive unity, which was already defined during the Renaissance by Alberti.[67]

With his biological concepts, Goethe envisaged the implications of organicism in architecture. According to Goethe, Van Eck explains, the imitation is indirect; that is, it should not be based on the exterior forms of nature, but rather on "the structure and unity which nature imports to her organisms."[68] Purposive unity and the rules governing the form generation process championed as the main characteristics of nature that the architects should imitate. Goethe's organic concept on the formal development, with the idea of purposive unity of the parts did not perceive the final form as teleological, which means that the purpose was considered as the general system guaranteeing the unity.[69] Although, he put stress on the progressiveness of the process, his was unable to form a larger concept of nature.[70] Along with the German Romanticism, which is an "aestheticized type of science,"[71] Goethe's contributions on the account of organicism laid the background of especially British and German theories of ornament and style.[72]

Understanding the "organic" metaphor until the end of the 19th century within the context of architecture is not possible without knowing the ideas propounded by the romantic writers who were influential on the appreciation of nature in terms of what can be retrieved from the "organic" for artistic use.[73] Romantic writers, with their ambition towards nature, searched for the general rules effective on the

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[67] Ibid., 20.

[68] Ibid., 23.

[69] Kulper, "Of stylised species and specious styles," 393.

[70] Kulper, "Of stylised species and specious styles," 393.

[71] Barbara Whitney Keyser, "Ornament as Idea: Indirect Imitation of Nature in the Design Reform Movement," *Journal of Design History* 11, no. 1 (1998): 129, http://jdh.oxfordjournals.org/cgi/reprint/ 11/2/127 (accessed April 10, 2008).

[72] Keyser, "Ornament as Idea," 127-130.

[73] Eli Bornstein, "Toward an Organic Art," *Structurist*, no. 11 (1971): 58, http://pao.chadwyck.co.uk//PDF/1215424002294.pdf (accessed May 20, 2006).

variety of forms along with the formal generation process exhibited by nature. While being influenced by scientific researches, they revealed their own definition through their own visual contemplation. Although their concept of organic form, that is, the organic metaphor was decisively coined to interpret this notion for literature, their ideas were widely referred to by architects in the two continents.[74]

The idea of "from inside out," influential on the 20th century organic tradition in architecture, is first expressed by Samuel Taylor Coleridge (1772- 1834) for poetry in the *Lyrical Ballads* of 1798 in a lecture on Shakespeare.[75] Coleridge acknowledged the differences between organic and mechanic form. Being in favor of the former in *Biographia Literatura*, he stated that:

> The form is mechanic when on any given material we impose a predetermined form, not necessarily arising out of the properties of the material, as when to a mass of wet clay we give whatever shape we wish it to retain when hardened. The organic form, on the other hand, is innate; it shapes as it develops itself from within, and the fullness of its development is one and the same with the perfection of its outward form. Such is the life, such is the form. Nature, the primogenital artist, inexhaustible in diverse powers, is equally inexhaustible in forms.[76]

This understanding of organic can be found exactly in the same manner in the German romantic thinker August Wilhelm Schlegel's definition.[77] Briefly, the new understanding of organic form was not related with the imitation of the exterior form of nature. Natural analogy was to be found not in the visual appearance, but in the autonomous principle which generates forms, that is, the 'unfolding from within.' The reasons for the development and change of form are encapsulated within the organic self.[78] As seen before, this principle was already defined by Kant as 'purposive unity' while propounding the self-referential and self-regulating

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[74] For the relationship between the Romantic Movement and architecture see, Adams, "Architecture and the Romantic Tradition: Coleridge to Wright," 46-62.

[75] Ibid., 47.

[76] Coleridge cited in ibid., 47.

[77] Hvattum, "'Unfolding from within,'" 497.

[78] Ibid. See also, St. John Wilson, *The Other Tradition of Modern Architecture,* 49-78.

system of nature, identified as an immanent system.[79] This organic principle was considered as the way to an autonomous artistic style.

The shift within the classification system of the organic world from the 'stair/chain analogy' towards a connected network system found its reflection in modern architectural theories as well.[80] The stair concept entailed a world view dependent on a hierarchical relationship between organic beings as entailed in Linneaus' classification. The organic understanding –which can best be exemplified with "the comparative tableau of functional relationships in animals across time and place,"[81] prepared by Cuvier to demonstrate the self-contained nature of organic beings– changed this hierarchical view of nature into an interrelated network system.[82] This system can be compared to "a complex relational structure in which all entities are at the same ontological level."[83] Emmons argues that, while defining a complex system formed through what Schlegel called 'innate' relationships, this organic view led to the development of bubble diagrams of the 20th century.[84]

The appreciation of nature is seen to have definitely changed. The classification of the organic world is now replaced with the theories of evolution which change the static conception of nature by a dynamic conception of nature. As Brett identifies accurately ""laws" relating design to "the distribution of form in nature" are stealthily replaced by "laws" prescribing the process of designing in terms of evolving types."[85] The shift within the biological sciences, with the contributions of

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[79] Hvattum, "'Unfolding from within,'" 498-499.

[80] Ibid., 499.

[81] Ibid., 500.

[82] Ibid., 499.

[83] Ibid.

[84] Paul Emmons, "Embodying networks: bubble diagrams and the image of modern organicism," *The Journal of Architecture* 11, no. 4 (2006): 441-461, http://www.informaworld.com/10.1080/13602360601037867 (accessed July 4, 2008).

[85] David Brett, "Design Reform and the Laws of Nature," *Design Issues* 11, no. 3 (1995): 41, http://www.jstor.org/stable/1511770 (accessed May 23, 2008).

the Romantic Movement, defined a shift for the re-conceptualization of organicity in architecture. As will be seen, this redefinition caused a dualistic approach, on the one side those who were willing to imitate the formal appearance of nature and, on the other hand, those who are admitting an organic form generation process for architecture which relies on an indirect imitation.[86] Here, the intent is to delineate the second approach due to its relevance for contemporary architectural praxis.

Coleridge's ideas on organic form, the biological developments, in which Cuvier's theory of correlation was the most referenced, and the German Romantic movement, which was best identified with Goethe and Schlegel, were influential on the formation of German and English aesthetic theory. Moreover, these generalizations on the organic concept formed the ideological part of the formation of organic architecture in America, which will be introduced later.[87] In order to grasp the role of the architect within this new organically designed architecture, understanding the principles of these newly introduced aesthetic theories is required.

3.1.4 Redefinition of the Organic Approach within the Architectural Realm: Germany, Britain, France and America

During the late 19th and the early 20th centuries, architects were interested with all these developments in science and technology, which brought forth a vast mass of principles that could be used to redefine the role and the design process of architecture to deal with the problems introduced by the industrial revolution.[88] During the 19th century, return to historical periods was central for the search of

[86] Edgar Kaufmann, Jr., "Nineteenth-Century Design," *Perspecta* 6 (1960): 59, http://www.jstor.org/ stable/1566892 (accessed April 24, 2008).

[87] Mark Mumford, "Form Follows Nature: The Origins of American Organic Architecture," *Journal of Architectural Education* 42, no. 3 (1989): 26, http://www.jstor.org/stable/ 1425061 (accessed May 4, 2008). See also Adams, "Architecture and the Romantic Tradition: Coleridge to Wright," 47.

[88] Kaufmann, Jr., "Nineteenth-Century Design," 58.

an appropriate style for current problems.[89] It is seen that the organic metaphor took a decisive role in this conceptualization of architectural history, in which the major attempt was to compare the history to an organism.[90]

This organism metaphor for the history was firstly introduced by Johann Joachim Winckelmann (1717-1768) with his book *Geschichte der Kunst Alterthums* (The History of Ancient Art, 1764), which was written according to his enthusiastic researches on Georges Buffon's book *Histore Naturelle* (Natural history).[91] Winckelmann attempted to define the generation of architectural forms as if they were natural bodies. Kulper states that "[f]rom Buffon [Winckelman] acquired a meticulously historicized sense of nature and natural species, which he developed into an equally historicized sense of style."[92] His description of the history of art implies the needed correlation between the lifespan of biological species and the artistic styles. By referring to the origin, progress, change, and downfall of an artistic style, he aimed to demonstrate that the relationship between specimen and species exists also between the art object and style. He thereby proposed the possibility that style can be biologically transmitted.[93] This idea aims to demonstrate a continuous and lawful development for history. A later approach which is indebted to Kant's idea on organism was propounded by Johann Gottfried Herder, who was also the antecedent of Goethe (1744-1803).[94] He compared history to a living being that was a tree at this moment. He demonstrated on the one hand the continuity and lawful development that was attained, and on the other, "an idealist vision of the history as a succession of autonomous epoch each with its particular and distinct *Zeitgeist*."[95] From this point of view, history as an organism continues to develop, but at every stage its

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[89] Ibid.

[90] Hvattum, "'Unfolding from within,'" 502-505.

[91] Kulper, "Of stylised species and specious styles," 391-392.

[92] Ibid., 392.

[93] Ibid.

[94] Hvattum, "'Unfolding from within,'" 502.

[95] Ibid.

form is complete.[96] Actually, this comparison aimed to demonstrate the organic unity between the formal properties and the content, that is, style and epoch.[97] On this metaphor, Hvattum states that:

> The notion of the epoch as an organic totality had important consequences for the domain of art, not least for the modern idea of artistic style. If the epoch formed a self-sufficient whole with its own unique 'soul', it was the role of art and architecture to give visible expression to this epochal unity. In the same way that late eighteenth century anatomy could see the outer form of an organism as a direct expression of its inner workings, early nineteenth century art history could see the style of an epoch as the outer manifestation of the spirit of the time. From this perspective, architecture is essentially an embodiment of the epoch: its role is to represent the *Zeitgeist* in as truthful and coherent a manner as possible.[98]

This notion of epoch as an organic totality, nourished by the scientific comparisons made in the biological sciences as well, showed that the 19th century, could not achieve that needed unity.[99] The notion of style expressing the life of the nation or the epoch, while referring to an organic unity, had a correlation with the idea of having "a principle."[100] This approach by an English architect A. N. Welby Pugin (1812-1852) aimed primarily to understand the new conditions of the 19th century for the purpose of adopting the new construction techniques, as well as new materials, and thereafter formulating an appropriate style, or principle out of them.[101] Regarding the organic notion of history, the theorists championed Gothic architecture as a good example which could represent the organic relationship between style and epoch, with its structural properties used appropriately to its construction methods and materials.[102] In this

[96] Ibid.

[97] Ibid., 504.

[98] Ibid., 503.

[99] Ibid., 504.

[100] Kaufmann, Jr., "Nineteenth-Century Design," 59-60.

[101] Ibid., 60.

[102] Hvattum, "'Unfolding from within,'" 503.

sense, the influence of Gothic architecture is seen to reappear within the projects designed with an organic approach as well.[103]

The impact of the new understanding of history is explained by Hvattum in the following manner: "The constant cry for an 'architecture of our time' and the frequent invocation of a crisis of the present heard throughout the nineteenth century may be seen as a direct consequence of the organic conception of history."[104]

With the aim to re-conceptualize an 'architecture of our time,' the problematic due to the industrial revolution, accompanied with the developments in biological sciences and newly introduced construction technologies, laid the foundation of the organic approach in the architectural realm. The emergence of the organic approach can best be traced through the pivotal works of architectural theorists of the 19th century: Gottfried Semper, Christopher Dresser, and Viollet-le-Duc. Their counterpart in America will be addressed through a review of the romantic writers. It should be pointed out that all these theorists and architects have been interconnected through their visits or the translation of their books. Their contribution to the organic approach of the 19th and early 20th centuries will be used to clarify the role of the architect within the design process.

Gottfried Semper (1803-1879), known as one of the main influential characters of 19th century architectural discourse, claimed the usefulness of Cuvier's "principle of correlation" as the basis of a theory of architectural style.[105] He was influenced by Cuvier's comparative method and what this method has revealed, that is, the dependence of the form on its performed function.[106] Hvattum explains the consequences of this method in the following manner:

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[103] Donald Hoffmann, "Frank Lloyd Wright and Viollet-le-Duc," *The Journal of the Society of Architectural Historians* 28, no. 3. (Oct., 1969): 173-183, http://www.jstor.org/stable/988556 (accessed May 23, 2008); Kaufmann, Jr., "Nineteenth-Century Design," 57-59.

[104] Hvattum, "'Unfolding from within,'" 504.

[105] Kulper, "Of stylised species and specious styles," 394.

[106] Hvattum, *Gottfried Semper and the Problem of Historicism*, 136.

> No longer referring to a reality to which the organic system belongs, the comparative disciplines formulated immanent criteria for meaning and truth, thus opening the possibility of an autonomous science of life, language, and art. The comparative method challenged the traditional notion of art and science as modes of representation of a world order. Within the comparative matrix, the world order itself becomes an abstract set of coefficients, potentially open for scientific explanation.[107]

Just as this method enabled the scientists such as Cuvier to gather the autonomy of organic world without any reference to an outer world, it was then possible for Semper to use this model for architecture as well.[108] It was this immanence which generates the self-sufficient totalities that attracted Semper through his search for the appropriate style for the period. His aim "to formulate a science of art"[109] was dependant on his redefinition of the notions of type and comparison according to an organic model, which takes into account the functional and structural relationships.[110]

Inspired from the effect of the function on natural form generation process, Semper defines style as "the accord of an object with its genesis, and with all preconditions and circumstances of its becoming."[111] This growth scheme will ensure the appearance of wholeness, along with the autonomy of architecture. From this point view, Cuvier's functional classification has brought forth the consideration of function, programme, and typology in architectural designs.[112] Semper suggested that architecture should grow as an organic being with the interaction of inner forces according to the purpose of configuration.[113] Semper envisaged that different manifestations of inner forces would enable a variety of

[107] Ibid.

[108] Ibid.

[109] Ibid.

[110] Ibid.

[111] Kulper, "Of stylised species and specious styles," 395.

[112] Ibid., 402.

[113] Keyser, "Ornament as Idea," 137-138.

architectural forms according to the purpose of configuration. This model acquired from Kantian philosophy proclaims the importance of purpose in nature as well as in the work of art. Stated further by Semper, as "an internal coefficient,"[114] purpose enables to generate the needed autonomy through its own organic principles.[115] In order to underline the importance of the organic notion, Semper seems to suggest that "[a] truly organic architecture is an architecture that carries the reason for its own expression *within itself*, within its own material and aesthetic composition."[116]

The idea of 'unfolding from within,' is seen to reappear in Semper's organic model, but within this system, the growth process is tied strictly to the functional and structural unity of the parts. Only the self-referential character of nature is seen to be referred to in terms of architecture. Hvattum explains one the significant contributions of Semper's organicity: "The transformation of the microcosm from an analogous to an innate phenomenon is significant, corroborating the drive towards formal autonomy that is part and parcel of modern organicism."[117]

In France, a similar organic approach is seen to be referred to for the architectural design process. The French architects at the Ecole des Beaux-Arts especially sought to relate the principles derived from natural sciences principles to architectural theories in order to generate a new style.[118] Eugène-Emmanuel Viollet-le-Duc (1814-1879) was one the prophets of this approach. Along with his colleagues, he admitted that "the natural principles of creation" should be followed in order to be true to architecture.[119] By meaning true, they referred actually to the self-referential character of architecture, with the proper use of

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114 Hvattum, *Gottfried Semper and the Problem of Historicism*, 5.

115 Ibid., 5, 136.

116 Hvattum, "'Unfolding from within,'" 497.

117 Ibid., 506.

118 Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 27.

119 Hoffmann, "Frank Lloyd Wright and Viollet-le-Duc," 177.

materials and structure, accompanied with function.[120] For the organic approach of the 19th century, derived from the biological sciences, it is possible to admit a commonplace in architecture, that is, the relationship between function and structure, or function and form. It is held that exterior formal qualities are the result of internal composition.

The counterpart of this commonplace, that is, the unity of function and form was also stemming out from America. It is accurate to state that the affinity was not a coincidence since the origins of the artistic concept of the American organic tradition were derived from European philosophers and architects.[121] Inspiration from nature was considered as the only way by the American architects and theorists aiming to define a modern aesthetic.[122] In this sense, they were in line with the American transcendentalist philosopher Emerson and his successors Thoreau, Whitman, Hawthorne and Melvill, and considered their writings as an intellectual basis.[123] They referred to the method of creation exhibited by nature, which can present one of the best examples with its ability to develop abstract forms governed by its own growth process.[124] In this sense, Frank Furness, Louis Sullivan, and Frank Lloyd Wright, the founders of the organic approach in America, looked for how nature as conceived by Emerson could generate a new way of production for the artists through an indirect imitation. [125]

Motivated by Emerson's ideas, Horatio Greenough pointed out the relationship between form and function in nature.[126] His enthusiasm felt for the variety of natural forms led him to search for natural construction principles. He admitted that an undeniable principle shapes the organic forms in a way that there are no

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[120] Ibid.

[121] Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 27.

[122] Ibid.

[123] Ibid., 26.

[124] Ibid.

[125] Adams, "Architecture and the Romantic Tradition: Coleridge to Wright," 46-62.

