# PROCESSING MATERIALITY THROUGH ARCHITECTURAL INFORMATION

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

BY

MERAL CANA DAİ

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

DECEMBER 2015

Approval of the thesis:

**PROCESSING MATERIALITY THROUGH ARCHITECTURAL INFORMATION**

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## ABSTRACT

### PROCESSING MATERIALITY THROUGH ARCHITECTURAL INFORMATION

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December 2015, 94 pages

Constituting a fundamental ground for the discipline of architecture, the concept of materiality is the central consideration of this thesis. Besides a particular set of materials by which architectural production made out of, the literal aspect, materiality also refers to all architectonic qualities that form the physical constitution of an architectural product, the referential aspect. Taking referential aspect as its basis, this thesis considers architecture as an "organizational system" and approaches materiality as "the substance of architectural totality" touching upon the formal, structural, spatial and material qualities of architecture.

Within this context, this study interrogates the dissolution of organization systems of architecture into information systems and, accordingly, investigates how this dissolution affects and gets affected by the status of materiality in architecture.

In general, such dissolution reveals a synthesis between materiality and information by associating materiality with its ability to generate information and to be generated by information over time. This reciprocal reproduction results in the formulation of diverse modes of materiality. In order to recognize,

differentiate and organize these diverse modes, this thesis proposes a categorization of materiality by means of information flows and relative responses. The primary classifications are defined as the formed and informed materiality, dynamic and kinetic materiality, segregated and integrated materiality, and predictable and unpredictable materiality. Considered as a method of exploration throughout the process, this categorization attempts to provide a ground on which a comparative analysis of materiality can be conducted.

Keywords: Materiality of architecture, Architectural information, Categorization of materiality.

# ÖZ

## MADDESELLİĞİN MİMARİ BİLGİ YOLUYLA İŞLENİŞİ

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Aralık 2015, 94 sayfa

Maddesellik kavramı doğrudan ele alındığında mimariyi oluşturan malzemeleri ifade ederken, dolaylı olarak ele alındığında mimarinin fiziksel oluşumunu şekillendiren biçimsel, yapısal, mekânsal ve malzemeye dayalı özelliklerin tümüne değinerek mimarlığın bütünselliğini belirtir. Dolaylı bakış açısını esas kabul eden bu tez, mimarlığı bahsedilen özellikler tarafından tanımlanan örgütsel yapılanmaya dayalı bir sistem olarak ele alır.

Bu bağlamda, bu tez, mimari örgütsel sistemlerin bilgi sistemlerine dönüşümünü incelerken, bu dönüşümün mimarlığın maddeselliği üzerindeki etkisini ve mimarlığın maddeselliğinden nasıl etkilendiğini de araştırır.

Genel anlamda, bu dönüşüm sonucunda maddesellik bilgi tarafından üretilir ve aynı zamanda bilgi üretir. Bu durum maddesellik ve bilgi arasında bir sentez oluşturur. Bahsedilen karşılıklı üretim süreci, bilgi akışı ve buna verilen tepkiye bağlı olarak farklı maddesellik ortamlarını ortaya çıkarır. Bu farklı ortamları anlamak, ayrıştırmak ve düzenlemek adına, bu tez sistematik bir sınıflandırma önerir. Kurguya ve bilgiye dayalı maddesellik, dinamik ve kinetik maddesellik, ayrık ve birleşik maddesellik, öngörülebilen ve öngörülemeyen maddesellik sınıflandırmanın ana başlıklarını oluşturur. Tez

süresince araştırma yöntemi olarak ele alınan bu sınıflandırma, maddeselliğin karşılaştırmalı incelemesinin yapılabileceği bir zemin oluşturmayı hedefler.

Anahtar kelimeler: Mimarinin maddeselliği, Mimari bilgi, Maddeselliğin sınıflandırması.

To Wanda

## ACKNOWLEDGMENTS

I would like to express my gratitude to my supervisor Prof. Dr. Ayşen Savaş. She not only supported me with her intellectual guidance, but also encouraged me to achieve my best and follow my own path all the way down the line.

I am grateful to Assoc. Prof. Dr. Arzu Gönenç Sorguç who has been a great mentor and supporter to me throughout the process. I would also like to thank to the other members of the examining committee, Assoc. Prof. Dr. Mine Özkar, Assoc. Prof. Dr. Burcu Şenyapılı Özcan and Assist. Prof. Dr. İpek Gürsel Dino, for their valuable critics and inspiring comments.

I am grateful to Utku Karakaya for his guidance, as this thesis could not have been accomplished without his endless support and encouragement. I am also indebted to my friends Deniz Dilan Kara, Emre Uğur, Erald Varaku, Ensar Temizel, İrem Dökmeci, Yasemin Fillik, İpek Mehmetoğlu, Neris Parlak and Seda Sokullu for their support and contributions throughout the process. Our discussions and collective studies have provided me not only invaluable insight and inspiration but also motivation and encouragement.

Finally, I would like to express my deepest gratitude to my parents, Rengin and Selim Dai, and to my brother, Kaan Dai, who have been encouraging and supporting me at all aspects of life. Any thank would be an understatement.

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# INTRODUCTION

## 1.1. Materiality for Architecture

As is indicated in the international conference entitled "What's the Matter? Materiality and Materialism at the age of Computation," co-organized by ENHSA, EAAE and COAC, hosted by the Chamber of Architects Barcelona, ETSAB and ETSAV, in 2014, in Barcelona, materiality is a term that has been enhanced by a variety of strategies and approaches.[1] Cited in different publications, the paper I have presented in this conference finds its roots in this

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[1] A different version of this thesis has been presented in the above mentioned conference and published in the proceedings:

Meral Cana Dai. "Processing Materiality through Architectural Information," What's the Matter? Materiality and Materialism at the Age of Computation, ed. Maria Voyatzaki, Barcelona: ENHSA, 2014, pp.703-715.

(ENHSA: European Network of Heads of Schools of Architecture; EAAE: European Association for Architectural Education; COAC: Collegi d'Arquitectes de Catalunya; ETSAB: Escola Tecnica Superior d'Arquitectura de Barcelona; ETSAV: Escola Tècnica Superior d'Arquitectura del Vallès)

thesis.[2] In this regard, the thesis starts with the presentation of these diverse strategies and approaches developed in other disciplines.

Focusing on the anthropologist David Miller's interpretation, the definition of materiality is directly correlated with social sciences.[3] Miller situates materiality on a cultural platform and distinguishes the "colloquial" and "philosophical" use of the term. While the colloquial approach focuses on the quantitative aspects of objects under study, the philosophical approach indicates that an "object" is formed to indicate the presence of an immaterial "subject". According to Miller, the definition of a temple, for instance, goes beyond being merely a physical entity: it is interrelated with social life, human acts and ideologies.[4] Such approach leads to theorize materiality as a diagnostic tool rather than a study of mere physical conditions. Here, materiality is associated with "phenomenology". From a totally different perspective, art historian Erwin Panofsky provides an alternative approach to materiality investigating the "subject" of artworks.[5] Panofsky asserts that the material attribute of any object is directly correlated with the underlying values that constitute deeper structures. In this regard, according to Panofsky, a certain

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[2] See citations in, Ayşen Savaş. "Reconstructing Authenticity: Erimtan Archeology and Arts Museum in the Ankara Citadel," Authenticity in the Conservation of Historic Houses and Palace-Museums, ICOM DEMHIST-ARRE, France, 2014; Ayşen Savaş. "Tarihin İzini Sürmek: Erimtan Arkeoloji ve Sanat Müzesi'nin Tasarım Süreci," Arredamento Mimarlık, vol. 06, 2015, pp.63-77.

[3] Daniel Miller. "Materiality: An Introduction," Materiality, ed. Daniel Miller, Durham, NC: Duke University Press, 2005, pp.1-51.

[4] Ibid.

[5] Panofsky, Erwin. "Introductory," Studies in Iconology: Humanistic Themes in the Art of the Renaissance, New York, NY: Harper & Row, 1972, pp.3-17.

motif carries a meaning beyond its pure form.[6] That means materiality becomes the manifestation of the underlying structure that asserts specific meanings. In this case, materiality is associated with "iconology".

In parallel with these theories progressed in the related disciplines, architecture has developed its own approaches towards materiality, which are associated with phenomenology, iconology and comparable subthemes developed in other disciplines. Following the theories of Eugene-Emmanuel Viollet-le-Duc, Gottfried Semper, Karl Bötticher, and latter Kenneth Frampton the discipline of architecture has developed a particular concern to understand the physical constitution of an architectural product. This concern led Frampton to contextualize building as "an act of construction:"

> "Thus one may assert that building is ontological rather than representational in character and that build form is a presence rather than something standing for an absence. In Martin Heidegger's terminology we may think of it as a thing rather than a sign." [7]

As opposed to the subjectification of architecture, this point of view provides an alternative approach to materiality foregrounding the formal characteristics of an architectural product. Following this path, the thesis intends to present "a formal approach" to materiality.

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[6] Ibid.

[7] Kenneth Frampton. "Rappel a l'Ordre: The Case for the Tectonic," Theorizing a New Agenda for Architecture: An Anthology of Architectural Theory 1965-1995, ed. Kate Nesbitt, New York, NY: Princeton Architectural Press, 1996, pp.516-530.

## 1.2. Materiality of Architecture

> "Marco Polo describes a bridge, stone by stone. 'But which is the stone that supports the bridge?' Kublai Khan asks. 'The bridge is not supported by one stone or another,' Marco answers, 'but by the line of the arch that they form.' Kublai Khan remains silent, reflecting. Then he adds: 'Why do you speak to me of stones? It is only the arch matters to me.' Polo answers: 'Without stones there is no arch.'"[8]

In the discipline of architecture, the literal meaning of the term materiality is directly correlated with material quality. 'Materiality' with its tactile dimension, which shapes the physical constitution of its products, is an inseparable and inescapable component of architecture. In other words, every built architectural product is a result of materials: brick, concrete or stone. As Kenneth Frampton states, "[t]his proclivity for the tactile is what possesses a vestigally resistant core in architecture."[9] However, the notion of materiality implies more than a particular set of materials by which architectural production made out of. In the extensive context, materiality reframes itself, taking on a new identity as a multi-layered model that refers to the assembly of form, structure, space and material. That is to say, in this case, materiality no longer refers to a mere material condition, but rather indicates "the substance of architectural integrity."

Herein, it is inevitable to refer to the categorizations of Gottfried Semper, which explicitly reveal the aforementioned distinction. In his book "Style:

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[8] Italo Calvino's story about Marco Polo and Kublai Khan, in Invisible Cities, as referred in Fabio Gramazio and Matthias Kohler. Digital Materiality in Architecture, Baden, Switzerland: Lars Müller Publishers, 2008, pg.58.

[9] Kenneth Frampton. "The Owl of Minerva; An Epilogue," Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture, Cambridge, MA: The MIT Press, 1996, pg. 377.

Style in Technical and Tectonic Arts, or, Practical Aesthetics" Semper introduces four categories of raw materials according to their technical purposes. Materials can be pliable, tough, like fabrics; soft like clay; stick shaped, elastic, like wood; or strong, dense, like stone.[10] As a second step, Semper constructs a new classification based on the materials, but this time, by specifying the way these materials come together. According to these materials introduced earlier, he defines four main artistic activities; textiles, ceramics, tectonics (i.e., carpentry), stereotomy (i.e., masonry).[11] Rather than referring directly to the material characteristics, this classification focuses on "the domain of form" based on "the technical procedures".[12] For instance, if textile refers to act of knitting, the material is not certainly selected as fabric or wood; that is to say, the main concern is the methods of assembly and organizational characteristics of a specific material.

While the former categorization of Semper focuses on the literal aspect of materiality, the latter emphasizes the interest on "the different instances and modes in which the architectural product comes into being;"[13] the referential aspect. This is where architecture will begin to be identified as an organizational system. Thus, materiality becomes the manifestation of formal, structural, spatial and material qualities by moving away from simply referring to a material condition. In this regard, contrasting the more common use of the term in architecture, materiality provides a platform from which these architectural dynamics can be conducted.

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[10] Gottfried Semper. "Classification of the Technical Arts," Style in the Technical and Tectonic Arts; or, Practical Aesthetics, Los Angeles, CA: Getty Publications, 2004, pp. 109-113.

[11] Ibid.

[12] Ibid.

[13] Ibid.

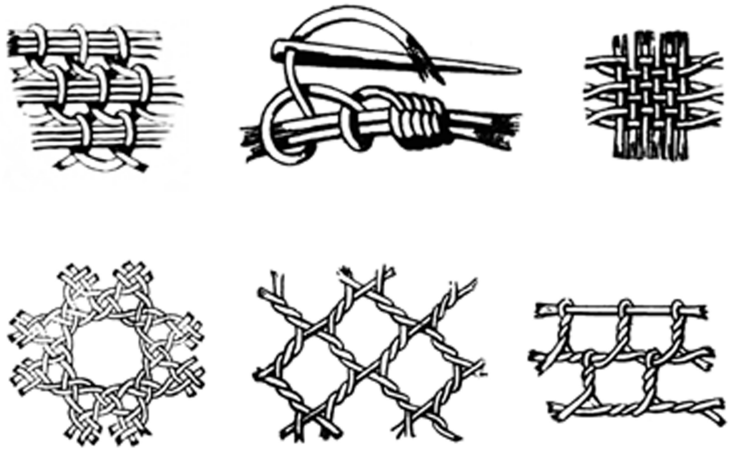

**Figure 1.1 Gottfried Semper's illustrations of knotted fabric**

Source: Mari Hvattum. "The Primitive Hut Rebuilt," Gottfried Semper and the Problem of Historicism, New York, N.Y.; Cambridge University Press, pg. 65.

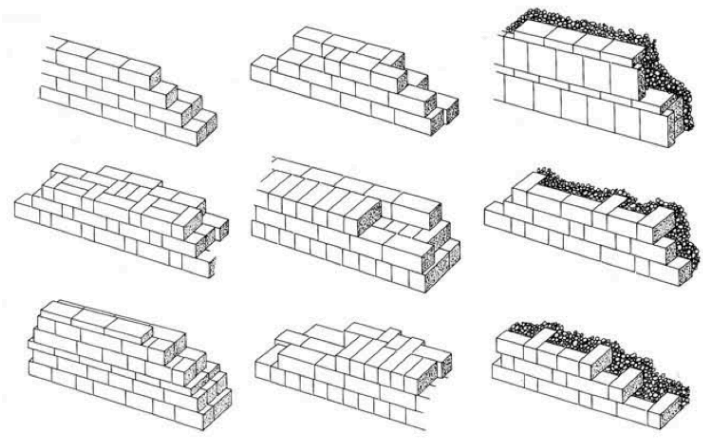

**Figure 1.2 Methods of Roman brick bounding**

Source: Kenneth Frampton. "Introduction: Reflections on the Scope of Tectonic" Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture, Cambridge, MA: The MIT Press, 1996, pg.6.

The referential aspect asserts that limiting materiality with the singularities of form, structure, space or material results in the reduction of the term. Herein, materiality is predicated upon a multiplicity of domains. Supporting this standpoint, the thesis considers architecture as an "organizational system" and approaches materiality as "the substance of this architectural totality." Once materiality is understood as such, any form of architectural organization is directly related with the fundamental question of materiality. In this regard, throughout the thesis, materiality will be discussed taking the referential aspect as its basis.

### 1.3. Materiality and Architectural Information

Mario Carpo in his seminal book "The Alphabet and Algorithm" indicates that, "[t]he history of architecture features a conflation of different technological timelines."[14] Regarding this, Carpo differentiates between the technological timelines of built architecture and architectural design. While built architecture is linked to the traditional chronology of industrial revolution depending on the production of material objects (i.e., bricks, nails, iron, beams), architectural design and its processes are defined by a specific range of cultural and media technologies. [15] Contemporary architecture dwells upon the confluence of these technological timelines since the recognition of new cultural and media technologies, together with the invention of new fabrication technologies, simultaneously changed the practices of architectural design and the nature of built architecture. Along with the digital turn of the nineties, architectural design has given a prominence to computational, information-based, approach. Depending on this new orientation, contemporary architecture converges

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[14] Mario Carpo. "Variable, Identical, Differential," The Alphabet and the Algorithm, Cambridge, MA: The MIT Press, 2011, pp.1-51.
[15] Ibid.

toward a unique system of organizations that receive, organize, and distribute various streams of information. This noticeable change in the practices of architectural design and the nature of architecture ultimately affects the status of materiality in architecture. Referring to physicality of information, Antoine Picon argues that today materiality is defined at the intersection of two seemingly opposed categories oscillating between the actual and the virtual.[16]

In this regard, this study interrogates the dissolution of organization systems of architecture into information systems and, accordingly, investigates how this dissolution affects and gets affected by the status of materiality in architecture.

The dissolution of organization system of architecture into information systems emerges as part of a larger paradigm shift, which can be traced back to the change in the perception of natural phenomena, which is directly correlated with the conception of matter. From this point of view, the thesis starts the interrogation by exploring this epistemological shift that ultimately gives rise to an ontological shift in the discipline of architecture. In general, through advances in modern sciences, the static understanding of nature is replaced by the dynamic understanding, in which matter is conceptualized in a continuous differentiation. Along with the dynamic conception of matter, architecture has gone through a similar shift in its system reference used as a basis for design conception from mechanic to organic system.[17] This alteration sets up a substructure for the emergence of new organizational strategies in the discipline of architecture. Acknowledging organic system as a basis for design

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[16] Antoine Picon. "Architecture and the Virtual: Towards a New Materiality," Praxis 6: New Technologies, New Architectures, eds. Ashley Schafer and Amanda Reeser, Cambridge, MA: Praxis Inc., 2004, pp.114-121.