[126] Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 26.

arbitrary proportions, no excess, and especially all fit to what is necessary. Regarding Greenough's aesthetic theory, accompanied with the English – especially Coleridge– and German aesthetic theories, Emerson urged the artists to search for the relationship between form and function.[127]

Emerson stated that the artistic composition could not be gathered directly from nature; natural aspects should be appreciated by imagination in order to conceive a new reality. The artistic materials should then be revisited with the light of the organic method as identified above. The contributions of transcendentalists, regarding the appreciation of organic form were valuable, but they could not posit an aesthetic theory directly applicable to architecture.[128] Mumford states that American architects borrowed the artistic concept, that is, the formal process in accord with the organic method from the theories of the French "Romantiques" at the Ecole des Beaux-Arts.[129] As one of the pioneers of this theory, Viollet-Le-Duc's ideas were studied extensively by American architects. Mumford explains the transition of these theories from France to America. As already mentioned, the relation between structure and function was propelled as the main guiding principle for the artists.[130]

The study of French "Romantiques" enabled the American organic followers to turn to Greek Arts as a model which shows an organic art without merely copying natural forms. They envisaged that the "Greek artists converted nature to abstract form."[131] These forms were stemming out of the imagination of the artist by the contemplation of nature. By consequence, the position of the artist was considered as an interpreter of the natural harmony. In this sense, the abstract lines were the most convenient expression to depict what was seen beautiful in nature: Van Burnt defined the abstract lines as "the immediate source of

[127] Close, "Commonplace Theories of Art and Nature in Classical Antiquity and in the Renaissance," 467-468.

[128] Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 26.

[129] Ibid.

[130] Ibid., 28.

[131] Ibid.

emotion,…presenting it palpably to the senses…by an instinctive and universal symbolism. Hence came those lines, which aesthetic writers term as 'lines of beauty,'…animated with life and thought and musical motion…"[132] Herein lies the consideration of the motion and development of natural beings, as a metaphor for architectural praxis.

Another influential artistic concept came from the English theorist Christopher Dresser (1834- 1904) –associated also with the French "Romantiques"– whose books were widely read by American architects.[133] Dresser accentuated the study of nature on his way to unite artistic work, scientific effects and industrial production. He maintained that during the form generation process of nature, the internal –that is, the energy of growth– and external forces –that is, gravity, wind, water, and soil– are at play.[134] By stressing the importance of this dynamic property of nature, he stated that it was then possible to find the visual expression of these forces on the final form, which also expresses its own life. Dresser pointed to the necessity to study the character of nature for being able to search the expression in artistic form.[135] It was in this course that 'Art-botany' has been introduced into the realm of architecture as a teaching based on the study of plant forms in England.[136] Regarded as the foundation of modern movements by David Brett, Art-Botany was among the preliminary attempts to integrate "scientific instruction with design training."[137] Depending on the stylization of natural form and its growth through drawings, this study enabled "the contribution

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[132] Ibid.

[133] Ibid. Dresser was a pupil of Richard Redgrave (1804-1888) and Owen Jones (1809-1874). The contributions of these architects are valuable on the formation of Dresser's own theories. Influenced by the taxonomic studies in the biological sciences, Owen is well known with his book *The Grammar of Ornament* which is compared to a taxonomy of ornamental styles. See, Kulper, "Of stylised species and specious styles," 396.

[134] Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 28. Keyser, "Ornament as Idea," 138-139.

[135] Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 28. See also David Brett, "The Interpretation of Ornament," *Journal of Design History* .1, no. 2, (1988): 105, http://jdh.oxfordjournals.org/cgi/reprint/1/2/103 (accessed May 10, 2008).

[136] Keyser, "Ornament as Idea," 127.

[137] Ibid.

of mind to representation,"[138] and demonstrated the possibility of expressing "thoughts, feelings, and ideas without the aid of recognized symbols."[139] The unity of feeling called for the unity of expression. Thus this novelty in decoration had enumerable contributions.[140] Regarding the indirect imitation of nature, Brett states, "Here was the key to the 'infinite variety' that the study of Nature would bring to manufactures: the combinatorial methods of conventional [stylizitation] drawing could be allied to the generative systems of the natural world."[141] In this sense, this understanding also attributes the artist the role of the interpreter of the seen world, and the role of artistic form giver.

All these approaches to nature, gathered through English, French, German, and American aesthetic theories, are seen to culminate in Leopold Eidlitz's (1803-1908) organic aesthetic theory.[142] He suggested generating architectural forms by imitating the principles of natural structures. He maintained, as did the French theorists, that expression of the function is directly related with the natural laws. So, artistic expression should also depend on "the forces acting through the structure of a composition."[143] The growth and motion considered as the main cause of form is seen to be referred extensively. To this end, Eidlitz explained the role of the architect as follows:

> [i]n this way [natural organisms] convey to the mind an expression of these functions, and thus tell the story of their being. The architect, in imitation of this natural condition of matter, so models his forms that they also tell the story of their functions… [144]

As explained by Richard P. Adams, the properties of the organic form gathered through the ideas of romantic writers laid the foundation of an organic

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[138] Ibid., 139.

[139] Brett, "The Interpretation of Ornament," 105.

[140] Ibid.

[141] Keyser, "Ornament as Idea," 139.

[142] Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 29.

[143] Ibid.

[144] Ibid.

architecture in America.[145] It is seen that, in America, although the organic metaphor connotes similar notions that appeared in European theories, such as the imitation of natural growth and the importance of the function on the organic form, the organic forces along with the movements of natural beings comes into prominence. One of the leaders of this understanding is Frank Lloyd Wright. His architectural design process along with his understanding of organic form will be revealed in the third chapter.

3.1.5 Reducing the Quantitative into Quality: Ernst Haeckel, D'Arcy Thompson and Raoul Francé

Interest in the attempt to clarify the underlying system –or better law– generating the variety of forms in nature have long continued to be at the core of the organic approach in architecture after Cuvier's and Darwin's theories, and with much eager.[146] Among the main challenges which especially influenced the architectural realm is the work by the German zoologist Ernst Haeckel (1834-1919), who studied microscopic single-cell sea creatures in the 1880s.[147] Following Darwin as well as his ancestors, his investigations aimed to reveal the concepts of "unfolding from within," which can be called also self-generation, and the underlying continuity and integration of nature, through the evolution.[148]

Ernst Haeckel, in his popular book published in 1904, *Kunstformen der Natur* (The Art forms of Nature), as well as his *Report of the Scientific Results of the Voyage of H.M.S.* Challenger (1887), presented a great amount of these uni-

[145] Adams, "Architecture and the Romantic Tradition: Coleridge to Wright," 47.

[146] His close relationship with the architects enabled to disseminate his biological findings to the architectural realm. Matthias Gross, "Restoration and the Origins of Ecology," *Restoration Ecology* 15, no. 3 (2007): 375-376, http://www3.interscience.wiley.com/cgi-bin/fulltext/117979244/PDFSTART (accessed May 15, 2008).

[147] Mertins, "Bioconstructivism," 364.

[148] Robert Proctor, "Architecture from the cell-soul: René Binet and Ernst Haeckel," *The Journal of Architecture* 11, no. 4 (2006): 415, http://www.informaworld.com/10.1080/13602360601037818 (accessed July 4, 2008).

cellular organisms by giving their drawings on plates.[149] His works on species of radiolarian showed that there were approximately over four thousand species of radiolarian found all over the world.[150] He already assumed that nature contained within itself its own form generation mechanism,[151] and given the number of different of species, he pointed out that the uni-cellular species of organisms can present a good example for learning about self-generation, that is, unfolding of forms in nature, as these can produce an "endless variety –if not multiplicity per se- in complex as well as simple forms of life."[152]

To deal with the complexity and variety of the given forms, Haeckel referred to "crystallography for its ready principles of geometrical complexity described through the analysis of different kinds of symmetry."[153] Even though the fallacy of his method, along with its consequences, would be proved by his successors during the 20th century, the geometrical system that he used was appropriate to demonstrate the similarities between the organic forms.[154] According to his belief that the whole of nature could be incorporated into an evolutionary system, he classified radiolarians "into a system of development from the visually simple to visually complex."[155] In brief, Haeckel explicitly assumed, like Lamarck, that the formal complexity was generated by progressiveness of evolution, according to which the species are not fixed. Regarding the underlying law of nature, the natural development was always towards formal complexification.

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[149] Ibid., 407.

[150] Ibid., 410.

[151] Ibid., 415.

[152] Mertins, "Bioconstructivism," 364.

[153] Proctor, "Architecture from the cell-soul," 412.

[154] Paul Dombrowski, "Ernst Haeckel's Controversial Visual Rhetoric," *Technical Communication Quarterly* 12, no.3 (2003): 303-319, http://www.informaworld.com/10.1207/s15427625tcq1203_5 (accessed April 24, 2008).

[155] Proctor, "Architecture from the cell-soul," 412.

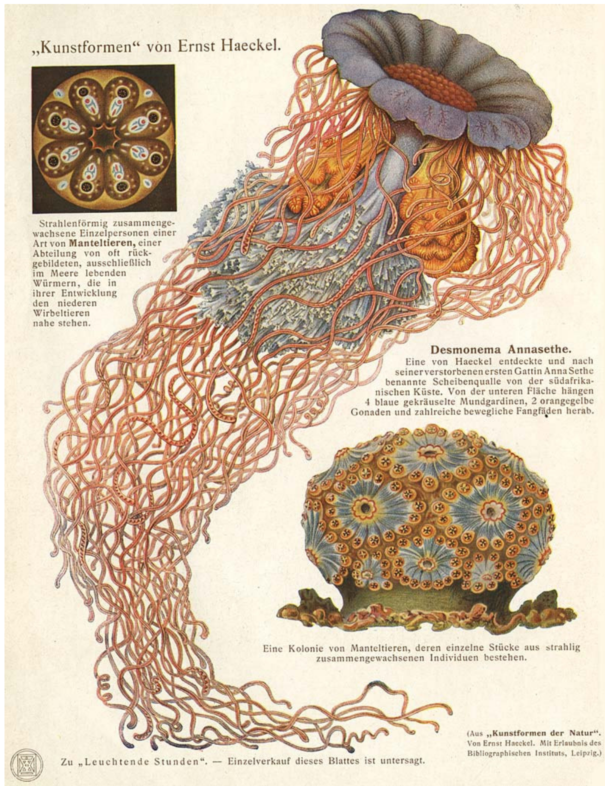

Figure 3.3: From *Kunstformen der Natur* (The Art forms of Nature)

ASIFA-Hollywood Animation Archive, http://www.animationarchive.org/pics/ nature03-big.jpg (accessed June 10, 2008).

Actually, Haeckel himself was well aware of the usefulness of his drawings representing the formal variety of radiolarians for artistic purposes. In his book, *The Riddle of the Universe*, he underlined that the artist, with a proper knowledge of natural laws, should imitate the organic world in order to reveal the unity which lies beneath its forms, which were described as beautiful and sublime.[156] In this sense, the reflections of Heackel's representation on the architectural realm had a dual consequence. On the one hand, all the representations appearing in his books revealed the formal beauty of nature, and have been used as visual inspiration. In this sense the imitation of nature remained a formal analogy in architectural praxis, in terms of the mere copying of natural forms that were represented on the plates. Proctor, in his article on Haeckel and Binet,

[156] Ibid., 415.

acknowledges one of the main advantages of the representation technique used in the book *Kunstformen der Natur*:

> This absence of scientific order, however, combined with Haeckel's diagrammatic illustration technique (by abstraction from more realistic sketches), served to emphasize a deeper aesthetic order in nature. Similar forms and patterns are made to appear in widely different species types, at various scales in nature, and it often seems that one plate follows another because of similar motifs or patterns… The chosen animals offer themselves up for artistic consumption, but not as individuals: rather, each one presents itself to the reader as an aspect of a total aesthetic system already present in nature.[157]

On the other hand, this aesthetic system, which depends on the repetition of basic forms and elements, along with Haeckel's concept of evolution, urged the artist to seek for an evolution, that is, the development of its own architectural forms, and therefore for an analogy of self-generation.[158] With the demonstration of the microscopic world of radiolarians, he enabled the architects to be a part of the scientific world, and to make them see how evolution guaranteed the variety and the laws of natural forms. These laws under which the organic form gains shape depended on a non-arbitrary organization. This self-generation was considered as an emergent system growing without losing its unity.[159] In addition, Detlef Mertins stresses that Haeckel's studies also demonstrated the mathematical relatedness between parts that would sound like the proof for the so-called organic unity. Consequently, his studies aiming to relate the whole organic into a continual systematization were dependent on his belief of the origin that generated the whole natural system from one "type", which he called Ur-animals and Ur-plants.[160] Haeckel emphasized the need to have knowledge of

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[157] Ibid., 416.

[158] Ibid., 412. See also, for the two reflections of natural concepts on Victor Horta, Kulper, "Of stylised species and specious styles," 399-403.

[159] Gustave Geffroy cited in ibid., 414.

[160] Mertins, "Bioconstructivism," 364.

the origins to “raise the understanding of the plastic arts to a higher theoretical level.”[161]

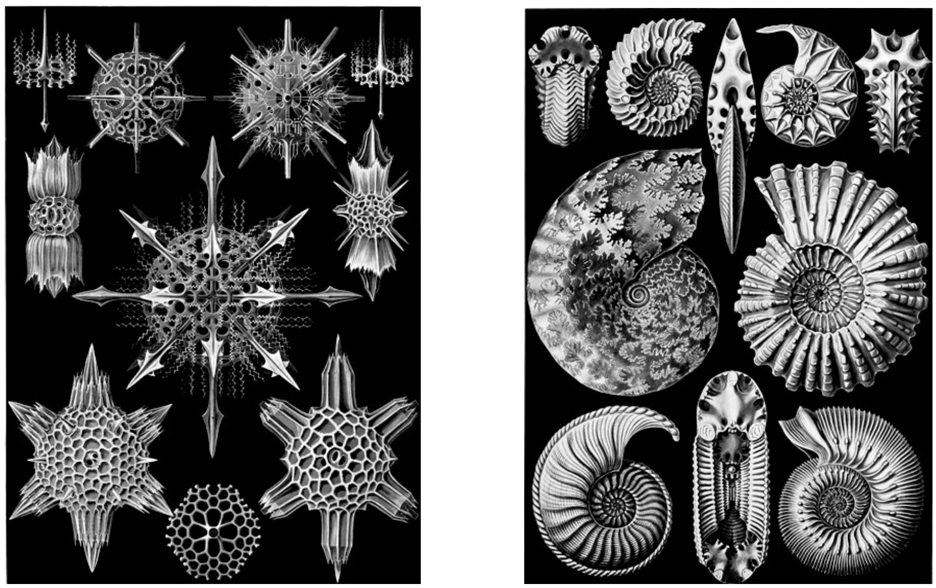

Figure 3.4 and Figure 3.5: Plate 41 and Plate 44 from Ernest Haeckel’s Art Forms in Nature.

Exhibitions, Marine Biological Laboratory, Exhibitions Curator MBLWHOI Library, Ann Weissmann, http://www.mblwhoilibrary.org/haeckel/wallcharts/images/large/ plate_41.jpg, http://www.mblwhoilibrary.org/haeckel/wallcharts/images/large/plate_44.jpg (accessed May 10, 2008).

What was important in his stance towards nature is acknowledged by Matthias Gross:

> For Haeckel, nature itself is regarded a designer, an artist that also makes copies, and thus, he speaks of the “artforms of nature” or even of “nature as an artist.” Consequently, humans, including scientists, should participate in nature’s artistic expressions and should act as parts of nature, not apart from it, because scientific field workers in the course of their work often realize that they are intimately part of the natural processes.[162]

[161] Ibid.

[162] Gross, “Restoration and the Origins of Ecology,” 376.

Owing to his close relation with the academic as well as artistic groups, his attempts to make nature intelligible had a direct influence on the architectural design theories suggesting the imitation of the process or law within nature. [163] These influences with their dual conception, that is, formal and process, can be traced through the projects of the early 20th century architects and artists. Especially, the architects associated with the Art Nouveau were influenced by Heackel's book.

One of the most prominent contributions for the rationalization of organic forms to clarify the belief in the intrinsic law in Nature came from the works of D'Arcy Thompson (1860-1948), which appeared in his book *On Growth and Form* (1917). The dependence of organic form on its growth process, is re-evaluated by D'Arcy Thompson with more focus on the importance of movement and forces. This furthered the importance of the growth process in the generation of natural forms.[164]

Influenced by Kant's idea, according to which a true science could only be attained through an attuned mathematical basis, D'Arcy Thompson stated that "Numerical precision is the very soul of science, and its attainment affords the best, perhaps the only criterion of the truth of theories and the correctness of experiments."[165] Furthermore, his interest in the biological ideas developed during the classical period by Aristotle and Plato, inspired him to work on "the geometrical aspect of number"[166] in which the harmony, simplicity and regularity of nature are found. Hence, he aimed to reconcile and explain the morphological differences between organic forms according to a mathematical-geometrical and mechanical theory. The trigger of his investigations was the regularity and the

[163] Ibid., 375-376.

[164] Mertins, "Bioconstructivism," 364.

[165] D'Arcy Thompson cited in Gould, "D'Arcy Thompson and the Science of Form," 235.