[17] Gary Brown. "Freedom and Transience of Space (Techno-nomads and Transformers)," Transportable Environments 2, ed. Robert Kronenburg, London; New York: Spon Press, 2003, pp.3-15.

conception, architecture rejects the recognition of static and deterministic organizations and rather acknowledges dynamic and evolving organizations that emerge through processing information. This way, information becomes the essential dimension in the development of the architectural organization. As a consequence, materiality of architecture becomes associated with its ability to generate information and to be generated by information over time. This condition constitutes the intimate relation between information and materiality by revealing a synthesis between these two dimensions.

Materiality and information, in that sense, reciprocally reproduce each other. In this regard, this reproduction results in the formulation of diverse organizations of architecture; likewise, diverse modes of materiality.

### 1.4. Categorization of Materiality

Learning from the historical categorizations of materiality, as in the case of Semper, and considering the contemporary approaches to architecture, this thesis intends to categorize materiality by means of information flows and relative responses. (See Fig.3) In this context, considerable attention is paid to distinguishing types of informed materiality with the primary classifications being: dynamic and kinetic, segregated and integrated, predictable and unpredictable models. The purpose of this categorization is to recognize, differentiate and organize the modes of materiality by proposing a systematic theory. Therefore, this categorization attempts to provide a ground on which a comparative analysis of materiality can be conducted. In this sense, this categorization is considered as a method of exploration throughout the process.

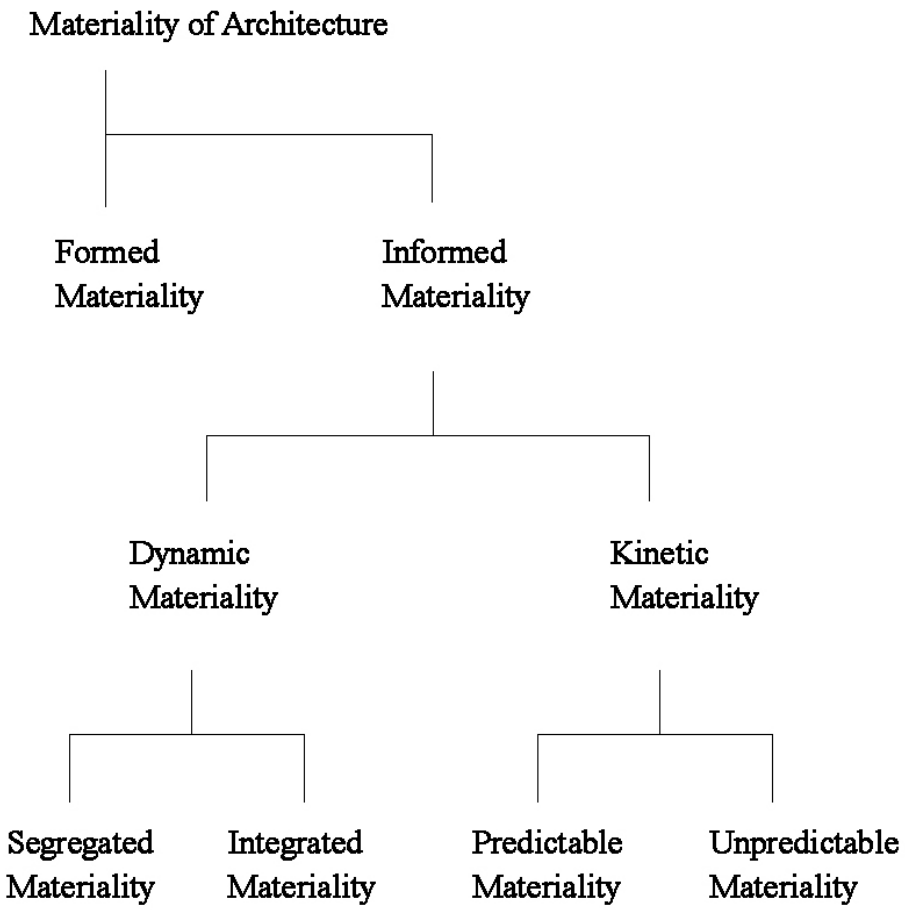


**Figure 1.3 Categorization of Materiality**

Source: Drawn by the author.

The chapters of the thesis are organized according to certain categories of materiality proceeding from general to specific models. In general, materiality of architecture is divided into two major categories namely, **formed and informed materiality** based on the ability of response. Formed materiality is predicated on the static and deterministic organizations of architecture conceived in a "passive space of static coordinates." [18] Unlike formed materiality, informed materiality is predicated on the dynamic and evolving organizations of architecture conceived in an "active space of interactions." [19]

Informed materiality is divided into more specific categories of **dynamic and kinetic materiality** based on the continuity of response. [20] Dynamic materiality restrains the information processing in a periodic duration embracing a static organization at a certain state of a dynamic process. Kinetic materiality, on the other hand, maintains information processing during the complete lifecycle of architecture displaying dynamic processes of transformation in real time and in real space.

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[18] Greg Lynn. "Animate Form," Animate Form, New York, NY: Princeton Architectural Press, 1999, pp.8-44.

[19] Ibid.

[20] It must be indicated that "dynamic materiality" is selected as a proper noun that indicates a specific mode of materiality. However, it does not intend to imply that the other categories listed under informed materiality are not "dynamic." As a matter of fact, any sub-category of informed materiality can be considered as dynamic. Therefore, the term "dynamic" that used in general sense throughout the thesis differentiates from the "dynamic materiality" that indicates a specific category of informed materiality.

As it is indicated in the examination jury the separation between dynamic and kinetic materiality is not definite as it is demonstrated in the categorization. As Assoc. Prof. Dr. Arzu Gönenç Sorguç states, while the term "dynamic" defines a system, the term "kinetic" defines a component of this system. Considering this definition, the categorization can be reconsidered. However, such reconsideration is remained open-ended for the prospective researches.

Taking a step further, dynamic and kinetic materiality is discussed in advanced settings. In this regard, dynamic materiality is divided into categories of **segregated and integrated materiality** based on the order of response. Integrated materiality is predicated on the synthesis of form, structure, space and material establishing active relations between these domains. As opposed to integrated materiality, segregated materiality establishes passive relations between these domains prioritizing one domain over another.

Kinetic materiality is divided into categories of **predicted and unpredicted materiality** based on the cycles of response. Predicted materiality operates through "a single loop interaction,"[21] responding to a fixed set of information flow with a predictable set of organizations. On the contrary, unpredictable materiality operates through "a multiple loop interaction,"[22] responding to a variable set of information flow with an unpredictable set of organizations.

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[21] Usman Haque. "Architecture, Interactions, Systems," AU, Arquitetura and Urbanismo, vol.149, 2006.

[22] Ibid.

# CHAPTER 2

# MATERIALITY: FORMED AND INFORMED

## 2.1. Matter and Energy: The Nature of Form

> "In the very beginning there was a void- a curious form of vacuum- a nothingness containing no space, no time, no matter, no light, no sound. Yet the laws of nature were in place, and this curious vacuum held potential. Like a giant boulder perched at the edge of a towering cliff.
>
> …
>
> Like a giant boulder perched at the edge of a towering cliff, the void's balance was so exquisite that only whim was needed to produce a change, a change that created the universe. And it happened. The nothingness exploded. In this initial incandescence, the space and time were created.
>
> Out of this energy, matter emerged –a dense plasma of particles that dissolved into radiation and back to matter. Particles collided and gave birth to new particles. Space and time boiled and foamed as black holes formed and dissolved. What a scene!"[23]

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[23] Leon Lederman is Nobel Physics prizewinner of 1988. Leon Lederman, Dick Teresi. "The Invisible Soccer Ball," The God Particle, If the Universe is the Answer, What is the Question?, New York, NY: Dell Pub., 1993, pp.1-25.

As it is stated in the introduction, the dissolution of organization system of architecture into information systems emerges as part of a larger paradigm shift, which can be traced back to the change in the perception of natural phenomena, directly correlated with the conception of "matter." Therefore, it is inevitable to refer to the specific progresses in scientific discourse that lead to this change. Although it may seem irrelevant at first glance, it is the claim of this thesis that, these progresses are explicitly important that they can be transferred from a more general discussion to a specific case of architectural discourse.

Following Einstein's field theory, and its corresponding notion of space-time, matter surpassed its static substance by integrating forces and events into the definition of space and considering material substratum as a carrier for these forces and events.[24] Before acknowledgement of this dynamic understanding, classical sciences rendered the universe as static and deterministic.

As Sanford Kwinter states "the concept of space as it developed from antiquity founded on Euclidean Mathematics," in which "space itself emerged only as secondarily," deriving from the idealized solid bodies, of point, line and plane, and through their relations.[25] Correlating Euclidean geometry and algebra, introducing analytic geometry, René Descartes led the way for an alternative conception of space. Constituting a foundation for the analytical geometry, Cartesian coordinate system presents "an infinite and generalized three-dimensional continuum where points and figures are describable by their coordinates."[26] This metrical approach demonstrates that the space is self-

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[24] Sanford Kwinter. "Physical Theory and Modernity: Einstein, Boccioni, Sant'Elia," Architectures of Time: Toward a Theory of the Event in Modernist Culture, Cambridge, MA: The MIT Press, 2002, pp.52-102.

[25] Ibid.

[26] Ibid.

existent. Thus, not until Descartes did the space emerge as autonomous that exists independently of solid bodies.[27] However, the objects remained as static refined from the flow of time.

Isaac Newton's conceptual theories were accepted as the basis for the classical mechanics, which is also referred as the "Newtonian mechanics." The absolute space and time, the absolute reference system, set the framework for the Newtonian conceptual schema. According to Newton, "[t]he absolute space, in its own nature, without relation to anything external, remains always similar and immovable; and, absolute and mathematical time, of itself, and from its own nature flows equally without relation to anything external, and by another name is called duration."[28] Therefore, the Newtonian standard of space is undifferentiated and the time is universal. In this regard, Newton's physics is a closed system that refuses the exchange of matter; that is to say, the matter remains constant as forces applied to it. Although it is defined as universal, the concept of time is included in the equation as a fundamental paradigm. In this regard, as John Earman states, Newton established the first model of space and time.[29] However, this mechanistic view still depicts the matter as static that is devoid of temporality.

This mechanistic view has also influenced Immanuel Kant's proposition. According to Kant, "intuition" is what parameterizes the world and the conceptions of space and time are the pure forms of intuition. Following Kant, "space is the form according to which we organize variations in what occurs to

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[27] Ibid.

[28] Isaac Newton as referred in John Earman. "Newton on Absolute Space and Time," World Enough and Space-Time: Absolute versus Relational Theories of Space and Time, Cambridge, MA: The MIT Press, 1989, pp.7-11.

[29] Ibid.

us simultaneously, just as time is the form according to which we organize variations in what occurs to us in succession."[30] In this context, time is not an empirical concept deduced from experience, since the perception of succession is impossible.[31] By the notion of simultaneity, Kant claims that the events occur at the same time; and, such conception rejects temporal relations in space. Thus, in Kantian philosophy temporality is an impoverished entry, as in the case of Newtonian philosophy.

In general, classical sciences are predicated upon the mechanistic view of the universe bringing static and deterministic conception of matter along.

In the nineteenth century, Carl Friedrich Gauss and succeeding mathematicians proved the existence of non-Euclidean geometries by objecting the fifth postulate of Euclid, the parallel axiom.[32] The introduction of non-Euclidean geometries contributed profoundly to the acknowledgement of alternative conception of space. Along with the Einstein's Special Theory of Relativity, the concept of field replaced the idea of absolute space and time rendering the universe in a four-dimensional continuum of interactions between space and

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[30] Bernard Cache. "Plea for Euclid," ANY: Architecture New York, No: 24, 1999, pp. 54-59.

[31] Max Jammer. "The Concept of Absolute Space," Concepts of Space: the History of Theories of Space in Physics, New York, NY: Dover Publications, 1993, pp. 95-127.

[32] "That, if a straight line falling on two straight lines make the interior angles on the same side less than two right angles, the two straight lines if produced indefinitely, meet on that side on which are the angles less that the two right angles."

Euclid as referred in Max Jammer. "The Concept of Space in Modern Science," Concepts of Space: the History of Theories of Space in Physics, 1993, pp. 127-215.

time. While the three dimensions suffice to locate a "point-object" in space, four dimensions determine a "point-event" in space-time continuum.[33] This point of view asserts that the definition of an event requires four coordinates, three coordinates for determining the location and one for determining the time of an event. Thus, an event indicates a point in space-time continuum. In this regard, space-time continuum is structured through the multiplicity of these point-events. Further, the geometry of this continuum is bent with regard to forces that govern space-time:

> "The theory incorporates the effect of gravity by saying that the distribution of matter and energy in the universe warps and distorts space-time, so that it is not flat. Objects in this space-time try to move in straight lines, but because space-time is curved, their paths appear bent. They move as if affected by gravitational field."[34]

In this context, "Einstein's theory stands for the relevance of non-Euclidean geometries by proving that the space (-time) is actually curved in the presence of field."[35] Thus, this theory endorses the non-Euclidean geometry and contributes to the dynamic conception of the matter. While Euclidean geometry, with a constant curvature, predicates on "the indeformability of figures in movement," Non-Euclidean geometry, with varying curvatures, asserts that "a figure cannot be moved about without changes occurring in its own shape and properties."[36] In this context, while former signifies the rigid object, the latter

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[33] Max Jammer. "The Concept of Space in Modern Science," 1993, pp.127-215.

[34] Stephen Hawking. "The Shape of Time: Einstein's General Relativity Gives Time a Shape. How this can be Reconciled with the Quantum Theory," The Universe in a Nutshell, New York, NY: Bantam Press, 2001, pp.29-67.

[35] Bernard Cache, "A Plea for Euclid," 1999, pp. 54-59.

[36] Linda Dalrymple Henderson. "The Nineteenth-Century Background," The Fourth Dimension and Non-Euclidean Geometry in Modern Art, Princeton, NJ: Princeton University Press, 1983, pp.3-44.

signifies the deforming object.[37] In this regard, the curve of space-time determines the deformation of matter; controversially, deforming matter determines the curve of space-time.

More recently, experiments at CERN proved the existence of a fundamental particle called, Higgs boson. Hypothesized in 1964, Higgs mechanism, together the Higgs boson and Higgs field, directed modern science towards the fundamental structure of matter. Experiments verified that the elementary particles acquire their masses from an invisible energy field and, accordingly, these particles lead the formation of the Higgs boson.[38] Moving beyond the dynamic understanding of matter, the theory reveals how the subatomic quantum field permeates the space and leads towards the formation of matter in time. This condition proves that the forces and events not only operate matter, but also generate matter at the first place.

Through advances in modern sciences, the mechanistic view of the universe is replaced by the organic view of the universe. In parallel, matter is no longer considered as static and deterministic but as dynamic and undetermined. Acknowledged as in continuous differentiation, the new conception of matter is identified through uncertainty and change.

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[37] Ibid.

[38] Higgs mechanism is proposed by Robert Brout and François Englert; Peter Higgs; and Gerald Guralnik, Carl Richard Hagen, and Tom Kibble in 1964. The theory has not grounded in the discipline of architecture, yet. However, it provides a fertile ground for the future studies by enhancing the theories on matter and energy, consequently theories on space and time.

Emma Sanders. "Swimming against the Tide: Explaining the Higgs," CERN Bulletin, CERN Publications, Issue No: 06-07, 2012. 11 Jan. 2015. <http://cds.cern.ch/record/1420890>

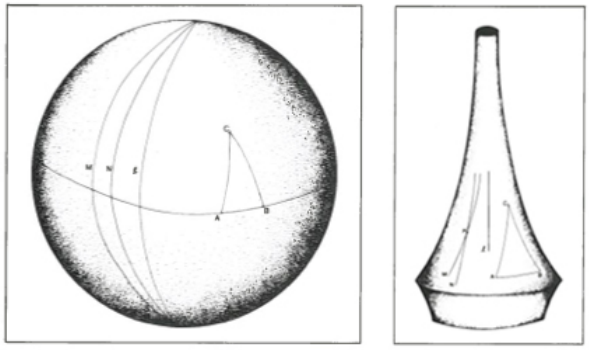

**Figure 2.1 (left) Riemannian geometry represented in a sphere, (right) Beltrami's pseudosphere for the Lobachevsky-Bolyai geometry**

Source: Linda Dalrymple Henderson, "Plate1," The Fourth Dimension and Non-Euclidean Geometry in Modern Art, Princeton: Princeton University Press, 1983.

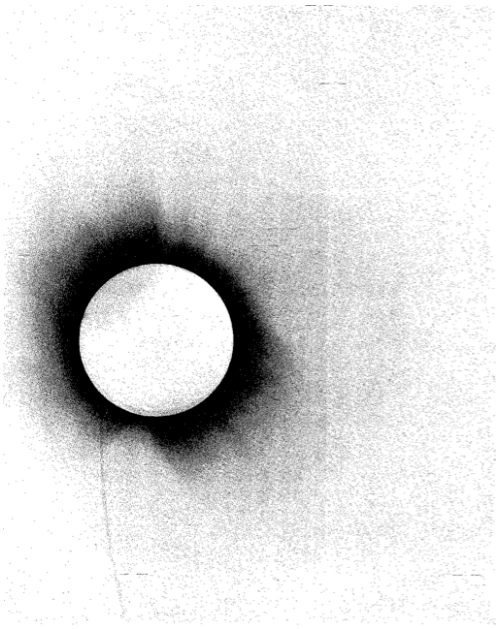

**Figure 2.2 Arthur Eddigton's photograph of the total solar eclipse, confirming Einstein's theory that light bends, 1919**

Source: F. W. Dyson, A. S. Eddington, and C. Davidson. "A Determination of the Deflection of Light by the Sun's Gravitational Field, Observations Made at the Total Eclipse of May 29, 1919" Philosophical Transactions of the Royal Society of London, Series A, Vol. 220, Plate 1, pg.332.