[166] D'Arcy Thompson cited in ibid., 237.

repetition of natural events.[167] The relationship of sizes and shape of organic forms, accompanied with the physical forces exerted on them grounded his guiding principle.[168] Following Haeckel's theory of 'bio-crystallization,' he examined the organic forms as if they were subject to physical forces exerted on inorganic ones.[169] Therefore, according to D'Arcy Thompson, the correspondence between these two worlds, that is, organic and inorganic, was more than an analogy. It was subject to a common cause.[170]

His main contribution on the geometrical appreciation of organic forms was his method of transformed coordinates used for complex structures. This method and its consequences are explained by Stephen Jay Gould in the following manner:

> D'Arcy Thompson imposes a net of rectangular coordinates upon various animals and generates series of related species by subjecting that net to simple deformations… D'Arcy Thompson was interested in the deformed net, not primarily in the animal that it generated. He saw that net as a diagram of forces;… the deformed net depict the forces that could transform one animal to another. Since these forces might produce a form directly, the deformed net is no mere framework for description; it may be a display of efficient causes.[171]

This net enabled him to prove a comprehensive 'law of growth', which transmits the exerted forces to the whole structure, and by consequence, generates the variety of forms.[172] During that period, the knowledge of mathematics was not adequate for Thompson's aim to reduce the qualitative properties of organic

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167 Maddalena Mazzocut-Mis, "D'Arcy Thompson, la forme et le vivant," *Alliage* 22, (1995), http://www.tribunes.com/tribune/alliage/22/mazz.htm. (accessed December 20, 2006).

168 D'Arcy Thompson cited in Gould, "D'Arcy Thompson and the Science of Form," 240.

169 Mertins, "Bioconstructivism," 364.

170 Gould, "D'Arcy Thompson and the Science of Form," 240-241.

171 D'Arcy Thompson cited in ibid., 245.

172 Ibid.

beings into quantitative ones.[173] As a result, Thompson's formalization could not find resonance in architectural projects.[174]

Gould traces two important principles prominent for the future of the science of organic form from Thompson's works:[175] First, he urged for a conceiving through a set of factors, the formative causes of organic forms instead of their resultant form. According to D'Arcy Thompson, these factors were "the physical forces molding form or pictorially as the simple patterns of transformed coordinate nets."[176] Second, as the factors effective on the formal process were known, it would be possible to question the motivation behind these factors that would open up to theories of formal fitness for the same functions.[177]

D'Arcy Thompson's insights into the characteristics of nature have been prominent in contemporary digital architectural realm, since his method of transformed coordinates is reminiscent of the current form generation process through computerized systems.

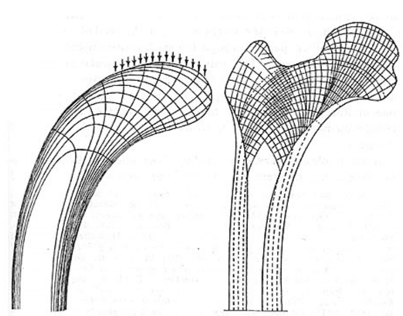

Figure 3.6: Crane head and head of femur.

Echo Studio official website, http://www.echostudiochicago.com/ learn/images/ pe-cranehead-femur.jpg (accessed June 10, 2008).

[173] Mazzocut-Mis cited in Mennan, "Des Formes Non Standard: Un 'Gestalt Switch.'"

[174] Ibid.

[175] Gould, "D'Arcy Thompson and the Science of Form," 256.

[176] D'Arcy Thompson cited in ibid., 256.

[177] Ibid.

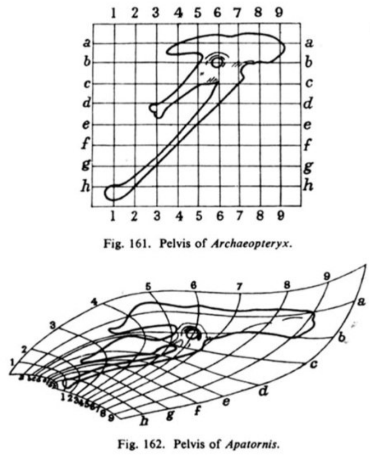

Figure 3.7: D'Arcy Thompson's deformed net.

Christian Hubert Studio official website, http://www.christianhubert.com/writings/mapping1.jpeg (accessed June 10, 2008).

Significant insights by the biological sciences into the formal generation process continued to underpin architectural theories and the communities dealing with the technological developments owing to the Industrial Revolution.[178] During the early 20th century, a great amount of debate in engineering sciences was concerned with the idea of "learning from nature." Being a central member of one these communities, a Hungarian-born botanist Raoul Francé (1874-1943) had a direct influence on the architects of the early 20th century with his ideas on the characteristics of nature. Francé is known through his book, *Die Pflanze als Erfinder* (The Plant as Inventor) (1920), which was read especially by the artists associated with constructivism.[179]

Francé aimed to explain the law inherent in Nature by propounding the concept of self-generation which is dependent on the various assemblages of seven basic elements, underscoring not just the natural beings but also human works such as

[178] For the relationship between technological and biological sciences, see Robert Bud, "Biotechnology in the Twentieth Century*," Social Studies of Science* 21, no.3 (1991): 415-457, http://www.jstor.org/stable/285174 (accessed May 15, 2008).

[179] Detlef Mertins, "Where Architecture Meets Biology," in *Interact or Die!*, eds. Joke Brouwer and Arjen Mulder (Rotterdam: V2, 2007): 110-131.

architecture, machine elements, and crystallography.[180] For this case, he used the term "biotechnics," which denoted the relationship between human and natural works. He also maintained the relatedness of form and function, and harmony within nature. His ideas contributed to the formation of the concept of "becoming."[181] Francé's contribution in terms of this concept had many implications in architectural theories, since it points to the continuous formal process in nature.[182] Furthermore, his monistic view of the world, [183] according to which there is no division between human and nature, opened a new understanding in architectural designs with a different insight to nature.[184]

The developments in biological sciences, especially in terms of the inherent characteristics of natural beings effective on their morphologies, indicate a paradigm shift in biological science. Stated briefly and simplistically according to the scientific knowledge of that period, the natural form gains shape through the natural growth process beginning with a basic organic form. The consequence of all these theories is seen on the shaping of a new architectural understanding which firstly altered the tradition of Renaissance. Designing according to a predetermined idea, with proportional and static ordered forms and regardless of human use and the environmental aspects, have been challenged.[185] In this process, the effects of external –environmental– and internal forces –coming from the inner-self of the organic being– are dominant. To summarize, the relationship between form and function, the importance of the environment on the form generation process, the self-generation of organic forms along with the concept of evolution and the increasing awareness of the structural properties of organic beings can be counted among the basic influences brought forth by these

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[180] Mertins, "Bioconstructivism," 366.

[181] Mertins, "Where Architecture Meets Biology," 115.

[182] Mertins, "Bioconstructivism," 366.

[183] This view firstly introduced by Haeckel, see Proctor, "Architecture from the cell-soul," 414-421.

[184] Mertins, "Where Architecture Meets Biology," 110-131.

[185] Adams, "Architecture and the Romantic Tradition: Coleridge to Wright," 47-68.

developments in biology into the realm of architecture. Thus, this organic analogy is seen to be decisive in the design process.

3.2 The Organic Approach through the Architectural Projects of the Early 20th Century

Revisiting the architectural discourse of the late 19th and the early 20th centuries reveals manifold references to organicism. The paradigm shift within the biological sciences and the Romantic Movement are seen to be decisive on the shaping of an organic understanding in architecture. This paradigm shift, while explaining the elusive principles according to which natural forms gain shape, reconfigured a new way to look at Nature, the organic form was dependent on its form generation process, and was seen as the outcome of this process. The direct or indirect imitation of organic forms and the organic form generation process of this new understanding can be traced through many architectural projects in several countries.

Herein, the previously explained developments which update the biological knowledge will be related to the architectural projects aiming to imitate the natural form generation processes in the early 20th century. While giving credit to the general law specific to organic beings, this imitation is grounded on the conviction that following the natural path of the form generation process in design could enable the architect to attain a variety of forms, as “the diversity of nature’s forms and form-building through its evolutionary process of variation and change is endless.”[186] This imitation of organic creation can be considered as a “learning from nature” or “Nature as model”[187] approach within the architectural realm. By shifting the architect’s attention on the design process, it did not prescribe a style,

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[186] Eli Bornstein, “Notes on the Mechanical and the Organic in Art and Nature,” Structurist, no. 35/36 (1995/1996): 46, http://pao.chadwyck.co.uk//PDF/1215423505641.pdf (accessed May 20, 2008).

[187] Bornstein, “Toward an Organic Art,” 65.

but a principle.[188] According to this approach, the form was no more seen as predetermined. Rather, it was the result of a process which was accurately identified with the terms of "form-creation" or "form-becoming." [189] The dynamic understanding of the nature, with its formal growth never ending and its evolutionary characteristic, was re-conceptualized in terms of architectural means. Although, this concept is seen to have many effects on the formation of new structural systems and new forms, this survey is limited to the implication of the concept on the basic understanding of the architectural design process.

This study makes a survey on the projects of Frank Lloyd Wright and Hugo Häring, since both have referred to the organic form generation process, that is, the idea of "form-becoming" in architectural designs depending on their own formulations, in which forms were attained without the imposition of any geometrical constrains.[190] Regarding the focus of this study, the implications of this organic metaphor for the architectural design process are surveyed through two illustrative projects: Wright's Unity Temple (1906)[191] and Häring's Garkau Farm (1922-1925).

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[188] Bornstein, "Notes on the Mechanical and the Organic in Art and Nature," 45.

[189] Mertins, "Where Architecture Meets Biology," 110-131.

[190] For Wright see, *Frank Lloyd Wright: An Autobiography* (Petaluma, CA: Pomegranate, 2005), 145-149. For Haring see, Peter Blundell Jones, *Hugo Häring: The Organic Versus the Geometric* (Edition Axel Menges: Stuttgart, London, 1999).

[191] Wright considered Unity Temple as his first building which has been designed according to the organic principle. Wright cited in Merfyn Davies, "The Embodiment of the Concept of Organic Expression: Frank Lloyd Wright," *Architectural History* 25, (1982): 121, http://www.jstor.org/stable/1568417 (accessed May 27, 2008). The survey of the design process of this project depends on Wright's *Autobiography*, in which he explained the design stages in his own words. Wright's own autobiography, *Frank Lloyd Wright: An Autobiography*, 153.

3.2.1 "Unfolding from Within:" The Form-Finding Process

As one of the prophets of organic architecture in America, Louis Sullivan says:

> …a typical seed with two cotyledons. The cotyledons are specialised rudimentary leaves containing a supply of nourishment for the initial stage in the development of the germ. The germ is the real thing; the seat of identity. Within its delicate mechanism lies the will to power: the function of which is to seek and eventually to find its full expression in form. The seat of power and the will to live constitute the simple working idea upon which all that follows is based… [192]

His pupil, known as the founder of organic architecture, Frank Lloyd Wright, furthers his Master's ideas:

> The word 'organic' applies to living structure –a structure or concept wherein features or parts are so organised in form and substance as to be applied to purpose, integral. Everything that lives is therefore organic. An organic form grows its structure out of conditions as a plant grows out of the soil… both unfold similarly from within.[193]

Louis Sullivan's and Wright's words not only explain the property special to organic beings, they also underscore the outcome of the developments in biological sciences and the Romantic Movement reflected on the architect's point of view of nature. The endeavor to imitate the inherent qualities of nature was not dependent anymore on an understanding gained through the investigations of formal qualities of organic form. Instead, this view attributes the architect the role of an examiner who aims to reveal the conditions generating the organic forms. That is, the organic metaphor transformed towards an imitation of self-generation as in nature.

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[192] Louis H. Sullivan cited in John Frazer, *Evolutionary Architecture* (London: Architectural Association, 1995), 9.

[193] Wright cited in Davies, "The Embodiment of the Concept of Organic Expression," 121.

The above-mentioned metaphor, that is, the growth process is to be found within the course of the 20th century's organic approach in architecture. Although there are slight differences between the architects' wordings, their general concept of design seems to be equivalent: the form develops from inside out, which is referred to as "unfolding from within."

Significantly, as a consequence of this metaphor, the formation of the final form dependent on the design process must be introduced as the first and major common point for Wright and Häring since they all proclaimed that the form was the outcome of the design process, as in nature; and they all refuted the imposition of a form from the outside, that is, from without. Instead, the form had to be discovered, beginning from the inside towards the outside.[194] As the form was emergent, it carried the properties of its formation process. Since these architects borrowed their design process from nature, they have also adapted the aspects effective on the organic form generation process into their own architectural understanding, such as the environmental properties, the human use, and the relationship between the form and its performed function. In line with Wright's analogy,[195] this survey will be executed by treating the design process of the architectural projects as if it were an organic being, and will focus on the beginning (i.e., the formation of the seed of the project) and will then watch its growing till the final form.

The seed –according to the knowledge of the biological sciences of this period until the late 19th century– besides containing the preliminary idea of the form that

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[194] For Haring, "However, the world of geometric culture the *Gestalt* [form] of things was given through the imposition of geometric rules. Häring suggested that if we try to discover form rather than constrain or impose it, we will find ourselves in consonance with nature, no longer working against it but within it." Mertins, introduction to *The Victory of the New Building Design*, 53.

For Wright, "…an architecture that develops from within outward in harmony with the conditions of its being as distinguished from one that is applied from without." Davies, "The Embodiment of the Concept of Organic Expression," 121.

[195] Wright while expressing the design process of Unity Temple stated that: "Let us follow this building through the thought that built it, from the beginning follow its evolution to final *form*." Frank Lloyd Wright, "In the Cause of Architecture," *The Architectural Record* (March 1908), 151, http://www.archrecord.com/inTheCause/onTheState/0412flw.pdf (accessed May 20, 2008).

will become, also codifies some of the major aspects of the formal growth process. The design process, initialized with respect to this analogy, had predetermined factors for Wright and Häring: The function that the building will serve and a certain kind of life offered by this building.[196] The origins of these factors date back to the mid-18th century: Functionality has been integral to architectural discourse, owing to the organic metaphor introduced earlier in this chapter. Following a brief insight into these architects' background, an emphasis will be made on how these factors were adapted into the design process.

3.2.1.1 The Form Creation Process of the Unity Temple, Frank Lloyd Wright

3.2.1.1.1 The Beginning of the Project

Born in 1867, Wright was among the founders of organic architecture in America.[197] Wright began to study as a special student in the University of Wisconsin, School of Engineering. After a short term, he left school due to his dissatisfaction and went to Chicago to continue his life as an architect.[198] Wright worked for approximately seven years for one of the leader firms of Chicago, Adler & Sullivan.[199]

A survey on his organic approach in designs reveals a variety of influences in the formation of his architectural understanding. As explained above, the organic approach in America developed out of the ideas of the Romantic Movement on organic form, accompanied with the architectural theories of the French

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[196] For Wright, *Frank Lloyd Wright: An Autobiography*, 344; For Haring, St. John Wilson, *The Other Tradition of Modern Architecture,* 55.

[197] Frank Furness (1839-1912), Louis Sullivan and Frank Lloyd Wright were linked chronologically. "Sullivan was an apprentice in Furness office and Wright was Sullivan's greatest disciple." Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 26.

[198] Bruce Brooks Pfeiffer, *Frank Lloyd Wright, 1867-1959: Building for Democracy* (Taschen, 2004), 8-9.

[199] Ibid.

"Romantiques" in the Ecole-des-Beaux Arts and the works on ornamentation called as "art-nature" in England.[200] Although, Wright enumerated just his master Sullivan as the major influence on the formation of his organic approach, his understanding was seemingly indebted to these developments as well.[201] Furthermore, Hoffmann explains Wright's indebtedness to the French architect and theorist Viollet-le-Duc, in the Ecole-des-Beaux Arts, by putting forth the similarities in their architectural understandings.[202]

According to Rubin, Wright's geometrical skills were first developed during his childhood with the Froebel games,[203] and enhanced while he was working for the firm Adler & Sullivan.[204] Wright's predilection for geometrical simplification, as will be seen below, was a tool for his future designs.[205] The Japanese art from which Wright acquired a useful way towards a geometrical abstraction of natural forms was a great influence on his designs.[206] This background, accompanied with his own experiences laid the foundation of his organic approach. His organic understanding, more than prescribing a set of rules strictly dependent on the imitation of natural forms, was based on the principles of nature.[207] All these influences should be considered as the seed of his organic approach. In this

[200] Mumford, "Form Follows Nature: The Origins of American Organic Architecture," 26-37.

[201] He worked for Sullivan and Adler for nearly seven years, before opening his own architectural office in 1893. Pfeiffer, *Frank Lloyd Wright, 1867-1959*, 7.

[202] Hoffmann, "Frank Lloyd Wright and Viollet-le-Duc," 173-183.

[203] For the importance of the Froebel games on Wright's architectural designs see, Jeanne S. Rubin, "The Froebel-Wright Kindergarten Connection: A New Perspective," *The Journal of the Society of Architectural Historians* 48, no.1 (1989): 24-37, http://www.jstor.org/stable/ 990404 (accessed May 29, 2008).

[204] Peter Blundell Jones, *Modern Architecture through Case Studies* (Oxford, Boston: Architectural Press, 2002), 178.

[205] Narciso G. Menocal, "Frank Lloyd Wright and the Question of Style," The Journal of Decorative and Propaganda Arts 2, (Summer-Autumn, 1986): 6, http://www.jstor.org/ stable/1503921 (accessed June 8, 2008).

[206] Ibid., 6-7.