This fundamental shift is recognized in various studies, in various disciplines of the twentieth century. While the dynamic understanding of the matter is acknowledged through the space-time concept of Einstein in physics, Henri Bergson dedicated himself to identify this dynamic model in philosophy. In his book "Creative Evolution," 1907, Bergson examines the real life and evolution of species based on the notion of change. Focusing on the continuity of matter, Bergson studies the living body and indicates that the body changes its form at every moment: "[w]hat is real is the continual change of form: form is only a snapshot of view of a transition."[39] Likewise, in 1917, biologist D'Arcy Thompson in his book "On Growth and Form" defines physical form as "the resolution at one instant of time of many forces that are governed by rates of change." [40] Contextualizing the physical form in an ever-changing time sequence, Thompson explores dynamical phenomena in natural processes. In this regard, both Bergson and Thompson focus on the temporality of form in relation to dynamic forces. That is also the reason for art theorist Gyorgy Kepes, to put forward the notion of experience in the definition of the plastic organization, 1944. In his book "Language of Vision," Kepes defines the experience of plastic image as "a form evolved through a process of organization." [41] The plastic image indicates a particular state that is experienced in a formation process. Thus, Kepes correlates the plastic image with a living organism, since it presents the characteristic of a gradual development. Gilles Deleuze and Felix Guattari in their book "A Thousand

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[39] Henri Bergson. "Form and Becoming," Creative Evolution, Mineola, NY: Dover, 1998, pp.302.

[40] D'Arcy Thompson as referred in Nicholas Negroponte. "Aspects of Design Processes," The Architecture Machine, Cambridge, MA: The MIT Press, 1970, p.39.

[41] Gyorgy Kepes. "Plastic Organization," Language of Vision, Chicago, P.Theobald: Dover Publications, 1944, pp.15-65.

Plateaus" address this shift in the understanding of matter by referring to diverse fields ranging from literature to biology.[42] Deleuze and Guattari's materialist philosophy emphasizes the dynamical processes, which remain "immanent to the world of matter energy," rather than essences, which mean "the core set of properties that define what these objects are."[43] In this regard, according to their philosophy, matter and energy flows acquire an important status driving dynamic processes in nature, as it is in the previous instances.

As it is mentioned before, these progresses in scientific discourse are important, since they can be transferred from a more general discussion to a specific case of architectural discourse. In this regard, influential architects/theorists refer to these visionary researchers constructing their specific theories on architecture.[44] While each architect/theorist presents a distinct approach, according to their subjects of specialization, indeed, all these studies/theories from physics to art indicates that the universe is constructed through dynamic processes rather than fixities and uniformities.

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[42] Gilles Deleuze, Felix Guattari. A Thousand Plateaus, Capitalism and Schizophrenia, Minneapolis, London: University of Minnesota Press, 1987.

[43] Manuel de Landa. "Introduction: Deleuze's World," Intensive Science and Virtual Philosophy, New York, NY: Continuum International Publishing Group, 2002, pp.1-9.

[44] See, Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002; Achim Menges. Material Computation: Higher Integration in Morphogenetic Design, Architectural Design, Vol. 82, No: 2, London: Wiley Academy, 2012; Manuel DeLanda. "Deleuze and the Use of Genetic Algorithm in Architecture," Designing for a Digital World, ed. Neil Leach, Chichester: Wiley-Academic, 2002; John Frazer, An Evolutionary Architecture, London: Architectural Association Publications, 1995.

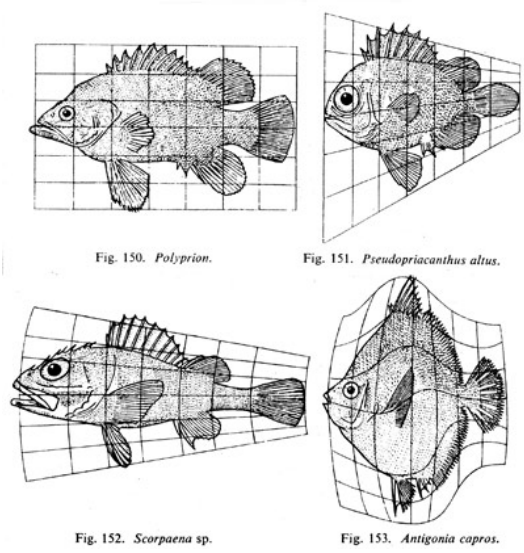


**Figure 2.3 D'arcy Wenthworth Thompson's deformation studies, 1917**

Source: David Mumford. 10 March 2015. <http://www.dam.brown.edu/people/mumford/vision/shape.html>.

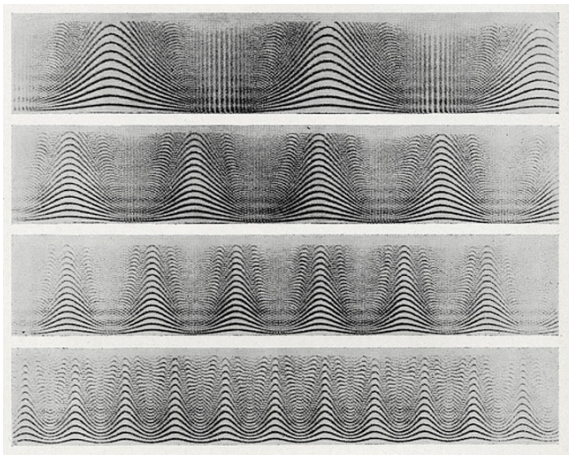

**Figure 2.4 György Kepes, Frequency modulation series, 1956**

Source: Art and Science Journal. 10 March 2015. <http://www.artandsciencejournal.com/post/36370958293/gyorgy-kepes>.

### 3.2. Materiality and Information

The critique of mechanistic worldview displays that the static and deterministic organizations of mechanic systems remain incapable of complying with the natural processes of the universe.[45] As it is in the other disciplines, this critique set up a substructure for the emergence of new organizational strategies in the discipline of architecture.

Considering the critical understanding of materiality, bonded with the definition of matter, today the discipline of architecture possesses a new ground. Along with the dynamic conception of the universe, "recent theory has altered the system reference used as a basis for design conception from a mechanic system to an organic system."[46] In this context, the organic system puts emphasis on dynamic and evolving organizations in architecture instead of static and deterministic ones, which are supported by the mechanic system.[47] Then, acknowledging the organic system as a design conception, architecture trivializes the prevalence of determinant formal models and instead unfolds a system of potentialities. "This perennial interest to transform the fixity of the architectural model into a system of potentialities has generated many theoretical assumptions that often referred to the nature of living organisms as

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[45] Gary Brown. "Freedom and Transience of Space (Techno-nomads and Transformers)," Transportable Environments 2, ed. Robert Kronenburg, London; New York: Spon Press, 2003, pp.3-15.

[46] Ibid.

[47] "Organicism has been a theoretical referent for architects for a long time." The fact remains that the discipline of architecture has developed diverse approaches towards it. Throughout the thesis, I use the term organic in order to address the generative logic that governs the dynamical processes of nature.

See, Sarah Bonnemasion, Phillip Beesley. On Growth and Form: Organic Architecture and Beyond, Halifax: Tuns Press, 2008, pp.7-16.

a source of information processing."[48] Thus, the concept of organic system is formalized within a framework that lead to interrelate the theory of architecture with the information systems of natural world where form is constantly informed by the interaction of matter and energy. This dynamic process of organization is vital to understand the logic that distinguishes between formed and informed materiality in architecture. In this regard, it is fundamental to get a grip on the generative logic that governs the dynamic processes of nature and, accordingly, constitutes a substructure for the organic theory:

> "Organic theory emerges from nature, an environment that possesses evolutionary patterns that have a base code, and an inherent program where information is strategically interrelated to produce forms of growth and strategies of behavior, optimizing each particular pattern to contextual situation. The codes are fixed but the way they are expressed or repressed dependent on the environment in which they exist."[49]

According to this definition of nature, founding a symbiotic relationship with environment is the constitutive principle in formation of an organic theory in architecture. However, this interaction between architecture and environment requires the generation of open systems in "quasi-steady state maintaining continuous exchange of material and energy with the environment," contrary to closed systems that are external to environmental stimuli.[50] Acknowledgement

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[48] Aaron Sprecher. "Architecture InFormation :On the Affluence, Influence, and Confluence of Information," Architecture in Formation: On the Nature of Information in Digital Architecture, eds. Pablo Lorenzo-Eiroa, Aaron Sprecher, New York, NY: Routledge, 2013, pp.22-31.

[49] Gary Brown. "Freedom and Transience of Space (Techno-nomads and Transformers)," 2003, pp.3-15.

[50] Ludwig Von Bertalanffy describes the concepts of open and closed systems in general systems theory. In general, open systems are defined as "the system in exchange of matter with its environment, presenting import and export, building-up and breaking-down of its material components" while,

of such systems of organization puts emphasis upon the dynamic processes in which energy flows acquire an important status stimulating continuous transformations. In nature, these dynamic processes unfold over time "through a complex series of exchanges between organism and its environment" and lead to the emergence of "biological forms and their behavior." [51] Then, internalizing the dynamic processes of nature, architecture proposes a new generation of buildings that are responsive to their environment- to forces and flows. In architectural perspective, these forces and flows can be programmatic, contextual or rather atmospheric. Responding to its environment, architecture develops strategic behaviors; and, consequently, optimizes its organization. As it is mentioned before, specific organizations of nature are fundamentally related to interaction of matter and energy. In this formulation information is the organizing force, which regulates the interplay of matter and energy. This is the point where the role of information gains an important status in the architectural organization. In architecture the critical assessment of these forces and flows results in hierarchically complex, ordered, organizations of information, and in return, these organizations give information back to the environment. This feedback and response mechanism constructs the ground for iterative processes of organization. Such dynamic process of organizations leads to considering architecture in terms of its performance, which "got

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controversially, closed systems are defined as "the systems that are considered to be isolated from their environment."

Ludwig Von Bertalanffy. "The Model of Open System," General System Theory; Foundations, Development, Applications, New York, NY: George Braziller Inc., 1968, pp.139-153.

[51] Michael Hensel, Achim Menges, Michael Weinstock. "Introduction," Emergent Technologies and Design: Towards a Biological Paradigm for Architecture, New York, NY: Routledge, 2010, pp. 9-23.

inherently associated to the ability for a given system to exchange information with its environment."[52]

As stated by Karl Chu, "[t]he metaphysics of matter, energy and information together constitute the three parameters of the physical universe."[53] Based on the former discussion, it can be inferred that these parameters function as substrata for one another and the interplay of these parameters reveals the developmental form of nature. Then, incorporating the dynamics of space in formulation, architecture becomes active and integrates with the natural processes of the universe. This condition ultimately renders architecture as a way of synthetic life form that is subjected to life-like processes:

> "In this regard architecture is considered as a form of "artificial life," which is subjected to the principles of morphogenesis, replication, selection, just as it is a part of natural phenomena."[54]

Considered as a form of artificial life, architecture serves as a generative venue absorbing information streams of nature. However, this absorption of information streams reveals a radical difference from that of the passive realization of nature, which depends on a mere idealization. As opposed to the realization, this absorption of information streams foregrounds another type of formation process, which is the actualization. While realization operates through reproducing what already exists in a given entity, the actualization

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[52] Aaron Sprecher. "Informationism:Information as Architectural Performance," Performalism: Form and Performance in Digital Architecture, eds. Yasha J. Grobman, Eran Neuman, London, New York: Routledge, 2012, pp. 27-31.

[53] Karl Chu. "Interview: Karl Chu," Architecture in Formation: On the Nature of Information in Digital Architecture, eds. Pablo Lorenzo-Eiroa, Aaron Sprecher, New York, NY: Routledge, 2013, pp.22-31.

[54] John Frazer. "A Natural Model for Architecture," An Evolutionary Architecture, London: Architectural Association Publications, 1995, pp.9-23.

"invents through a continuous, positive, and dynamic processes of transmission, differentiation and evolution."[55] In this regard, the processes of realization and actualization distinguish between the two types of organizational strategies in architecture; one that concerns the replication of the forms and structures of nature and the one that concerns about the integration of the generative logic, which constitutes these models of nature. Deleuze makes a distinction between "the realization of the possible" and "the actualization of the virtual" in order to "differentiate between two kinds of multiplicity: one that is redundant and one that is creative." [56] Depending on Deleuze's statement, it can be inferred that while the former strategy is redundant, neglecting the difference between the real and possible, the latter is creative, emphasizing the differentiation. According to Kwinter, this creative process of actualization "develops a radically different theory of morphogenesis" that "follows the dynamic and uncertain processes that characterize the schema that links the virtual component to an actual one:"

> "The virtual does not have to be realized but only actualized (activated and integrated); its adventure involves a developmental passage from one state to another. The virtual is gathered, selected –let us say incarnated- it passes from one moment-event (or complex) in order to emerge –differently, uniquely- within another. " [57]

Integration of information into architectural organization requires the process of actualization; that is to say, it requires the dynamic processes of

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[55] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.10.

[56] Gilles Deleuze as referred in Michael Speaks. "Folding Toward a New Architecture," The Earth Moves: The Furnishing of the Territories, Cambridge, MA: MIT Press, 1995, pp. xiii-xix.

[57] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.8.

differentiation. Thus, such integration requires acknowledging architecture as a dynamic system that processes information through developmental stages over time. This assigns a new status to architecture that it becomes operative designating a discrete sequence of operations. This perspective suggests that architecture can no longer be defined in terms of a duality between natural or artificial, organic or inorganic, living or non-living but is rather "incorporated in to a virtual assembly of operations" in which architecture processes information:

> "This technological absorption of nature reinforced the dissipative quality of an architectural system that was often compared to a living organism, being neither natural nor artificial but informational."[58]

This definition turns over a new ground that acknowledges architecture as a dynamic system that displays an informational continuum. This model of dynamic organization presents a radical break from the previous schema in which architecture is considered as static and deterministic. Consequently, it reveals a new type of morphogenesis. From this point of view, Sanford Kwinter differentiates two types of morphogenesis:

> "Morphogenesis occurs either as a mechanical process of translation fixed once and for all and external to the specific morphogenetic moment -event, with its highly particular and unreproducable conditions- or else, it is the very principle of life, that is, perpetual instability and therefore creation itself, and wedded to the ever-evolving particularities of time, or what one could call, in homage to mathematician Rene Thom, the minute and ceaseless procession of catastrophes."[59]

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[58] Aaron Sprecher, François Leblanc. "Dissipative Architecture: The Informed Nature of Atopia," Architecture and Utopia, Journal of Architectural Education, Vol.67, No.1, 2013, pp. 27-30.

[59] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.10.

This differentiation indicates that the information systems of natural world provide an alternative model of morphogenesis for architectural organization. As a consequence, these two types of morphogenesis generate two different modes of materiality. In this regard, this thesis makes a distinction between "formed materiality" and "informed materiality."

Formed materiality is predicated on the static and deterministic organizations of architecture conceived in a "passive space of static coordinates."[60] Thus, it is based on the static understanding of architecture that is constructed through fixities and uniformities. Unlike formed materiality, informed materiality predicated on the dynamic and evolving organizations of architecture conceived in an "active space of interactions."[61] Thus, informed materiality is based on the dynamic understanding of architecture that is constructed through generative processes.

In further explanation of the informed materiality, the thesis examines certain architectural interpretations and architectural approaches on which the dynamic understanding of architecture emerges.

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[60] Greg Lynn. "Animate Form," Animate Form, New York, NY: Princeton Architectural Press, 1999, pp.8-44.

[61] Ibid.

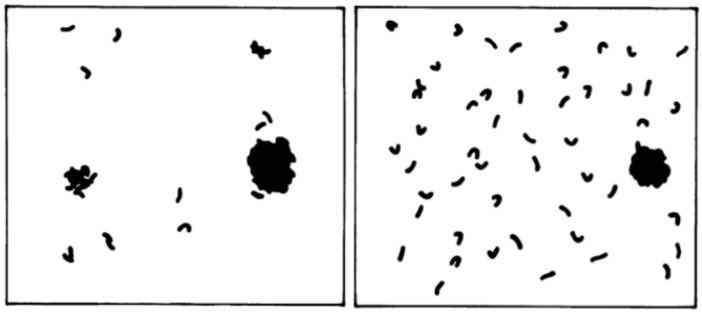

**Figure 2.5 Self-aggregation of coleoptera larvae**

Source: Sanford Kwinter and Umberto Boccioni. "Landscapes of Change: Boccioni's Stati d'animo as a General Theory of Models," Assemblage, No. 19, Cambridge, MA: The MIT Press, 1992, pg.55.

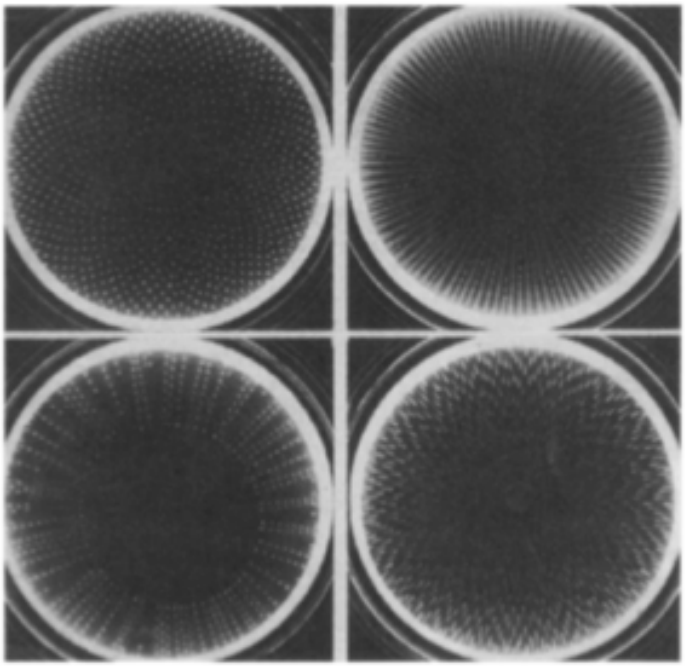

**Figure 2.6 Clustering of escherichia coli bacteria**

Source: Sanford Kwinter and Umberto Boccioni. "Landscapes of Change: Boccioni's Stati d'animo as a General Theory of Models," Assemblage, No. 19, Cambridge, MA: The MIT Press, 1992, pg.55.