[207] Maurice Lagueux, "Reconfiguring Four Key '-isms' Commonly Used in Architectural Theory," *British Journal of Aesthetics* 39, no. 2, (1999): 180, http://bjaesthetics.oxfordjournals.org/cgi/reprint/39/2/179 (accessed April 20, 2008).

sense, it is possible to follow Wright's first stage of design process while keeping in mind the above-mentioned emphasis.

While explaining his project, the Unity Temple in his *Autobiography*, Wright begins by saying, "First came the philosophy of the building in my own mind."[208] Then he continues, "Why not, then build a temple, not to God… but build a temple to man, appropriate to his uses as a meeting place, in which to study man himself for his God's sake? A modern meeting-house and a good-time place."[209] The traditional image of church had to be swept away, in order to attain the real function of the building.[210] This philosophy meant for Wright, the simplification of the problem, that is, searching for "the nature of a problem."[211] Wright called this stage the first condition of creation, since according to his understanding, "All artistic creation has its own philosophy."[212] Actually, it seems that this philosophy can not emerge without having in mind the functionality of the building. Possibly, it can be stated that he weaved his ideas into the process from the beginning, regarding the new social requirements in accord with his understanding.

3.2.1.1.2 The Design Process of the Project

Given the focus of the study, a brief look into what Wright understands from organicism and the stress on the interior space helps to better grasp his design process. Influenced by an ancient thought,[213] Wright defined "the reality of building" not as the composition of four walls and the roof, but as "the space to be

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[208] *Frank Lloyd Wright: An Autobiography*, 153.

[209] Ibid., 154.

[210] Ibid., 153; Davies, "The Embodiment of the Concept of Organic Expression," 121.

[211] Wright cited in Hoffmann, "Frank Lloyd Wright and Viollet-le-Duc," 177.

[212] *Frank Lloyd Wright: An Autobiography*, 156.

[213] Wright stated that he was influenced by a Chinese philosopher Lao Tze who lived five hundred years before Jesus. Wright cited in Bruno Zevi, *Towards an Organic Architecture* (London: Faber&Faber, 1950), 95.

lived in."[214] Therefore, the classical understanding of interior space, for which took the surface as appealed to the gaze, was replaced by an emphasis on the human elementary needs and human scale.[215] Regarding the progressively changing human requirements, the space designed in accord with an organic approach implied a continual becoming through the formal growth.[216] Foremost, we need to note here that, instead of conceiving the building from the outside as an artistic arrangement of blocks of building material, Wright focused on the rooms as forming a *"spatial enclosed*" to be expressed in the exterior.[217] This idea was consonant with his urge to design organically from the inside towards the outside, as the expression of the exterior is consistent with the outward shape of inherent properties or inward forces.[218] This natural law was fully acknowledged by Wright, like Viollet-le-Duc, as the only way to a true "style."[219] According to Wright and Viollet-le-Duc, the true style was to be found whenever the architect designs as the nature designs.[220] A complete explication given by Viollet-le-Duc explains what the designer should learn from nature in the following manner:

> Nature, in all her works, has style, because, however varied her productions may be, they are always submitted to laws and invariable principles. The lilies of the field, the leaves of the trees, the insects, have style, because they grow, develop, and exist according to essentially logical laws. We can spare nothing from a flower, because, in its organization, every part has its function and is formed to carry out that function in the most beautiful manner. Style resides in the true and well-understood expression of a principle, and not in an immutable form; therefore, as nothing

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[214] Ibid., 95.

[215] Ibid.

[216] Ibid.

[217] Wright, "In the Cause of Architecture," 148,150.

[218] Wright also affirmed that these designs have a character; this character belonging also to organic beings generates the style. It was not the style that generates the character, it was only the consequence of style. Wright, "In the Cause of Architecture," 150-151.

[219] Menocal, "Frank Lloyd Wright and the Question of Style," 6-7.

[220] In his article Wright explained in detail the relationship between the style of the organic beings and architectural styles. Wright, "In the Cause of Architecture," 145-151.

> exists in nature without a principle, everything in nature must have style.... it should be explained to you why the cat and the tiger, the flower and the insect, have style, and you should be instructed to proceed like Nature in her productions, and thus you would be enabled to give style to all the conceptions of your brain.[221]

Wright, consequent to the establishment of the philosophy, along with the simplified program of the building, began to generate his new forms out of the practical requirements of the buildings: its function, its cost, its structure, and its materials.[222] The relevance between these requirements required a reasonable approach by the architect, since the cost was effective on the material choice, and the material choice was effective on the structure.[223] For the Unity Temple, regarding the problems with the budget, Wright chose to use reinforced concrete for the constructions system owing to its cheapness. At this earlier stage, the material qualities, along with its required construction system, were determinant on his design process.[224] With respect to this construction system, Wright gave order to each plan of each building by imposing a grid.[225] The determinant of grid, within the case of Unity Temple, was reinforced concrete. The size of the grids mostly depended on the spanning possibilities of materials. He regarded this order as a way to make the building organic.[226]

Thus, according to the function of the Temple, he first focused the noble room due to its significance within a temple. He entailed each detail of its roof, its slab, and its walls in accord with the nature of their materials.[227] Wright then evaluated the same work for each room regarding their functions.

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[221] Viollet-le-Duc cited in Hoffmann, "Frank Lloyd Wright and Viollet-le-Duc," 178.

[222] Davies, "The Embodiment of the Concept of Organic Expression," 125.

[223] *Frank Lloyd Wright: An Autobiography*, 153-155.

[224] Ibid.

[225] Menocal, "Frank Lloyd Wright and the Question of Style," 16.

[226] Ibid.

[227] *Frank Lloyd Wright: An Autobiography*, 155-156.

According to Wright, the forms should always be shaped in accord with its surroundings.[228] During this stage, the forms, still in his mind, were revealed as a preliminary idea by taking into account all these conditions and the properties of the site.[229] Regarding his descriptions on the design, his concern was on the interior spaces all the time. There were not any descriptions about the outer form.[230] He summed up his concentration on the appropriate design requirements by calling it the "reasoned *arrangement*."[231] Wright described in detail this stage as follows:

> Second there was the general purpose of the whole to consider in each part: a matter of reasoned arrangement. This arrangement must be made with a sense of yet-unborn-whole in the mind… Holding all this diversity together in a preconceived direction is really no light matter but is the condition of creation. Imagination conceives here the PLAN suitable to the material and the purpose of the whole, seeing the probable possible from clearer all the time.[232]

What Wright accentuated the most during this stage in his mind was to conceive the idea of the whole in each part: The organic unity should always be kept by his mind.[233] Owing to the imagination of the architect, this process was not considered by Wright as a mere functional analysis of the design problem.[234] This was the main prologue, that is, the process leading to the creative activity which generates form.[235] Wright referred to the similarity of this process to nature: It was a fluid and elastic period of becoming and had originated from the idea or

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[228] Hoffmann, "Frank Lloyd Wright and Viollet-le-Duc," 179.

[229] *Frank Lloyd Wright: An Autobiography*, 155-156.

[230] Ibid., 154-160.

[231] Ibid., 156.

[232] Ibid.

[233] Ibid., 154.

[234] Davies, "The Embodiment of the Concept of Organic Expression," 125.

[235] At this stage, it is seen that the plan was also under the sign of his geometrical tendency towards more abstract forms, such as squares, rectangles, triangles. Actually, this choice was not a coincidence, that will be touch upon below.

principle; furthermore, it had the inherent "logic of the plan."[236] Owing to this logic, Nature exhibited a variety of possibilities.[237] Once the "plan" was attained through the first idea, earlier called philosophy, it was then possible to create the form. The plan was intertwined into imagination, and then the creative act of the architect "recorded" this process.[238]

"Recording the logic of the plan" was the last stage and the most difficult period for Wright, since the problem was to "weave the plan into a sense of whole"[239] in order to attain the organic unity. Merfyn Davies affirms that conceiving altogether the plan, the section, the form, and every aspect of a building as a whole was difficult. It is this aspect which makes the organic design process put into practice.[240] Wright's way to gain this unity was making sketches and looking at "the nature-of-the-thing" in terms of building materials. Therefore, Wright considered his building, which was built under the sign of the nature of materials and the thought, a unified form.[241] This creative stage towards attaining an organic entity, or rephrased by Wright as "part-to-whole-as-whole-is-to-part,"[242] was explained by Wright as follows:

> As to the logic of the plan it is easy to see there can be none except as the result of integrated scale: materials and building method clearly articulated. But with all that logically set, all the more, there is the important human equation at work in every move that is made. The architect weaves into every part as each step is taken, his sense of the whole.[243]

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[236] Wright, "In the Cause of Architecture," 148,150.

[237] Ibid.

[238] *Frank Lloyd Wright: An Autobiography*, 156.

[239] Davies, "The Embodiment of the Concept of Organic Expression," 126.

[240] Ibid.

[241] Ibid., 127.

[242] Frank Lloyd Wright, "The Language of an Organic Architecture," *Structurist* 11, (1971): 81, http://pao.chadwyck.co.uk//PDF/1215462207403.pdf (accessed April 24, 2008).

[243] Wright cited in Davies, "The Embodiment of the Concept of Organic Expression," 127.

In line with these understandings, together with the enthusiasm felt for the new materials –steel, glass, concrete,- Wright sought to integrate the organic, the inherent principle of nature, into his architectural forms.[244]

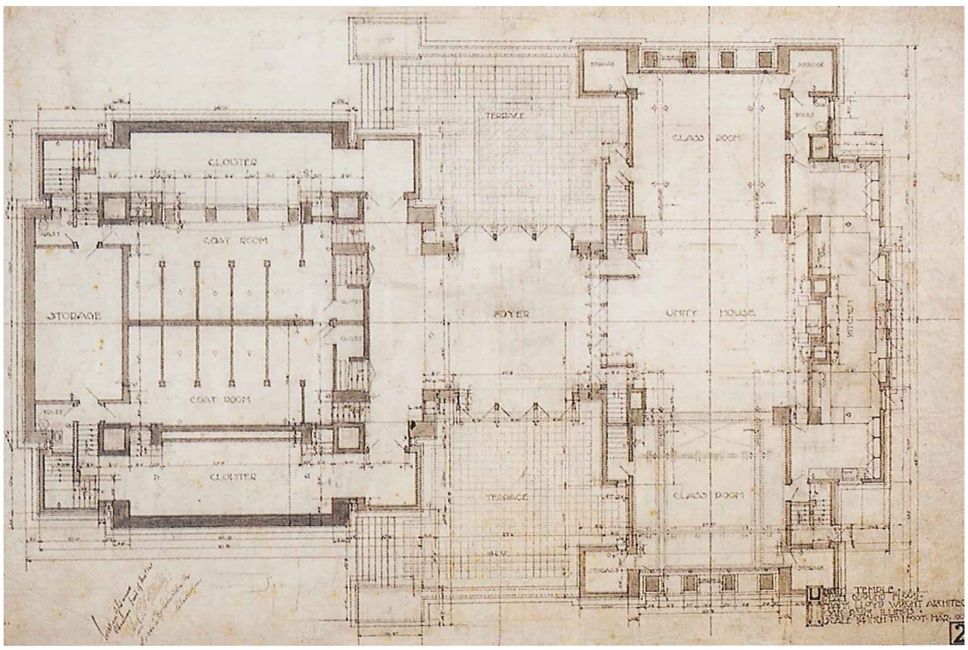

Figure 3.8: Ground Floor Plan of the Unity Temple

Bruce Brooks Pfeiffer, *Frank Lloyd Wright* (Taschen, 2007), 64.

[244] Ibid.

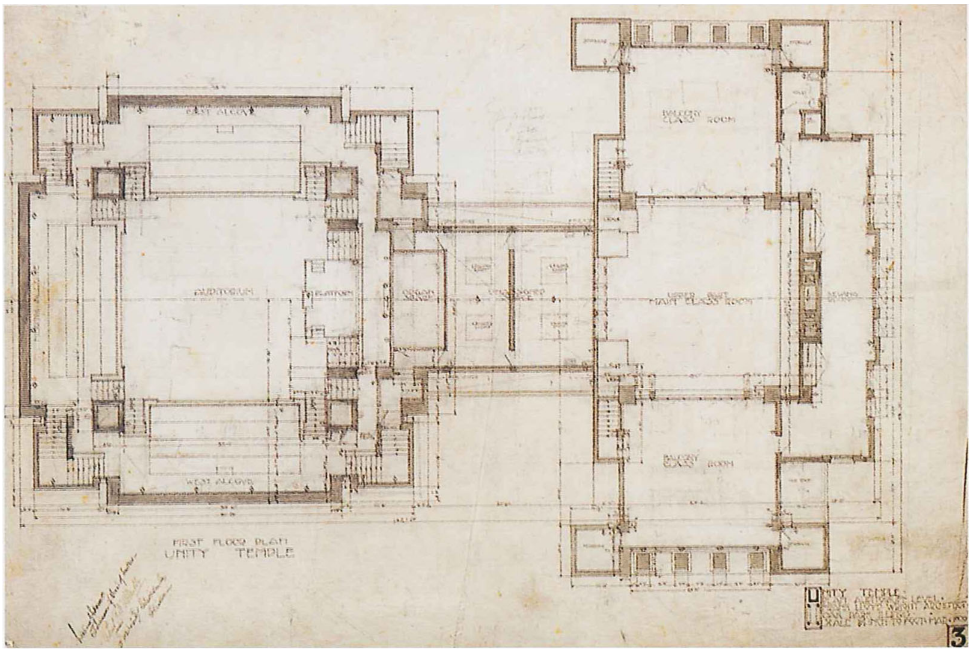

Figure 3.9: First Floor Plan of the Unity Temple

Bruce Brooks Pfeiffer, *Frank Lloyd Wright* (Taschen, 2007), 64.

Influenced by the way the intrinsic principle of nature revealed in the organic forms as pattern –from within– Wright sought to use the same resource as integral to his architectural forms. This inclination, as called by the "nature-pattern" introduced to Wright by his Master Sullivan, depended on the simplification of natural forms through stylization, for the purpose of finding out the inherent rhythm, which was considered as one the major natural properties to imitate. As mentioned in this part of the study, Dresser's contribution has been valuable to his American counterparts in this practice. The "nature-pattern" as an organic approach was valued by Wright on two terms: First, the nature of materials that has to be discovered "from the beginning of each project" for the purpose of integrating their innate geometrical qualities; second, nature was the basis for Wright in his geometrical abstractions which can be seen in his ornaments and the geometry of his buildings.[245]

[245] *Frank Lloyd Wright: An Autobiography*, 157.

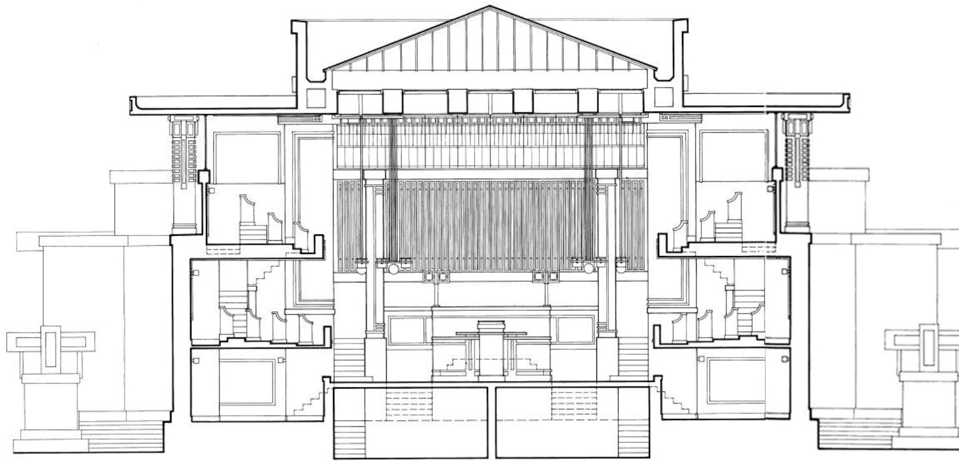

Figure 3.10: Section drawing of the Unity Temple

"Drawings and Photographs of Unity Temple," *Perspecta* 22, (1986): 158-159, http://www.jstor.org/stable/1567101 (accessed June 5, 2008).

Wright aimed to integrate organic formal process in accord with, or better, "true" to the nature of the material out of which the structure is designed. He explained this urge as "imagination giving natural pattern to structure itself."[246] Wright held that "design is abstraction of nature-elements in purely geometric terms."[247] He had the materials in hand and his "plan," the geometrical knowledge gained through nature and foremost through his imagination. He did not foresee a form; the form had to become out of these conditions. Beginning from the inside, from the interior space towards the outside, the form will take shape out of its own factors that are explained above. Actually, the formal development, while imitating the geometrical properties of nature, was to develop in the architects' hand and mind. In this sense, we need note that recent studies demonstrated how Wright was successful in terms of his geometrical abstractions, weaving the parts into a whole. [248] Wright's buildings have been revisited by using computer

[246] Ibid., 347.

[247] Ibid., 157.

[248] Mark Keane and Linda Keane, "The Geometry of Wright," *Nexus Network Journal* 7, no. 1 (2005): 48-57, http://www.springerlink.com/content/y21681244r3j0383/fulltext.pdf

technologies. Through the use of computer programs specially developed for generating fractal based geometries, this review showed that Wright's buildings exhibited "fractal" qualities at different scales. James Harris stated that "As one approaches one of his structures there is a progression or unfolding of additional elements or details which reflect variations of buildings characteristics."[249] Although, fractal geometry derived from natural forms were not discovered during Wright's life-time, finding this property in Wright's buildings should be treated as a talent of the architect.