### 3.2.1. Universality, Spatiality and Temporality

Acknowledging architecture as a dynamic system requires embracing "active space that is composed by the forces of interaction."[62] Incorporating the dynamics of space into its definition, architecture dissolves into information systems embodying spatial and temporal organizations. Eventually, these organizations stand against the deterministic principles imposed by any universal language. The challenge then is to engage architecture with the dynamics of space rejecting its homogenization, and or neutralization.

Influenced by modern physics, architecture has been re-contextualized in a new framework that coincides with the dynamic understanding of the universe. Analyzing modern architecture in this revolutionary perspective, Sigfried Giedion assumes a leading role directing the discipline towards the exploration of this dynamic understanding. In his book "Space, Time and Architecture: The Growth of a New Tradition," Giedion defines three conceptions of space in chronological order: The first conception of space focuses on the interplay of volumes emphasizing the external relations in a configuration; contrary to the first conception, the second conception of space puts emphasis on the interior relations addressing the time when vaulting became the major objective of architecture; the third conception of space refers to the integration of both first and second conception of space and, additionally, introduces the movement as an inseparable element of architecture. [63] In this context, Giedion

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[62] Brian Massumi. "Interface and Active Space: Human-Machine Design," Procedings of the Sixth International Symposium on Electronic Art (ISEA), Montreal, 1995.

[63] Sigfried Giedion. Space, Time and Architecture: The Growth of a New Tradition, Cambridge, MA: The MIT Press, 1941.

instrumentalizes the concept of space-time in order to trace the new conception of space that governs Modern architecture:

> "It is not the independent unrelated form that is the goal of architecture today but the organization of forms in space: space conception. This has been true for all creative periods including the present. The present space-time conception –the way volumes are placed into space is separated from exterior space or is perforated by it to bring about an interpenetration- is a universal attribute which is the basis of all contemporary architecture."[64]

The concept of interpenetration is introduced as the basic characteristic of Giedion's space-time conception in architecture. The concept refers to the permeation of internal and external spaces and leads to an advanced conception of space in which both interior and exterior space can be perceived simultaneously by the observer. Herein, simultaneity refers to apprehend various qualities of space from a single viewpoint perspective. However, according to Giedion, understanding a construction in space-time at a single viewpoint is impossible; contrary, it requires multiple points of reference.[65] Thus, the perception of a construction in space-time requires movement and this reveals the new dimension of modern architecture; that is, many-sidedness:

> "These cubes are juxtaposed and interrelated. Indeed, they interpenetrate each other so subtly and intimately that the boundaries of the various volumes cannot be sharply picked out. The views from the air show how thoroughly each is blended into a unified composition. The eye cannot sum up this complex at one view; it is necessary to go around it on all sides, to see it from above as well as from below. This means new dimensions for the artistic imagination, an unprecedented many- sidedness."[66]

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[64] Ibid.

[65] Ibid.

[66] Ibid.

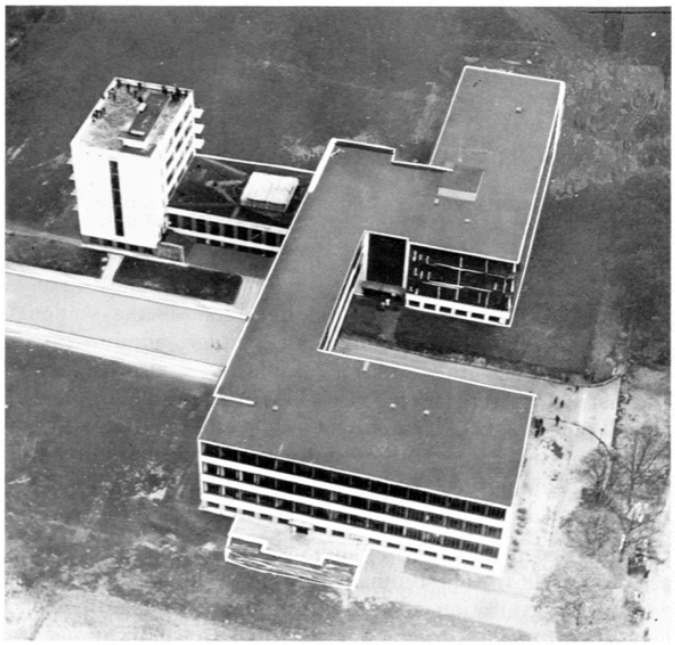

**Figure 2.7 The air view of Bauhaus, Dessau, Walter Gropius, 1926**

Source: Sigfried Giedion. "Space-time in Art, Architecture and Construction" Space, Time and Architecture: The Growth of a New Tradition, Cambridge, MA: The MIT Press, 1941, pg.492.

**Figure 2.8 The side view of Bauhaus, Dessau, Walter Gropius, 1926**

Source: Sigfried Giedion. "Space-time in Art, Architecture and Construction" Space, Time and Architecture: The Growth of a New Tradition, Cambridge, MA: The MIT Press, 1941, pg.441.

This new dimension indicates that the perception of a building alternates successively with the movement of the observer and, correspondingly, with the changing viewpoints. In this regard, Giedion's space-time conception corresponds to "an optical revolution that abolishes the single view point perspective."[67] However, what important at this point is that the movement is introduced as a specialty of the observer rather than of the architecture itself. In other words, while architectural organization remains fixed, the perception of it changes in a given time interval. In parallel, while there is a dynamic relationship between the architecture and its observer, this relationship remains static between the architecture and its space. Thus, the space-time concept of Giedion provides an influential ground for analyzing modern architecture; however, it does not comply with the dynamic understanding of architecture.

Depending on the preceding discussion, it can be inferred that twentieth-century modern architecture is accompanied by new organizational formulations (i.e., many-sidedness) and by new tectonic dimensions (i.e. transparency). This alteration ultimately modulates the materiality of architecture. However, despite the modulation, materiality of architecture remains as formed presenting a closed system of organization. Regulated by certain rules of formal composition, this organization reveals a universal language that exists independently of any spatial dynamics. Then, architecture presents a static organization with a deterministic relationship between architectural elements. Such organization rules out the multiplicity of events and forces by supporting homogenization and neutralization of space and, accordingly, proposing a uniform architectural formation.

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[67] Ibid.

Criticizing modern architecture for chasing around after new objects, Sanford Kwinter indicates that in order to express the conditions of revolutionized cosmos, "what clearly needed was not new objects but a new orientation toward a phenomenal field of events and interactions, not objects but the abstract regimes of force which organize and deploy them."[68] Such orientation emerges as a challenge to the traditional design practices and leads architecture towards a new direction. Herein, the dynamic understanding of space supplants the static understanding including forces and flows in the definition of space. Further, this dynamic understanding leads to a new form of design strategy that produces and organizes architecture through space. Thus, this orientation opens a way for the emergent organicism in architecture revealing a dynamic process of organization.

Acknowledgement of this dynamic understanding of space is supported by the emergence of field theory in architecture. Although the concept of field is not uniquely explained in architectural terms, Sanford Kwinter and Stan Allen's definitions are useful to ground the theory of field in the discipline of architecture. In this context, Kwinter provides a conceptual framework for the field, basing his definition on modern physics:

> "The field describes a space of propagation, of effects. It contains no matter or material points, rather functions, vectors and speeds. It describes a local relations of difference within fields of celerity, transmission or careering point, in a word, what Minkowski called the world."[69]

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[68] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pp.52-102.

[69] Ibid.

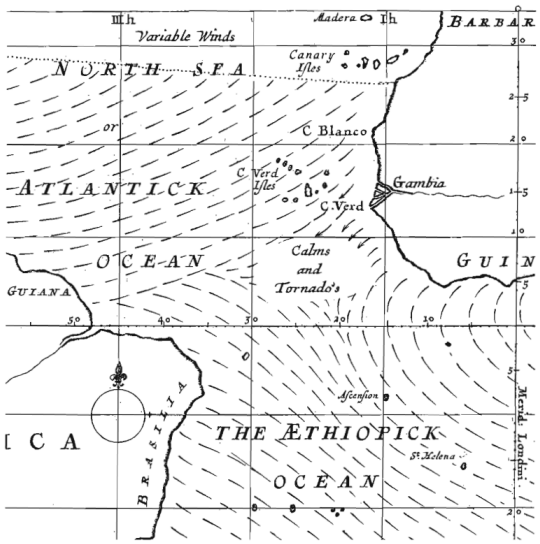


**Figure 2.9 Edmond Halley's chart of trade winds and monsoons, 1686**

Source: Edward Rolf Tufte. "Graphical Practice" The Visual Display of Quantitative Information, Cheshire, Connecticut: Graphics Press, 2001, p.23.