Figure 3.11: View of Unity Temple

A Digital Archive of American Architecture, http://www.bc.edu/bc_org/avp/cas/fnart/fa267/flw/unity02.jpg (accessed June 5, 2008).

(accessed March 12, 2008); see also, James Harris, "Integrated Function Systems and Organic Architecture from Wright to Mondrian," *Nexus Network Journal* 9, no. 1 (2007): 93-101, http://www.springerlink.com/ content/ 978w76v76k484547/fulltext.pdf (accessed March 12, 2008).

[249] Harris, "Integrated Function Systems and Organic Architecture," 97-98.

Figure 3.12: Interior view of Unity Temple

The Design Museum Website, Frank Lloyd Wirght, http://www.designmuseum.org/__entry/4918?style=design_image_popup (accessed June 5, 2008).

Figure 3.13: Interior view of Unity Temple

Picture taken by Sylvia E. Kim, Frank Lloyd Wright Foundation, http://www.franklloydwright.org/index.cfm?section=support&action=display&id=61 (accessed June 5, 2008).

3.2.1.2 The Form Creation Process of the Garkau Farm, Hugo Häring

3.2.1.2.1 The Beginning of the Project

Born in 1882,[250] Häring was part of the development of the Modern Movement in Germany, during the 1920s. His first encounter with the wooden constructions owing to his father's job, a cabinet maker, helps to explain the significant role of carpentry within his architectural designs.[251] He studied architecture at Technische Hochschule in Stuttgart, and in Dresden.[252] Haring's development in the architectural practice was to a large extent indebted to a leading figure of the 20th century, Theodor Fischer, who was a teacher in Stuttgart and was considered the father of European organic modernism.[253]

Blundell Jones underlines the importance of Häring's architectural education at the Stuttgart school, which became known for its progressive methods under the influence of Fischer.[254] His valuable contributions to the teaching system included the examination of local, vernacular buildings and the replacement of the drawing lessons of the academic tradition[255] by Fischer's liberal and open-minded system, in which the student was released from the dictation of drawings rules or the intention of the professor.[256] Fischer aimed "to bring out each pupil according to

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[250] His home town Biberach, being an important market town and regional centre in the 19th century, had an irregular plan and was dominated with timber framed houses. Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 13.

[251] "Haring's preference for wood as a living, elastic material, and the empathy for timber and carpentry techniques that permeates his work." Ibid.

[252] Ibid.

[253] Fischer was the teacher of Bruno Taut, Erisch Mendelsohn, and Hugo Häring. His architectural understanding was opposed to Peter Behrens, from whom Mies, Gropius and Le Corbusier had received their first influence. Ibid., 18.

[254] Ibid., 19.

[255] The academic tradition design courses was dependent on rendering the antique monuments. Ibid.

[256] Ibid.

his own talents and circumstances."[257] Consequently, the education was propelled into more experimental studies.[258] Häring, while explaining the atmosphere of this school, stated that he "felt the influences of van de Velde, Otto Wagner, Berlage, the Damstadt School, the people who were to found Werkbund."[259] As another impact of this atmosphere, Häring was introduced to the works of impressionists, and he read Adolf von Hildebrand's (1847-1921) book *Problem der Form in der Bildenden Kunst* (The Problem of Form in Painting and Sculpture) (1893).

Released from the academic tradition, the late 19th century nature romanticism across Europe lied behind Fischer's free-style and irregular forms.[260] Owing to the reflection of the local on forms, Fischer's designs showed a variety of forms.[261] Then, Fischer's main influence on the organic modernists was his urge to design in accord with the context, that is, place and purpose or program.[262] The resonance of this stress on the context, accompanied with the influence of Fiedler's theory, was to be found in Häring's architectural designs.[263]

After introducing Häring's earlier experiences in design, a brief note should be made of his political stance within modern architecture in Germany. In the 1920s, after his arrival in Berlin, for some years he shared a studio with Mies van der Rohe, and they were close friends.[264] He became a member of the avant-garde

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257 Ibid.

258 Ibid.

259 Ibid.

260 Ibid., 17.

261 Ibid.

262 Ibid., 19.

263 "…we must understand the special requirements of every task. We cannot set up systems but we have to start again and again and many times right from the beginning." Häring cited in St. John Wilson, *The Other Tradition of Modern Architecture,* 65.

264 Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 36.

groups “Ring” and “Novembergruppe.”[265] Furthermore, he was one the delegates of the first *Congrès International d'Architecture Moderne* (CIAM) (International Congress of Modern Architecture) in 1928.[266] During the early 1920s, Mies, with the Russian constructivists, published the periodical *G* (G, as the abbreviation of *Gestaltung*).[267] Blundell Jones expressed the relationship between this group’s publishing this periodical -and then “Nasci” issue of *Merz*- and Häring.[268] Giving a brief explication on Haring’s relationship with these architects aims to point out how the organic approach within the form creation processes, that is, “form-becoming”, was a central issue in the early modern period. Although, within this study, it is not possible to unveil all the details of this periodical, the organic metaphor proposed in terms of the design process deserves to be brought forth. The periodical written in a constructive manner propounded the form generation process of nature.[269] El Lissitzky, one of the key figures in the Russian constructivism, wrote in his “Nasci” issue of *Merz* in 1924:[270]

> EVERY FORM IS THE FROZEN INSTANTANEOUS PICTURE OF A PROCESS.
> THUS A WORK IS A STOPPING-PLACE ON THE ROAD OF BECOMING AND NOT THE FIXED GOAL.
> We acknowledge works which contain a system within themselves, a system which has not been evolved before the work started but has evolved in the course of it.
> We wish to design peace, the peace in nature, in which enormous tensions hold the heavenly bodies, rotating uniformly, in equal balance.[271]

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[265] Ibid., 37.

[266] St. John Wilson, *The Other Tradition of Modern Architecture.*

[267] For the relationship between Mies and the Russian Constuctivists please see, Detlef Mertins, “Architecture of Becoming: Mies van der Rohe and the Avant-Garde,” in *Mies in Berlin*, eds. Berry Bergdoll and Terence Riley (The Museum of Modern Art: New York, 2001), 106-133.

[268] Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 53.

[269] Mertins, “Bioconstructivism,” 366.

[270] Mertins states that El Lissitzky had reed Raoul France’s book. And this text was a paraphrase France.

[271] El Lissitzky and Kurt Schwitters, eds., 'Nasci,' *Merz* 8/9, (April/July 1924), http://sdrc.lib.uiowa.edu/dada/merz/8/index.htm (accessed May 15, 2008). Translation of text in Sophie Lissitzky-Küppers, *Lissitzky: Life, Letters Texts* (London: Thames &

Understanding the atmosphere in which Haring was practicing architecture has relevance to his own architectural program. Actually, the study will explain his design process in the same manner as Häring referred to the never ending aspect of nature. Mies and Häring, although belonging to different formal paradigms –Mies geometrical, and Häring's organic–, Blundell Jones underscores their common intention in architectural design, in Mies' words: "We do not recognise form but only problems of building. Form is not the aim but only the result of the work."[272] This method of design was actually a consequence of the organic metaphor related with the form generation process of nature. Mies' words, reminiscent of Häring's organicist ideas, were published in the first issue of *Die Form* in 1925.[273] Häring's article "Wege zur Form" (Approaches to form) was written after the completion of his first major work of architecture, Garkau Farm in northern Germany (1922-1925).[274] This article first touched upon a design problem known as the dichotomy between the requirements of form created by human beings,[275] that is, the fulfillment of the function and the

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Hudson, 1968): 351. Original text: "TOUTE FORME EST UN MOMENT CONCRÉTÉ D'UNE EVOLUTION. CE QUI FAIT QUE L'OEUVRE N'EST PAS LE BUT FIXÉ, MAIS UN POINT STATIONNAIRE DU DÉVELOPPEMENT.

Nous reconnaisons comme oeuvre, tout ce qui en soi, contient un systeme – mais un systeme qui a pris conscience de lui-meme non avant, mais dans l'exécution.

Nous voulons représenter le calme, le calme de la nature, dans lequel des tensions incroyables tiennent en équilibre la rotation régulière des mondes."

[272] Mies cited in Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 37.

[273] Mertins, introduction to *The Victory of the New Building Design*, 52.

[274] Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 53. These ideas on the form creation process which are introduced in this article were reflected on the debate between Häring and Le Corbusier in the first CIAM held in 1928. For the opposition between Le Corbusier and Häring, see St. John Wilson, *The Other Tradition of Modern Architecture*.

[275] St. John Wilson contends that this division went back to the misconception of Kant's idea of "the essence of art in terms of purposefulness without purpose" by the architects. Since Kant declared that this idea cannot be used in the realm of architecture, due to its charactere of working to an outer end than itself. And from the mid-18th century, this division between architecture (art for arts sake) and building (as a rationalist) came into the early modern period. St. John Wilson, *The Other Tradition of Modern Architecture,* 44; Kenneth Frampton in the intoduction of his book articulates the same problem, *Modern Architecture: A Critical History* (New York: Thames and Hudson, 1992), 8. Regarding this connotation of the word "architecture", it can be noted that Haring avoided using it, he preferred "*Baustil"* (Building) instead.

spiritual, or better functionality and expressive.[276] The former, associated with the utilitarian structures –such as houses, bridges–, has natural origins and is shaped organically and anonymously.[277] The second one, exemplified with monumental buildings and religious buildings, emerged out of the human mind and is bound to culture, place and time.[278] According to Häring, at the turn of the century, the former requirement had lost its meaning and the second one, under the "geometric culture", gained importance, with the disregard of function.[279] The second requirement had operated against the living, against becoming, movement, and nature.[280] His organic theory, directed towards this dichotomy, suggested turning to nature to resolve the problem. Häring explained the need and the way to imitate nature in the following manner:

> In nature, form is the result of the organization of many individual entities in space in order that life can unfold and take place, a fulfillment of both part and whole, whereas in the world of geometrical culture form is derived from the laws of geometry. If we prefer to search for shapes rather than to impose them, to discover forms rather than to construct them, we are in harmony with nature and act with her rather than against her.[281]

Häring's organic approach, consonant with the natural growth process or method, urged following the path of nature, an insistence related with the imitation of natural principles rather than organic forms.[282] Form was to arise from within outward, depending on its own essential characteristics, its inner identity, as in nature; it was to be derived out of its content, its function, and its place. Throughout his architectural life, Häring contended that without the content, it

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[276] Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 77.

[277] Ibid.

[278] Ibid.; Mertins, introduction to *The Victory of the New Building Design*, 52.

[279] Mertins, introduction to *The Victory of the New Building Design*, 52.

[280] Ibid.

[281] Hugo Häring, "Wege zur Form," *Die Form* 1, no.1 (1925): 3-5, cited in Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 77.

[282] Ibid., 186.

would not be possible to attain the form.[283] This functional approach laid the foundation of his form creation process, according to which the form "corresponded to its inner form-becoming."[284] He added that "We must call on things and let them unfold their own forms."[285] The form had to be discovered; the form had to be found. Throughout his article, Blundell Jones notes that Häring only articulated the usefulness of the principles of nature, and did not touch upon issues on the aesthetics, nor reduced the architecture into an objective scientific base.[286]

Garkau Farm, Häring's key work was the first chance to justify his ideas about architecture, which had radically changed during the early 1920s.[287] These ideas as explained above demanded an experimental work on functionalism: In accord with a practical process, this group of farm buildings near Lübeck in northern Germany was realized.[288]

The seed analogy, as referred to in this study, can be also accounted for Häring's design process, because instead of beginning from pre-determined form he gradually shaped his form from within. Häring's description of inner condition, that is, the first concern on the way to attain the final form, was dependent on the function that the building had to serve. That is, the content. His quest on this inner principle, as will be explained below, became central while he was pursing the form creation –or in Häring's words, discovering– process, as he declared that the outer appearance was generated out of this seminal function. In accord with his organic approach and his background, the other condition was the site, the environmental conditions.

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283 St. John Wilson, *The Other Tradition of Modern Architecture,* 52,55.

284 Mertins, introduction to *The Victory of the New Building Design*, 53.

285 Hugo Häring, "Wege zur Form," *Die Form* 1, no.1 (1925): 3-5, cited in Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 78.

286 Ibid., 78-79.

287 Blundell Jones, *Modern Architecture Through Case Studies*, 48.

288 Ibid. Although, the farm planned by Häring included a new farmhouse, only the barn, cowshed and sheds were built.

The special requirement for Garkau Barn was a place in which as much as possible for storage could be made. The task for the cowshed depended on a combination of functions. The major task was the placement of the cowstalls and the silo. At this stage, Häring seems to deal with the requirements of the projects, the functions becomes the central. Such as, to determine the shape of the cowstalls, Blundell Jones states that:" [Häring] asked his farmer client how cows would eat when left to their own devices, and the answer was that they gather around their food in a circle."[289] He searched for the inner principles, and his design was based on what was needed.

There is one point that this study has to underline: Häring was well aware of the developments in biological sciences, and he knew well the tie between form and function.[290] But he claimed elsewhere that mere functionality cannot explain the formal qualities of the organic beings.[291] In this sense, Häring viewed the Darwinian Theory of natural selection as inadequate and limited due to its consideration of only the question of function, and not of the main deeper essentials resulting in form, that is, what Häring called *Gestalt*.[292] His interest in the roots of the *Gestalt* was not tied only to functionality. Scientific knowledge was inadequate to explain the self-generation of organic beings; that is, how the inner self reflects on the outer appearance was still the main question that Häring attempted to resolve in his architectural designs.[293]

The above-mentioned urge, that is, the imitation of nature was considered a creative method for the architect, a property attributed to nature by the architects of the organic paradigm.[294] Throughout his article, Blundell Jones notes that Häring only articulated the usefulness of the principles of nature, and did not

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[289] Ibid.

[290] Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 186.

[291] Ibid.

[292] Ibid.

[293] Ibid., 186-188.

[294] Hugo Häring, "Wege zur Form," *Die Form* 1, no.1 (1925): 3-5, cited in Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 78.

touch upon issues on the aesthetics; nor did he reduce the architecture into an objective scientific base.[295] In this sense, the survey on his Garkau Farm project can reveal how his functionality, accompanied with the unresolved question of the self-generation, was to take form.

3.2.1.2.2 The Design Process of the Project

Häring argued that a new way of life and a new society can be brought by this new way of design which imitates nature for its form generation process.[296] This claim should also be noted as a commonplace for the organic paradigm. He continued, contending that the architect can find the way to attain a variety of forms only through the organic production system. Although Häring's forms were to some extent biomorphic due to his predilection that organic beings, whether human or animal –as in his project Garkau Farm–, were to live in more organic forms.[297] His major organic approach is released in the following phrase:

> "…we do not want to mechanize objects but only their production…To mechanize is to gain life."[298]

This mechanization of form creation was reflected on his Garkau Farm. We should then concentrate on how Häring pursued the production by beginning with the function and the environmental properties.

Following how Garkau Barn and Cowshed took their forms out of the initial conditions begins with Häring's own described stages for his design process, that

[295] Ibid., 78-79.

[296] Ibid., 78.

[298] Hugo Häring, "Wege zur Form," *Die Form* 1, no.1 (1925): 3-5, cited in Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 78. This article was written opposed to Le Corbusier's architectural designs that was the reason Häring referred too much to mechanical paradigm.

is, *Organwerk*.[299] *Organwerk*, the first stage was considered as the raw work by Häring, which meant technical works in terms of the functional view.[300] In the second stage, *that of Gestaltwerk*, the technical forms which are the raw form prepared by the *Organwerk*, are transformed, or better, developed to give form to the final design under the guidance of the spirit.[301] The organic metaphor used by Häring is explained by Blundell-Jones in the following manner:

> The building was no more bodily organ, it also had an individual identity, and [Häring] expressed this idea in what he saw as the transition from "Organwerk" to "Gestaltwerk." These he defined as two stages of the creative process, drawing a parallel with the human being. "Organwerk" is mere anatomy, the functional framework, and is always the same, while "Gestaltwerk" is essence, being, personality, life. In the secret of "Gestalt" [form] lay mysterious order of the natural world, and therefore of the human world also.[302]

Although, Häring's words refer to anthropomorphic claims, he used them as metaphors.

Organwerk of the Garkau Barn, beginning with the interpretation of the initial quest of the function, allowed the unfolding of its own form, the needed space being gathered through the structural logic. Häring chose to build a lamella roof. The advantage of this structure is "complete avoidance of trusses which would interrupt the space."[303] Therefore the whole volume will be at service for storage. Actually, this structure was a good example for the relationship between the form and the function in terms of form-of-performance, that is, *Organwerk*. The "organ-like" form was attained through the technical aspects, from within, from the circumstances, and the functions, but the formal qualities of this barn passed

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[299] Ibid., 150,186,195.

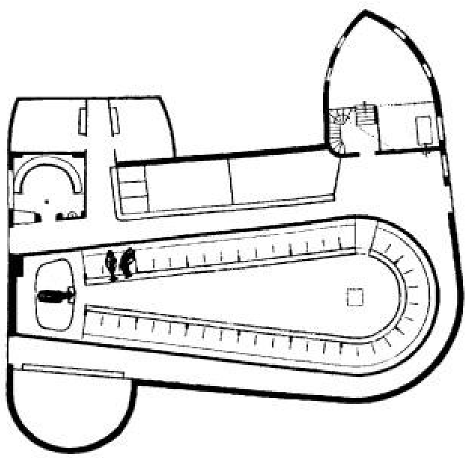
[300] Ibid.

[301] Ibid.

[302] Ibid., 160.

[303] Blundell Jones, *Modern Architecture Through Case Studies*, 50.

beyond these technical requirements.[304] This stage, in which the design process passed the practical aim in order to form a certain kind of life that the architect had in mind, was named *Gestaltwerk* by Häring. Colin St. John Wilson explains one of the main common points that the present study underlines for the architects of the organic paradigm: "an inherent 'end other than itself' that architecture has to serve…the 'end' in question is the satisfaction of a desire for a certain way of living."[305] As stated by Haring, the special requirements of every task brought him "again and again and many times right from the beginning."[306]



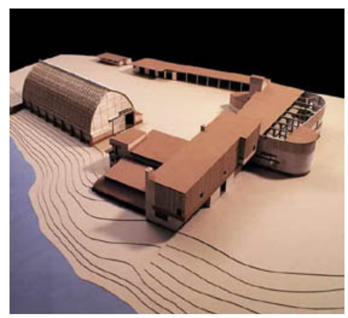


Figure 3.14: (left) Plan of the Garkau cowshed **Figure 3.15:** Model of Garkau farm

*arch*INFORM, International Architecture Database, http://eng.archinform.net/medien/00000060.htm?ID=4qa80dldq6bbm45sq1k6kd08o0 (accessed June 5, 2008).

The exhibition Hugo Häring: The Secret of Form, Cube Centre for the Urban Built Environment, http://www.cube.org.uk/exhibitions/detail.asp?id=33 (accessed June 5, 2008).

304 Ibid., 51-52.

305 St. John Wilson, *The Other Tradition of Modern Architecture,* 55.

306 Ibid., 65.

Blundell-Jones describes the role of these two stages in the following manner: "[Häring]'s concern was not just to produce a functionally efficient farm, but to discover a way of building through pursuing the nature of farming." This means the central problem became the generating of this life through formal qualities. In the course to form this life, Häring searched for "the quality of life and the experience offered when living in [the building]."[307]

In order to understand the stage named as *Gestaltwerk*, the following claim by Häring needs to be underscored:

> we attempt not to allow our attitudes towards function to conflict with our needs for expression, but to keep them side by side. We try to relate our ideas about expression about expression of life, creation, movement and nature; for in our creation of functional forms we follow the path of nature.[308]

When this path is followed, the form has to be discovered by the architect whose task was to give form to "the individuality of things. Their expression should be at one with their being."[309] The process followed by organic beings guaranteeing the relationship between the expression and the inner-self was grounded in the architectural realm for another important purpose. This important purpose active in the *Gestaltwerk* can be explained through the formal qualities of the Garkau cowshed.

Blundell-Jones underlines the influence of the Gothic Revival on Häring. Actually, for Häring the correlation between the inner-self –in terms of experiences of the building– and the outer-self, that is, external views, was an outcome of conceiving the building as a whole. A whole in which the building forms, rather then being a representative of functions, generates a frame imbued with active

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[307] Häring cited in Zehra Kuz, "Physiognomy of the New Architecture," in *The organic approach to architecture*, eds. Deborah Gans and Zehra Kuz (Chichester (England): Wiley-Academy, 2003), 29.

[308] Hugo Häring, "Wege zur Form," *Die Form* 1, no.1 (1925): 3-5, cited in Blundell Jones, *Modern Architecture Through Case Studies*, 56.

[309] Hugo Häring, "Wege zur Form," *Die Form* 1, no.1 (1925): 3-5, cited in Peter Blundell Jones, *Hugo Häring: The Organic Versus the Geometric*, 78.

relationship with the human beings.[310] This metaphorical usage of organic forms, besides representing a way to attain a variety of forms, was adapted into the architectural paradigm as a method. It meets one of main requirements of human beings, which according to Häring, is to identify their experiences with the built environment.[311]

Häring aimed to use traditional materials in a way to attain an expression or identity appropriate to the nature of building.[312] In this stage, the technical form was not sufficient to generate the needed expression; it had to be endowed with material used to some extent ornament as well. Häring followed the same process for the Garkau Cowshed. According to the answer of his farmer, he began to search for the right shape by adding his interpretation as well.[313]

Figure 3.16: Garkau Farm, from exterior

The exhibition Hugo Häring: The Secret of Form, Cube Centre for the Urban Built Environment, http://www.cube.org.uk/exhibitions/detail.asp?id=33 (accessed June 5, 2008).

[310] Ibid., 161.

[311] Ibid.

[312] Blundell Jones, *Modern Architecture Through Case Studies*, 51-52.

[313] Ibid., 53.

Figure 3.17: Garkau Farm, from exterior

The exhibition Hugo Häring: The Secret of Form, Cube Centre for the Urban Built Environment, http://www.cube.org.uk/exhibitions/detail.asp?id=33 (accessed June 5, 2008).

3.2.2 A Summary of the Design Processes

The aim of this chapter was to delineate the design process in which we can identify the influences of the organic approach, depending on the imitation of the form generation process of nature.

There are main common points between Wright and Häring in terms of their understanding of the organic approach. The function of the building was central to the beginning of their projects. Wright first began the project with an interpretation of the function. Häring began the project by understanding the requirements of the function.

During their design process, both claimed the importance of integrating their design with the environment. Their design processes began with the design of interior spaces, the inner form. The outer form was a result of the arrangement of the inner spaces. Hence, the form creation process was guided by the architect according to his interpretations of these conditions.

Another common point was that both Wright and Häring put forth the importance of human needs and human scales. For them organicity meant organic society as well.

CHAPTER 4

THE CONTEMPORARY ORGANIC TRADITION IN THE DIGITAL PARADIGM

In the early 20th century, the re-conceptualization of the scientific developments within the architectural realm, as introduced in the previous chapters, had many implications on the way the architects design and construct within an organic approach as understood by the architects' interpretation of nature. Owing to the biological innovations in the 20th century, the knowledge about the form generation processes of Nature has augmented and it is seen that, beginning with the late 20th century, the architectural realm is again in a process of re-conceptualizing the developments in biological sciences into their design theories.[1] While it should be noted at the outset that the organic approach is still alive within or outside the digital paradigm, this chapter's focus will be on aspects of the organic tradition in the digital paradigm. Branko Kolarevic underlines one of the main characteristics of the computational designs:

> The emerging digital generative processes are opening-up new territories for conceptual, formal and tectonic exploration, articulating an architectural morphology focused on the emergent and adaptive properties of form.[2]

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[1] Manuel De Landa, "Deleuze and the Use of the Genetic Algorithm in Architecture," in "Contemporary Techniques in Architecture," ed. Ali Rahim, special issue, *Architectural Design* 72, no.1 (2002): 9.

[2] Branko Kolarevic, "Towards Non-Linearity and Indeterminacy in Design," *Cognition and Computation in Digital Design*, The University of Sydney Faculty of Architecture, First International Conference on Design Computing and Cognition '04, http://faculty.arch. usyd.edu.au/kcdc/conferences/dcc04/workshops/ workshopnotes6. pdf (accessed June 3, 2008).

Beginning with an emphasis on the major innovations in the biological sciences, especially in developmental and genetic biology, the chapter will briefly describe the impact of these findings on contemporary computational design.

4.1 Biological Developments after 1920s

As the examples given in the previous chapter were involved with the imitation of the formal growth of organic beings, that is morphogenesis, the examples that will be given in this chapter are chosen in the same manner. There will be a slight difference compared to the earlier examples, since within contemporary digital paradigm, besides the imitation of the growth process, evolutionary theories are seen to hold a decisive role on the design processes. Furthermore, the contemporary projects, armed with the digital technologies, are very much interested in the mathematical modeling of the growth process of natural beings. In this sense, the focus of this survey concerns the impact of the major innovations and findings in the biological sciences on the understanding of natural form generation process on which contemporary organicism in the digital architecture is grounded.

The contemporary organicism is seen to have been involved with questions such as: "How do plants grow in relation to multiple extrinsic influences? How can environmentally sensitive growth be instrumentalized in architectural design? What are the available methods and tools, and how can they serve architectural design?"[3] In the light of Michael Hensel's questions,[4] the biological developments

[3] Michael Hensel, "Towards Self-Organisational and Multiple-Performance Capacity," in "Techniques and Technologies in Morphogenetic Design," eds. Michael Hensel, Achim Menges and Michael Weinstock, special issue, *Architectural Design* 76, no.2 (2006): 6, http://www3.interscience.wiley.com/ (accessed December 20, 2006).

[4] Michael Hensel is a partner in OCEAN NORTH and the Emergence and Design Group. One of his research interests includes a biological paradigm for architectural design.

along with their own computational modeling programs[5] will be delineated, and related to the contemporary computational paradigm.

4.1.1 Back to the Radiolarians, the Dissolution of Regular Forms, and a new to Process

Apart from the studies on morphogenesis, the computationally designed projects demand a return to the studies made on the radiolarians in the early 20th century by Haeckel and then by D'Arcy Thompson. Actually, this return is justified with a new use of these uni-cellulars (owing to their formal qualities, and self-generation capabilities) in the digital paradigm as a basic geometry, according to which a whole architectural surface is generated.[6]

Ernst Haeckel aimed to demonstrate the regularity of the radiolarians forms, through the use of crystallization.[7] He aimed to prove the validity of a symmetrical organization of their forms. Detlef Mertins notes that D'Arcy Thompson's experiments on natural forms, as already mentioned, have been important in terms of bringing forth the regularity and order in organic forms, while deciphering the inner logic on which the movement and forces are active and which are responsible for the growth process that enables simple forms to attain complex ones within nature.[8] Thompson's lengthy efforts to account for the diversity of radiolarians through the mathematics of Haeckel's theory of 'bio-crystallization' could not be accomplished, since, according to this theory, it was not possible to

[5] In the 20th century, with the introduction of computer technologies, the biologist used several techniques to model the growth process of organic beings, especially plants. And the contemporary digital architecture has borrowed these programs to integrate into their form-finding reseaches. See, Ingeborg M. Rocker, "When Code Matters," in "Programming Cultures," ed. Mike Silver, special issue, *Architectural Design* 76, no. 4 (2006), http://www3.interscience.wiley.com/ (accessed May 5, 2008).

[6] Mertins, "Bioconstructivism," 368-369.

[7] Ibid., 365.

[8] Ibid., 364-366.

attain symmetry of crystallization in radiolarians and other organic beings without mathematical grounds.[9]

Besides, the impossibility of attaining a regular formal explication for the radiolarians, D'Arcy Thompson's contribution to the biological sciences should be recalled. As introduced in Chapter 3, Thompson's comparative work on the related forms within a genus through the use of the Cartesian transformations of coordinates put forth "the morphogenetic tendency between forms."[10] This analysis has many connotations in computational designs, as within the computational paradigms, the deformations of forms through the use of 'field force" is a common use within the generative formulations defined within the model.

During the 1960s, it was not possible to explain the geometrical character of organic forms through a geometrical approach which aimed to demonstrate regularities. In that period, a new argument that still depended on the crystal metaphor argument was put forth. While Kathlene Lonsdale aimed to define the organic forms as "arrangements of atoms in repeating pattern" as in animal genetics, Conrad Waddington (1905-1975)[11] turned to study irregularities through the radiolarians.[12] Waddington stated that organic form "is produced by the interaction of numerous forces which are balanced against one another in a near-equilibrium that has character not of a precisely definable pattern but rather a slightly fluid one, a rhythm."[13] Actually, this view was consonant with Alfred North

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[9] Ibid., 366. As introduced in the third chapter, Raoul Francé was also part of the scientists who used the geometrical forms in order to explain the formation of organic ones. All these attempts depending on the use of geometrical, that is, the crystal metaphor, explanation, were dependent on the appreciation of living organisms exhibiting regular forms.

[10] Weinstock, "Morphogenesis and the Mathematics of Emergence," 10- 17.

[11] Conrad Hal Waddington was a developmental biologist, paleontologist, geneticist, embryologist and philosopher.

[12] Mertins, "Bioconstructivism," 367.

[13] Waddington cited in ibid.

Whitehead's (1861-1947)[14] understanding, which depended on viewing the world as processes in which nature is the consequence of the interactions among patterns of activity.[15] This view explains the importance of environmental effects on the organic beings, which are considered by Whitehead as "bundles of relationships that maintain themselves by adjusting their own behaviour in anticipation of changes to the patterns of activity all around them."[16] Behavior is generally defined as "an observable action or response of an organism or species to environmental factors."[17]

The consequences of these arguments are significant since they call for a departure from the regularity of organic forms towards an irregularity depending on a form generation process. This deduction shows that the organic form, different from the man-made, is not just attained through the repetition of the same simple forms. Consequently, Michael Weinstock explains the role of the process on the organic form in the following manner:

> It is the process that produces, elaborates and maintains the form of structure of biological organisms (and nonbiological things), and that process consists of a complex series of exchanges between organism and its environment. Furthermore, the organism has a capacity for maintaining its continuity and integrity by changing aspects of its behaviour.[18]

Although it was well known that the environment and the form generation process in nature were determinative on the evolution in nature -since Lamarck and in

[14] Alfred North Whitehead was a British mathematician, logician and philosopher. His is best known for his work in mathematical logic and the philosophy of science. This argument was developed in his book *The Concept of Nature* (1920). A. D. Irvine, "Alfred North Whitehead," *The Stanford Encyclopedia of Philosophy* (Winter 2006 Edition), ed. Edward N. Zalta, http://plato.stanford.edu/archives/win2006/entries/whitehead/ (accessed June 5, 2008).

[15] Weinstock, "Morphogenesis and the Mathematics of Emergence," 12.

[16] Ibid.

[17] Michael Hensel, "Computing Self-Organisation: Environmentally Sensitive Growth Modelling," in "Techniques and Technologies in Morphogenetic Design," eds. Michael Hensel, Achim Menges and Michael Weinstock, special issue, *Architectural Design* 76, no.2 (2006): 15, http://www3. interscience. wiley.com/ (accessed December 20, 2006).

[18] Weinstock, "Morphogenesis and the Mathematics of Emergence," 12.

Darwin's theory natural selection- regarding the above-mentioned developments, they have gained much more importance on the formation of irregularities. This development is relevant with the new tradition of organic architecture in the digital paradigm, since the forms, as will be seen, are generated in physical and computational environments.[19]

4.1.2 The Relationship between Form and Environment: The Importance of Feedback

Weinstock introduces the relationship between the organic form and its behavior when the organism is subject to the environmental effects.[20] It is entailed that the form of an organism is effective on its behavior within an environment, and within different environments a particular behavior has different consequences. Furthermore, that particular behavior belonging to a different form produces another effect.[21] In this sense, the behavior is non-linear; that is, the system changes indeterminately and it is not feasible to preconceive the outcome.[22] This feature of the organic beings is relevant to the new digital design techniques which aim to challenge the conventional stable design process by openly conceiving non-linearity, indeterminacy and emergence. A further important role of this feature when adapted into the computational design process is explained by Weinstock as follows:

> Cybernetics organises the mathematics of responsive behaviour into a general theory of how machines, organisms and phenomena maintain themselves over time. It uses digital and numerical processes in which pieces of information interact and the transmission of information is optimised.[23]

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[19] Ibid.

[20] Ibid.

[21] Ibid.

[22] Kolarevic, "Towards Non-Linearity and Indeterminacy in Design."

[23] Weinstock, "Morphogenesis and the Mathematics of Emergence," 12.

This process works as a feedback which is compared to a control device to regulate behavior. The use of information gathered through the environment is used to compare the actual performance with the optimal performance.[24] This feature generates the base of a dynamic feedback relation between the natural systems and their environment. The self-organization process underlying the growth of organic beings in this sense is considered as an alternative for the form creation process in the computational design process. Before fully explaining the detail of this organization special to a living organism, I will describe the constituents of this system.

The feedback mechanization is furthered by a work in thermodynamics by Prigogine.[25] According to his argument, through the flow of energy inherent in the system, every biological and many natural non-living systems are maintained. Without giving the details of this system, it should be noted that there is not a point in which the equilibrium is attained due to the energy flows. The patterns exhibited by the nature are formed from ever increasing complexity owing to the tendency of 'self-organized' systems.[26] A new order in nature emerges out of the chaos of the system at the point of collapse. In this sense, beyond the growth process, regarding the relation to environment, the natural systems are dynamic and emergent.[27]

Feedback, besides its role in maintaining the form within an environment, is also active on "modeling the relationship of geometrical pattern and form during biological morphogenesis."[28] The form-pattern relationship is dependent on two stages: "from pattern to form and from form to pattern."[29] As the details of this formation are out of the scope of this study, we just need to note that these

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[24] Ibid.

[25] Ibid., 13.

[26] Ibid.

[27] Ibid.

[28] Ibid., 14.

[29] Ibid.

stages have a dynamic loop, which continues until the equilibrium with the geometry of the evolving model is attained.[30] At the end of this dynamic process, the organic form emerges.

4.1.3 The Relationship between Intrinsic and Extrinsic Properties: Genotype/Phenotype

Until now, what has been explained was actually an explication of the adaptive process according to which the organic form gains shape. In order to understand the last innovation relevant to contemporary digital praxis, it is appropriate to give a full definition of the concept of self-organization that is effective on computational design:

> Self-organisation is a process in which the internal organisation of a system adapts to the environment to promote a specific function without being guided or managed from outside. In biology this includes the processes that concern developmental biology, which is the study of growth and development of organisms and comprises the genetic control of cell growth, differentiation and morphogenesis. Cell growth encompasses increases both in cell numbers and in cell size. Cellular differentiation describes the process by which cells acquire a 'type'. The morphology of a cell may change dramatically during differentiation. Morphogenesis involves the shapes of tissues, organs and entire organisms and the position of specialised cell types.[31]

The external effects on the growth process delineated above are actually bounded also to the intrinsic characteristics of organic beings. At this point, one of the major discoveries in the biological sciences, that is, the discovery of DNA (deoxyribonucleic acid) double-helix in the late 1950s needs to be mentioned.[32] This discovery is emblematic indeed the starting point of morphogenesis.

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[30] Ibid., 13; For further details of the energy flows in nature with an insight into organic architecture see, Mae-Wan Ho, "The New Age of the Organism," in *AD: Architecture and Science*, ed. Giuseppa Di Cristina (Chichester : Wiley-Academy, 2001), 118-119.

[31] Hensel, "Computing Self-Organisation," 13.

[32] Mae-Wan Ho, "The New Age of the Organism," 117.

Furthermore, the DNA was the outcome of a long search –actually since Aristotle– for the form-determinant principle. DNA can be considered as the "information-carrying structures."[33] Although, it is not yet understood how an organism is to gain shape through such minimal information, it is well known that the combination of all the DNAs of an organic being forms the genome, which encodes the form generation process.[34] Within the computational designs, it is seen that organicism takes up this internal characteristic of organic beings and aims to create its architectural forms through the imitation of genotypes.[35] As explained above, the environmental properties are also determinative of organic forms, the combination of the genotype with the extrinsic qualities forms the phenotype.[36]

The discovery of the genetic code explains the so-called inner logic of Nature and the organic metaphor of the 'unfolding from within' is reshaped anew by computer-based techniques in architectural designs.[37] Beginning first with the use of genetic algorithms developed by John Holland in the 1960s to design artificial systems imitating the natural ones, now contemporary computational designs use analogous systems to generate their forms. These projects also use Darwin's natural selection theory; that is, the evolutionary characteristic is part of the organic analogy. In this sense, the present study aims to reveal the organic approach which depends on the imitation of this process owing its resemblance to the concept of seed, which has been referred to in Chapter 3.

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[33] Müller, *Developmental Biology*, 2.

[34] Müller explains the role of the genome in the following manner: "It contains knowledge of how to make distinct proteins…how to make replicas of the DNA itself. It apparently embodies some hierarchical organization… The genome contains elements of spatiotemporal program to control the order of the gene expression." Ibid.

[35] "The genetic constitution of an organism or cell; also refers to the specific set of alleles inherited at a locus." Genetics Home Reference, http://ghr.nlm.nih.gov/ (accessed June 6, 2008).

[36] "Observable characteristics of an organism produced by the organism's genotype interacting with the environment." Ibid.

[37] Frazer, *Evolutionary Architecture*, 99-103.

4.1.4 A Brief Description of "Emergence"

It is appropriate to cast here the change that occurred in the way we look at Nature, since, with the light of the above-mentioned findings in biological sciences, a new understanding of nature gradually shaped. The organic form in the two time intervals that this study draws attention to –the early 20th and the late 20th centuries– depended on the form generation process. But in the latter the interdependence of the form and environment becomes emblematic, since the feedback, that is the response given by the organic beings to an external stimulus, shifts the dependence of the organic form to its inner-self in the latter. The relationship between the inner-self of the form, which was defined as the seed for the early 20th century, and the outer-self is not linear with respect to the feedback and also to the energy flows. The old idea of regularity of the organic forms led to the view of near-equilibrium by the new process, which is explained by Weinstock in the following manner:

> Processes produce, elaborate and maintain form of natural systems, and those processes include dynamic exchanges with the environment. There are generic patterns in the process of self-generation of forms, and in forms themselves.[38]

The organic forms are then emergent. The outcome of the process can be varied depending on the form and behavior, and it is not predictable. The form creation process is defined as natural systems in which the interactivity of a variety of coefficients can be identified. With respect to the properties of the process, along with all the coefficients, the emergent form gains a complexity; its property cannot be determined thorough the intrinsic properties of the final form.[39] The concept of emergence which appears actually in many disciplines in the sciences refers "to

[38] Weinstock, "Morphogenesis and the Mathematics of Emergence," 17.

[39] Ibid., 10; Michael Silberstein, John McGeever, "The Search for Ontological Emergence," *The Philosophical Quarterly* 49, no. 195 (1999): 186, http://www.jstor.org/stable/2660261 (accessed May 2, 2008).

the production of forms and behaviour by natural systems that have an irreducible complexity."[40]

Furthermore, with the contribution of complexity theories, which reveal "the prevalence of instability which is expressed by the phenomenon of small changes in initial conditions leading amplifications to the effects of the changes,"[41] the characteristics of organic forms could be understood more accurately.

4.2 The Computational Design Tools as a New Design Medium

The introduction of computer technologies into the realm of architecture as a design tool and the new construction techniques as well as new materials are now totally altering the design process. It is worth briefly explaining the properties of these new design techniques in order to understand organicism within this new paradigm. Since within the computational paradigm there is a variety of different models which aim to create form through the use of computational logic, this section aims to delineate the programs which are used to imitate nature.

The computer technologies have begun to be a part of the daily life, beginning with Alan Turing's experiments[42] in the late 1930s. His works laid the foundation of the theoretical framework for computing.[43] Although, the use of computers were used a design tool since the 1960s, it is in the late 20th century that the use of the computational design tools regarding its generative and creative potentials, along with manufacturing advances already attained in automotive, aerospace and shipbuilding industries, began to expand the formal and material boundaries

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[40] Weinstock, "Morphogenesis and the Mathematics of Emergence," 10.

[41] Frazer, *Evolutionary Architecture*, 13.

[42] For the details of the history of computer see, Rocker, "When Code Matters," 16-25.

[43] Ibid., 20.

of architectural design."[44] The developments in computer-aided design (CAD) and computer-aided manufacturing (CAM) made during the last decades of the 20th century have introduced many opportunities in terms of their capability to attain any form and structure. Through the use of CAD, it is now feasible to design free, complex forms and manufacture them owing to the same data structure used in the two realms.[45] Furthermore, the digital medium made possible to conceive the whole design process of a project from its first conception until the compilation of its construction.[46] Branko Kolarevic, while underlining the possible consequences of the digitally-driven processes which generate a new "digital continuum," notes the challenge on the conventional relationship between architecture and its production techniques.[47]

Below, the new role of the digital medium in the form creation process will be briefly explained. It was first used in architecture as a tool for representation, drafting, communication, and visualizing. In contemporary architectural designs, Kolarevic states that the digital media, with its generative and creative potential, is used as a tool "for the derivation of form and its transformation –the *digital morphogenesis*."[48] This use underpins a shift in terms of the design process. The conventional design techniques are totally altered since the forms are generated by the digital medium, instead of being designed or drawn as understood in traditional designs, and are calculated in accord with the generative computational method chosen by the architect.[49] In this computational method, the calculations, or better, alterations of the constituents which are in the model, depend on the generative structure which is formed by the identification of relations, systems of influences, rules, and constrains of the model. Therefore,

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[44] Branko Kolarevic, "Digital Praxis: From Digital to Material," *Era 21*, 2005, no. 4: 50-53, http://www.erag.cz/era21/index.asp?page_id=98 (accessed June 1, 2008).

[45] Ibid.

[46] Branko Kolarevic, "Information Master Builders," in *Architecture in the Digital Age: Design and Manufacturing*, ed. Branko Kolarevic (Oxon: Taylor&Francis, 2005), 55-60.

[47] Kolarevic, "Digital Praxis: From Digital to Material."

[48] Branko Kolarevic, "Digital Morphogenesis," in *Architecture in the Digital Age: Design and Manufacturing*, ed. Branko Kolarevic (Oxon: Taylor&Francis, 2005), 13.

[49] Ibid.; Kolarevic, "Towards Non-Linearity and Indeterminacy in Design."

working on an interdependently formed system enables the designers to extend the variety of computational approaches.[50] This method, working as an internal generative logic, generates "in an automatic fashion" a variety of forms which are then chosen with respect to their appropriateness to the project by the designer.[51] Thus, the formal qualities of the project are not known until the process is finished in that the architect only enters the needed parameters. Kolarevic briefly explains how the form creation process is altered, and how working on the relations within a model affects the computational design in the following manner:

> The emphasis shifts away from particular forms of expression (*geometry*) to relations (*topology*) that exist between and within the proposed program and an existing site. These interdependences then become the structuring, organizing principle for the generation and transformation of form.[52]

After outlining the general idea on the design process in the computational paradigm, the generative computational method derived from the organic approach will be delineated.

As understood in this study, the most important feature of the computational paradigm is its design process. Instead of attaining the form from a 'mechanical' point of view, the form is generated out of design process, as in nature. On this issue, Kolarevic states that: "The emphasis shifts from the 'making of form' to the 'finding of form.'"[53] Actually, as propounded accurately by Detlef Mertins[54] and explained in the chapter 3 through the works of Wright and Häring, form-finding was already present during the modern period, an idea that was an outcome of the organic approach. In the contemporary digital paradigm, the organic approach is still seen to play an important role during the design process. This similarity in the two periods underpins why the present study examines the

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[50] Kolarevic, "Digital Morphogenesis," 26.

[51] Ibid., 13.

[52] Ibid.

[53] Kolarevic, "Digital Praxis: From Digital to Material."

[54] Mertins, introduction to *The Victory of the New Building Design*, 1-60.

organic approach in contemporary computational designs. To this end, the study continues with a survey of the generative computational methods denoting an organic approach. Instead of making a survey on the architect's works, a focus on the design medium already points out how the new design processes altered the way architects design.

4.2.1 How the Architects Translate the "Plant Growth Process" into the Digital Architectural Realm

Wienstock, as an architect practicing in the field of the computational architecture, brings forth the usefulness of determining the essential qualities of natural systems, such as its mathematics and processes, which set an example for a concept of emergence for the designers.[55] The present study continues to delineate this approach from another perspective, that is, how the architect of the digital paradigm interprets the form generation process of nature with respect to his own field through an article written by Michael Hensel, an architect of the digital paradigm.[56]

This article, written on the research undertaken in the field of computational modeling of plant growth and development by Professor Przemyslaw Prusinkiewicz and his collaborators at the Department of Computer Science at the University of Calgary, examines the potential use of this model for architectural design.[57] The team explains its main aim in the following manner:

> One of the main goals of science is to find principles that unify apparently diverse phenomena. With this broad objective in mind, the Biological Modeling and Visualization group apply notions and

[55] Weinstock, "Morphogenesis and the Mathematics of Emergence," 10.

[56] Hensel, "Computing Self-Organisation," 12-17.

[57] Ibid., 13.

> methods of computer science to gain a better understanding of the emergence of forms and patterns in nature.[58]

Throughout the article, Hensel draws parallels between this model and its possible use in architectural models. Although the architect's attention is on the model, it is actually the search for a way to imitate nature regarding its benefits for the design process and the potential to attain emergent forms through this growth process.

First, Hensel notes that "Modeling plant growth and development is predominantly based on mathematical, spatial models that treat plant geometry as a continuum or as discrete components in space."[59] One of the main features of this model, which describes plant form as a result of the growth process, is its parametric aspect enabling the researcher to change the growth-process variables and compare the resultant forms with previous ones. The output of the program is numerical and it can be visualized as well.[60]

Prusinkiewicz underscores the benefits of the use of this computational model in such a way that, while providing a quantitative understanding of the development mechanism, the model reveals the interrelationships between various properties of development.[61] Hensel puts forth that such models, by providing a new analytical and generative approach, might enhance the architectural designs, as they reveal an appropriate understanding of "synergies between systems and environments, or subsystem interaction" through their behavioral properties and capacities.

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[58] Algorithmic Botany, the website of the Biological Modeling and Visualization research group in the Department of Computer Science at the University of Calgary. http://algorithmicbotany.org/ (assecced June 9, 2008).

[59] The explication of the discreet and continuum component is given in the following manner: "Components might include the local scale of individual plant cells, the regional system scale of modules such as nodes, buds, apices, leaves and so on, or the plant taken as a whole for ecological models." Hensel, "Computing Self-Organisation," 14.

[60] Ibid.

[61] Prusinkiewicz cited in ibid.

A brief insight into the Prusinkiewicz's computer system will be useful: The team used the Lindenmayer System or L-system, which was developed by the Hungarian biologist Aristid Lindenmayer in 1968 to maintain the development of the growth patterns of different, simple multicellular organisms.[62] An L-system depends on the formal description of development, called formal grammar in the computer sciences.[63] Briefly, L-systems are formed out of "four elements (a starting point, a set of rules or syntax, constants and variables)"[64] and grow through writing and rewriting the code.[65] The variety of forms is attained by changing the starting point and the growth period. Besides its capability to generate a variety of plants, the model specification and parameters of L-systems can easily be altered. By considering these qualities Prusinkiewicz's team chose to study the growth process of plants by using L-systems.[66]

Two different levels of modeling are pursued by Prusinkiewicz's team: the modeling of individual plants sensitive to system-extrinsic influences and modeling of populations. In the case of populations, the team also developed a simulation tool responsible for the spatial distribution of plant communities.[67] The main criterion for all these models is that they are "grown" according to environmental input in the computational medium. Without getting into detail on the modeling properties, I will focus on the architect's, that is, Hensel's interpretation of the modeling profits in terms of architecture.

The first level, the modeling of individual plants is undertaken by integrating the extrinsic physical, biological and environmental input to the plant growth.[68]

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[62] Ibid., 13.

[63] Ibid.

[64] Rocker, "When Code Matters," 21.

[65] Ibid.

[66] Hensel, "Computing Self-Organisation," 14.

[67] Ibid., 14-17.

[68] The incorporation of "the combined impact of the gravity, tropism, contact between various elements of a plant structure and contact with obstacles" is exercised on more advanced models. Ibid., 14.

Actually, as explained above, this integration refers to the behavior of the organic beings while adapting an environment or while just being subject to external stimulus with respect to its intrinsic properties.[69] In this respect, Hensel sees the potential of modeling, or better, in the case of digital architecture, designing the building by pursuing the same logic with the same variables. He argues that by releasing the conventional "step-by-step or objective-by-objective optimizations" made at the end of the design process by specialists outside the realm of architecture, following a similar way to the biologists, the architects can integrate the physical conditions into the toolset of their own model.[70] By imitating the capability of organic forms of fulfilling many requirements at the same time, an entire building system will be informed of the physical conditions through this method, and therefore its form will be grown by the same unity. This means that at each stage of the design process the visual outcome will always be bound to the defined factors.[71]

The second level, the modeling of populations, concerns the formation of "all organisms that constitute a specific group"[72] living in a specific habitat. While explaining this level, Hensel states that "[p]opulation ecology involves the dynamic of populations within species, and the interaction of these populations with environmental factors."[73] The difference from the former level within this model is that the interactions among the different species are effective, besides the physical ones. There are two models working in this level to constitute the population: a higher-level model responsible for the distribution of the plants and a lower-level model executing the formal development of each plant.[74]

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[69] Ibid., 15.

[70] Ibid., 14.

[71] Ibid.

[72] Ibid., 16.

[73] Ibid.

[74] Ibid.

Hensel underscores the importance of this model, working on two levels, not just for the architectural paradigm, but also for designing on the urban scale. Hensel foresees the usefulness of this application in the urban scale and states that:

> Depending on their particular interaction with the environment, buildings can be distributed and clustered in appropriate ways, so as to accumulate or disperse the effects of their interaction and its impact on the evolution of their further relationship.[75]

At the turn of the 21st century, armed with new technologies, the biological sciences took great steps in development. Owing to their findings, the major secrets of organic forms are revealed, but there are a lot of questions still waiting for a response.[76] In the realm of architecture, the look to nature shows similarities when compared to the early 20th century's understandings. As described here, the concept of emergence and the capability of adaptation of nature comes into prominence. Besides, seen as an emergent form, nature turns into a lesson. In order to understand how the above-introduced image of nature is understood in the digital paradigm, first a general overview of the new design processes in the computational paradigm will be presented, followed by the description of cases in which organicism seems decisive.

4.2.2 Evolutionary Computation

The main common point among the architects of the computational paradigm, who imitate the form generation process of nature, is the aim to generate complex adaptive systems. These systems, as introduced-above, entail both self-organization and emergence. Let us recall that self-organization is a dynamic and adaptive process according to which "the systems achieve and maintain structure

[75] Ibid.

[76] Müller, *Developmental Biology*, 2.

without external control"[77] and that emergence is open to extrinsic forces. These two different concepts are the characteristics of a system's behavior. Michael Hensel explains their aim in the following manner:

> Self-organisational systems often display emergent properties or behaviours that arise out of the coherent interaction between lower-level entities, and the aim is to utilise and instrumentalise behaviour as a response to stimuli towards performance-oriented designs.[78]

In order to attain the needed formal development for the projects, the evolutionary techniques are used. The present survey focused on two works: the Genr8[79] which is surface design tool designed by Martin Hemberg and a research project on high-rise buildings by Emergence and Design Group (Michael Weinstock, Achim Menges and Michel Hansel)[80]. Herein will be given just the main idea on how these surveyed generative methods work throughout the process. This chapter will follow the metaphor of seed and the growth process. However, within the contemporary digital paradigm, the seed and the growth process form actually an analogy, since the development of forms as will be seen below begin with a piece of material, or polygon. First, a brief description of the form creation processes will be given, and then a summary of the new form creation processes will be made.

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[77] Hensel, "Towards Self-Organisational and Multiple-Performance Capacity in Architecture," 6.

[78] Ibid.

[79] Una-May O'Reilly, Martin Hemberg, and Achim Menges, "Evolutionary Computation and Artificial Life in Architecture: Exploring the Potential of Generative and Genetic Alghorithms as Operative Design Tools," in "Emergence: Morphogenetic Design Strategies," eds. Michael Hensel, Achim Menges and Michael Weinstock, special issue, *Architectural Design* 74, no. 3 (2004): 48-53.

[80] Michael Weinstock, Achim Menges and Michel Hensel, "Fit Fabric: Versatility Through Redundancy and Differentiation," in "Emergence: Morphogenetic Design Strategies," eds. Michael Hensel, Achim Menges and Michael Weinstock, special issue, *Architectural Design* 74, no. 3 (2004): 40-47.

4.2.2.1 Genr8: A Surface Design Tool

Genr8 as a design tool used as a computational method is formed of the integration of evolutionary computation, generative computation and physical environment modeling techniques.[81] Its aim is "to instrumentalise the natural processes of evolution and growth, to model essential features of emergence."[82] This method enables developments of surface geometries in 3-D space. The growth process is undertaken in virtual environmental conditions.[83]

"The development is governed by an algorithm that mimics organic growth."[84] Briefly, the formal development process can be described as follows:[85] The seed of the design is an equilateral polygon. This seed is grown according to the generative method. During its growth, the external forces identified by the architect are present, and thereafter the emergent forms are generated. Then, this cycle that is called genotype and phenotype is repeated in order to attain enough population. Regarding natural selection, the fittest of these grown forms are selected. Then, through the recombination of the selected forms the improved 'descents' are attained. All these phases are done through the use of evolutionary algorithms.[86]

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[81] "Genr8 is a combination of grammatical evolution (the evolutionary computation alghorithm) and extended Map Lindenmayer systems (the generative alghoritm)… Implemented as a plug-in for Alias Wavefront's 3-D modeller Maya." O'Reilly, Hemberg, Menges, "Evolutionary Computation and Artificial Life in Architecture," 48-49.

[82] Ibid., 48.

[83] Ibid. For details of this method see, Una-May O'Reilly and Martin Hemberg, "Integrating generative growth and evolutionary computation for form exploration," *Genetic Programming and Evolvable Machines* 8, no.2 (2007): 163-186, http://www.springerlink.com/content/a94p17317q316774/fulltext.pdf (accessed May 20, 2008).

[84] O'Reilly, Hemberg, Menges, "Evolutionary Computation and Artificial Life in Architecture," 48-49.

[85] Ibid., 48-50.

[86] Ibid., 48-53.

Although, this method is not recently used for an architectural project, it opens a new framework for the future projects aiming to imitate the natural growth process. It is this reason this study has chosen to delineate its design process.

Figure 4.1: Form designed Using Genr8, a photograph of the sectional surface model.

Martin Hemberg, Una-May O'Reilly, Achim Menges, Katrin Jonas, Michel da Costa Gonçalves, and Steve R. Fuchs, “Exploring generative growth and evolutionary computation in architectural design,” http://projects.csail.mit.edu/emergentDesign/genr8/hemberg_chap.pdf (accessed April 6, 2008).

4.2.2.2 A research project on high-rise buildings by Emergence and Design Group

The evolutionary process of the Emergence and Design Group begins with a consideration of the needs of the project, that is, a high-rise building. Before beginning the development of the project, they look into natural structures and choose to develop a spiral helix, regarding its qualities. In order to attain this helix, they first begin with the seed which is “the section of a steel tube 150 millimeters in diameter."[87] This steel tube "was swept along a helix to the bounding limits"[88] of the site. Through the evolutionary algorithms, they attained a double-helix structure. This evolutionary period was considered as the development of the genotype. Afterwards, the development of the phenotype was undertaken by putting the geometry into the midst of the environmental forces. This stage was used to increase the structural capacity "by sharing and distribution of loads," then the final form was a variation of the genotype. The building envelope was generated through the use of the surface geometry of custard apple.

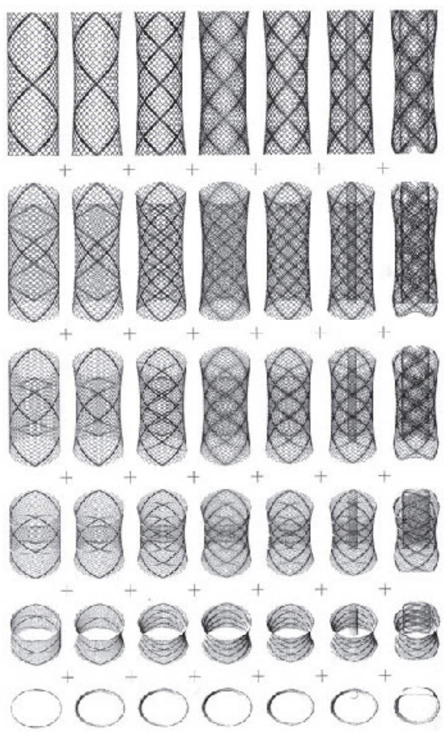

Figure 4.2: Helix evolution

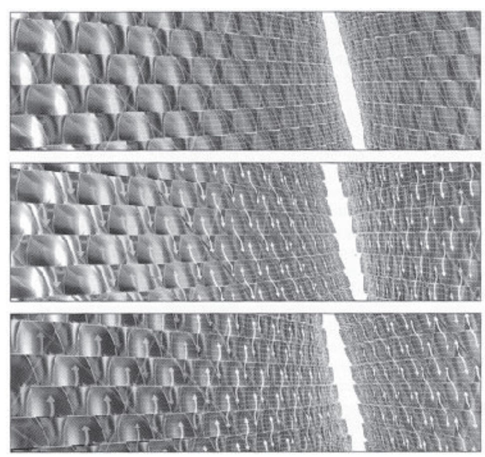

Figure 4.3: Skin panel

Weinstock, Menges and Hansel, "Fit Fabric: Versatility Through Redundancy and Differentiation," 42, 44.

[87] Weinstock, Menges and Hansel, "Fit Fabric: Versatility Through Redundancy and Differentiation," 41.

[88] Ibid.

4.3 The "Natural Growth Process" as the Design Method

The works that have been given above pursued a design method which is to some extent borrowed from the organic form generation process, that is, from morphogenesis. The intention is not a mere copy of the organic forms, but its process, since the findings of the biological sciences by now explain a great amount of factors guaranteeing the emergent forms of nature. The laws governing the form generation process of the organic form are now well known. They can even be virtually modeled by the computer to some extent. It is showed that the generative methods for the formal development are also borrowed from the biological sciences, since the discourse that these evolutionary processes draw upon are their proper terms.

The common ground of the organic approaches in these two projects is that the natural laws can help to attain adaptation and complex forms, or emergence. The medium used for this design process is depending on a mathematical logic, and the visualization of the projects is bound to this mathematical logic, called algorithm. The main purpose to pursue the organic form generation process as an inspiration is due to the desire to generate a variety of possible solutions with a multiplicity of unpredictable forms and to choose the best fit among this variety of solutions to the design problem. Conceiving the formal development as a whole, that is, the structural unity within the process are prominent ideas to attain the multi-performance for the buildings.

As did the architects of the early 20th century that this study referred, the forms are attained through a process. The forms are found, they are not designed. The processes that have been followed by the architects of the early 20th century were dependent on the architects who showed different attitudes in their interpretations of the process.

In the contemporary organic approach, the forms are not developed out of an idea or function, but by beginning just with a form, and the followed process simulates natural form development. In this sense, although the processes that this study pursued are different from each other, the processes used by the contemporary architects seem to follow the same way; the simulation of the natural form development process. This problem should be underlined, since today's architects have the chance to interact with the design process through the parameters. The process is nature, the starting point is a material piece, and the environment is codified. There are essential points missing in their process however. Branko Kolarevic explains the consequences of this design process on the role of the architect in the following manner:

> The designer essentially becomes an "editor" of morphogenetic potentiality of the defined system, where the choice of emergent forms is driven largely by the designer's aesthetic plastic sensibilities. The capacity of digital, computational architectures to generate "new" designs is, therefore, highly dependent on the designer's perceptual and cognitive abilities, as continuous, dynamic process ground the emergent form, i.e. its discovery, in qualitative cognition.[89]

In this sense, where the architects of the organic tradition of the 20th century began first by the human needs, the contemporary computational designs have to discover the fittest from a multiple choice. On this changing aspect of the design process, Manuel De Landa claims that "evolutionary simulations replace design, since artists can use this software to breed new forms rather than design them."[90]

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[89] Kolarevic, introduction to *Architecture in the Digital Age*, 23.

[90] Landa, "Deleuze and the Use of the Genetic Algorithm in Architecture," 9.

CHAPTER 5

CONCLUSION

This thesis delineated the different attitudes towards the form creation processes within the organic tradition in architecture, and suggested that these differences are significantly tied to scientific developments and the design medium. The thesis, while focusing on the interrelatedness of the knowledge of nature and the organic approach, traced the organic form creation processes in the two periods, that is, the early 20^{th} century and the contemporary computational paradigm. It underscored a similarity between these periods in terms of the form creation process, which is an imitation of the form generation process of nature. Regarding this similarity, architectural forms are found to be gradually shaped according to the understanding of the organic form generation process.

Beginning first with the famous phrase “art imitates nature” in the Classical period, the thesis revealed how the imitation of nature in architecture has become the imitation of the mechanism of natural form in the contemporary computational paradigm. Within the span of a century, the thesis put forth the idea that the belief for an inherent law of nature has always been the propelling force in the understanding of organicism in architecture as well as in different arts. Although it is possible to see this common belief for centuries, the thesis suggested that, depending on the knowledge of nature, the understanding of the law of nature has evolved within centuries and that, thereby, what nature signified for the architects underwent numerous changes. Owing to the instability of this notion, the imitation of nature in architecture also brought about different attitudes in the logic of imitation. The thesis, while underlining this change in the meaning of laws of nature, also tried to demonstrate the tie between the organic approach in architectural designs and the scientific paradigm.

The thesis especially focused on the 19^{th} century's biological developments and the Romantic Movement in Europe for two reasons: first, the understanding of the imitation in the 1920s in modern architecture depended on the laws of nature of this period; second, the 19^{th} century scientific developments produced a paradigm shift in terms of the inherent laws of nature. The top-down model of nature was replaced with the bottom-up model. This shift has led to the organic approach that the thesis dealt with studying the early 20^{th} century: the notion of 'unfolding from within', which is the understanding that organic beings achieve their form owing to the form generation process and that the final form would be the reflection of its inner workings. In order to understand the consequences of this organic understanding, the thesis surveyed the design processes of the architects Frank Lloyd Wright and Hugo Häring. This survey has been pursued through an organic metaphor which has been used at this time by Louis Sullivan and Frank Lloyd Wright, the 'seed' metaphor, to designate their own design process and formal development of organic form. In accordance with this metaphor, the thesis followed the form creation processes of these architects.

The findings of this survey are given below for the purpose of making a comparison of the design processes between the organic understandings of the early 20^{th} century and the contemporary computational paradigm.

The thesis articulated the biological developments which are relevant on the formation of contemporary organicism in the digital paradigm. According to these developments, the thesis underscored the importance of the concepts of self-organization and of emergence as the main influences on the organicism of the contemporary period. These developments, besides furthering the importance of the form generation process on the organic form, owing to the concept of emergence, underscore the importance of the environmental aspects on organic form. According to the new developments, the most important thing that the thesis underlined is that the outer form and the inner self are not totally related due to the impacts of the exterior forces on organic forms; that is, the environmental aspects become important. The thesis has drawn attention to the relationship between the architects and biologists, since it is seen that the architects of the digital paradigm, besides their own generative methods used in the form creation processes, borrow as well the methods used to modeling the form generation processes of plant forms such as the L-systems. Thereafter, the thesis introduced briefly the properties of the new medium of design; in other words, the computer-based design processes have been explained in order to understand the implications of the new design medium, along with the new developments in the biological sciences.

5.1 The findings of the thesis

It seems appropriate to begin with an overview of the evolution of the organic tradition. Throughout this thesis, a variety of organic approaches beginning from the Classical period until the computational paradigm have been described. Regarding this survey, the thesis suggests that the organic approach of the Classical period was based on simulating aspects of nature, while the modern period used a different understanding of the 'organic', which, has itself changed within the computational paradigm.

In the modern period, the organic metaphor of Wright and Häring borrowed the idea of 'unfolding from within' or the organic growth process, as well as the idea of functionality from nature. However, this did not mean for them that they strictly followed the way natural forms grow. In their design process, this 'growth process' has been helpful. As introduced in the third chapter while explaining Häring's form creation process, during the Gothic revival, one of the main imperatives was to have a unity between the inner life and its outer expression. Häring was influenced by this understanding. It is possible to suggest that attaining this unity could be done by imitating nature, since according to the scientific knowledge of the early 20th century, organic form was an example having this kind of quality, that is, a linear relationship between the inner-self and the outer appearance. Furthermore, for Wright the laws of nature were a key concept for attaining a "true style." As Viollet-le-Duc accurately explained this understanding in the following manner:

> …nothing exists in nature without a principle, everything in nature must have style… like Nature in her productions, and thus you would be enabled to give style to all the conceptions of your brain.[1]

This understanding of organicism did not mean to copy the principles of nature, but gives the idea of being like nature and having principles.

For both architects, the organic approach was also related with the social life that their buildings were to serve for. Their design processes was related with the human experiences and needs; in this sense the inner plan was important for them. Wright and Häring insistently talked about the material qualities, the descriptions of interior plans. Foremost, these qualities were linked to the spatial qualities that they offered. While to be organic meant the relationship between spaces for Wright, it was for Haring the movement within the building. Here, designing from the inside towards the outside was the genuine organic metaphor.

In the contemporary computational projects, the organic approach can not be considered as a metaphor. Instead of interpreting the formal development of organic beings, the design follows step-by-step the organic morphogenesis, through the generative method of computation. The interpretation of the form generation process leads to its simulation. The architectural considerations of the spatial qualities seems lost, and organicism leads just to a formal search. However, through the use of this imitation, the architectural space can be enhanced with new forms, and therefore new spatial qualities. Instead of diversity in terms of material use, this process leads to a diversity of forms.

Regarding the organic approach of the two periods, the following table has been developed to reflect the way the architects interpret the natural form creation processes in their projects. This table also refers to the metaphor of the seed and the natural form development used while explaining the projects of the two periods.

[1] Viollet-le-Duc cited in Hoffmann, "Frank Lloyd Wright and Viollet-le-Duc," 178.

Table 5.1: The comparison of the imitation of nature in the two periods

The Early 20th Century Wright and Häring	The Contemporary Computational Realm
1. The seed of the project: Function / interpretation of the function by the architect. 2. Form development: From the inside towards the outside. 3. The process: Dependent on the understanding of the architect. The process is as an organic metaphor. 4. The environmental aspects: Integration to the seen world. Formal integration is predictable and intentional.	1. The seed of the project: Form / material 2. Form development: From the smaller part towards the whole. 3. The process: Dependent on the parameters defined by the architect. The process is a simulation of natural growth process. 4. The environmental aspects: The environment is virtually defined and controlled through the use of the parameters. Formal integration is unpredictable.

The thesis underscores how the prevalent meaning of the organic unity which was once explained as "part-to-whole-as-whole-is-to-part"[2] turned into organic form irreducible to its parts. As the biological sciences demonstrated, the linear relationship between the inner-self and outer appearance was corrupted by the interaction of the organic being with environmental aspects. This aspect known as the new relationship between the genotype and the phenotype, became emblematic of the formation of the computational forms. The thesis refers to the use of the concept of emergence in computational projects in two ways: First as a

[2] Wright, "The Language of an Organic Architecture," 81.

way to attain complex forms, and second as used by the Emergence and Design Group to attain the multi-performance.

Designing the building following the natural growth process and the aim to conceive the whole at each stage signifies a commonplace for the two periods. In this sense, the thesis aimed to bring forth another difference concerned with this commonplace. While making the survey of Wright's project, the study brought forth the difficulty –in Wright's own words– he experienced during the design process. Wright stated that he aimed to conceive the building as a whole throughout the design process, which means that every detail such as its structure or materials should be in an organic unity. Although, during the early 20^{th} century, attaining this unity was dependent on the architect's capability; within the computational paradigm, it is seen that the building during the process is always considered as a whole. The difficulty that Wright put forth has been overcome, though in the digital paradigm conceiving the whole is dependent on the computational program and the parameters defined by the architect.

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