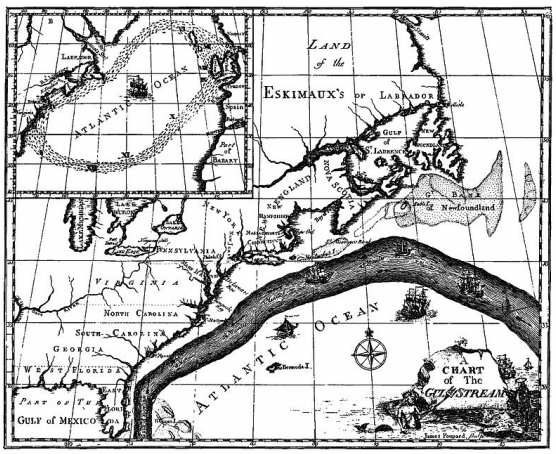


**Figure 2.10 Benjamin Franklin's map of gulf streams, 1768**

Source: Wikipedia, Gulf Stream. 11 November 2014. <http://en.wikipedia.org/wiki/Gulf_Stream#mediaviewer/File:Franklingulfstream.jpg>.

In general, field is the fundamental structure that occupies space and in which these "functions, vectors and speeds" are inscribed. It does not contain material points; however, it has material effects on physical formation. According to Kwinter, the concept of field and its corresponding notion of space-time, "express the immanence of forces and events in the description of space" and, additionally, "posits material substratum as a carrier of these forces and events."[70] This is the point where direct relation between the field and matter is constructed; accordingly, field theory investigates this interaction between the field and matter. From an architectural standpoint, as it is stated before, the acknowledgement of the field requires surpassing traditional concepts of architectural object. Aiming at this, Stan Allen's theory of field condition leads discipline towards the consideration of architectural organizations by means of "systems and networks:"

> "To generalize, a field condition would be any formal or spatial matrix capable of unifying diverse elements while respecting the identity of each. Field configurations are loosely bounded aggregates characterized by porosity and local interconnectivity. Overall shape and extent are highly fluid and less important than the internal relationships of parts, which determine the behavior of the field."[71]

Both Kwinter and Allen's theory of field emerges as opposed to classical modes of composition. Neither of them produces a "systematic theory of architectural form or organization,"[72] but rather they provide a conceptual basis for the understanding of field condition in the discipline of architecture. In

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[70] Ibid.

[71] Stan Allen. "Field Conditions," Points + Lines: Diagrams and Projects for the City, New York, NY: Princeton Architectural Press, 1999, pp.92-103.

[72] Ibid.

doing so, they support their theories by examining certain projects that can guide discipline towards the understanding of the field theory.

In order to construct his theory on field condition, Sanford Kwinter examines the projects of Boccioni and Sant'Elia, the key figures of Italian Futurism. In this regard, Kwinter formalizes Boccioni's conception of world in three interdependent hypotheses: First hypothesis mentions about the plastic zones defining matter in direct relationship to force fields; second hypothesis emphasizes the dynamic condition of force fields contextualizing matter in a continuous differentiation; the third hypothesis depends on the previous two hypothesis and indicates that the concept of field replaced the absolute time and space of classical mechanics considering matter within an unresolvable four dimensional whole.[73]

Following the framework constructed by these hypotheses, Kwinter proceeds to examine the projects of Sant'Elia and, accordingly, expresses how the laws of Boccioni's physical theory is related with the architecture of La Citta Nuova. According to Kwinter, "the special technique" used in drawings of Sant'Elia captures the buildings as belonging to "a greater whole" and depicts forms as the result of the reactions to "differentiating field of pressures and flows."[74] City is contextualized as a dynamic field composed of various flows of information, such as urban, industrial, social, and economic. Further, architecture of La Citta Nuova offers a new organization through which these flows are expressed. In this regard, the projects collected under La Citta Nuova differentiate from the traditional architectural styles of the nineteenth century, offering a unique "morphological language," as representative of a dynamic

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[73] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pp.52-102.

[74] Ibid.

system. [75] Explaining this language Kwinter refers to "conduits, circuitry, rhythmized cadences and progression including rotation, nesting, step-backs, tapers, telescoping and ranked columnar forms" and their implied "field of movement and circulating forces."[76] As it is understood, referring to this language Kwinter focuses on the specific instances and modes that architecture comes into being. From this it follows that these specific instances and modes become the indicative of the forces and flows. This indicates that Kwinter's dynamic interpretation, the morphological language, arises from the close examination of the materiality of La Citta Nuova. Thereby, this unique language lead Kwinter to approach these structures as "servomechanisms" in which buildings are considered as "operators or communications devices" entitled to "modulate and control" various systems of flows.[77] In this regard, buildings receive, organize, and distribute various flows of information. The city articulates the architecture and, reciprocally, the architecture articulates the city. This interplay reveals a dynamic relationship between architecture and city dissolving conventional demarcations. In this way, architecture becomes continuous with the city fabric offering a spatial continuum.[78]

According to Kwinter's interpretation, the architectural organization of La Citta Nuova is not determined but arises through its intimate relation with the city. Thus, such interpretation gives prominence to spatiality in architecture associating architectural organization with the dynamics of space. Through its association with space, architecture takes a stand against universal organization.

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[75] Ibid.

[76] Ibid.

[77] Ibid.

[78] Ibid.

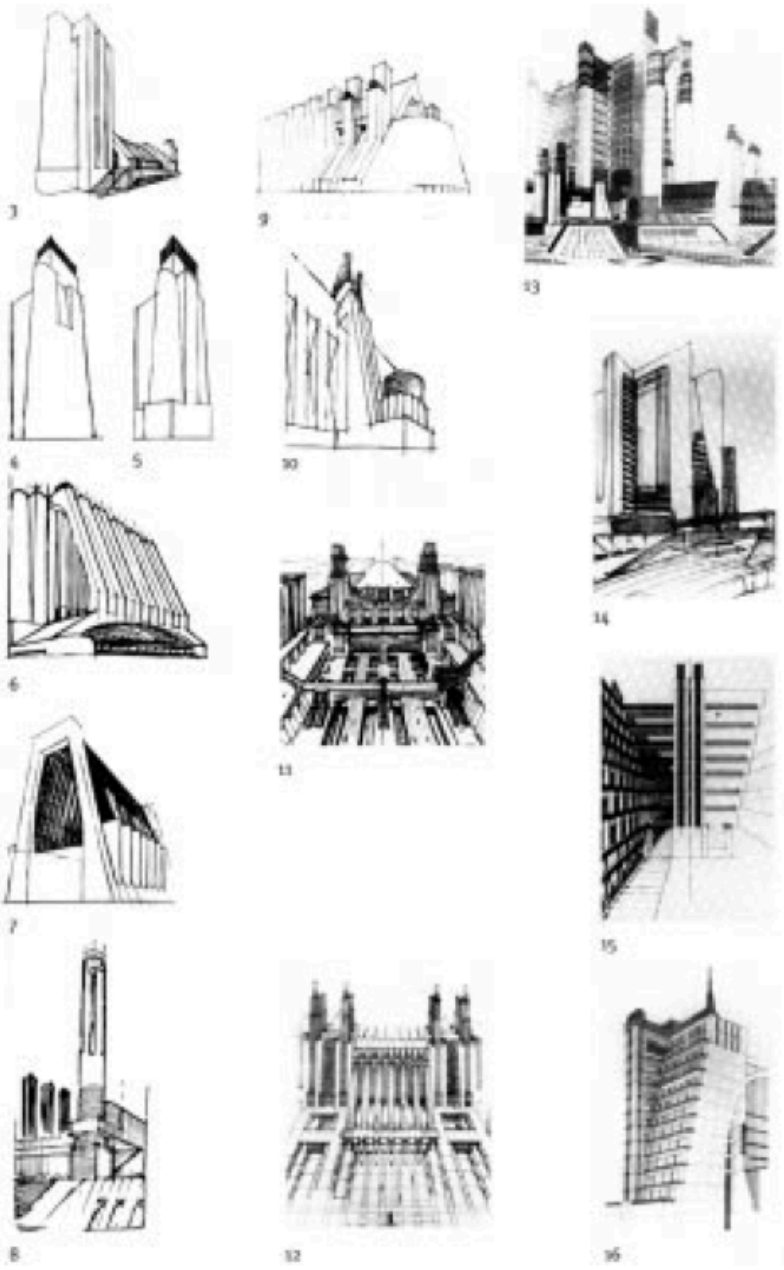

**Figure 2.11 Sketches for La Citta Nuova, Antonio Sant'Elia, 1913-1914**

Source: Sanford Kwinter. "La Citta Nuova: Modernity and Continuity," Architecture Theory Since 1968, Cambridge, MA: The MIT Press, 1998, pg.600.

Despite the dynamic understanding of the city, architecture of La Citta Nuova remains as a static organization. However, as Kwinter states, the notion of field requires the introduction of time into the predefined spatial continuum.[79] Taking this into consideration, in his further studies, Kwinter explored the evolution of forms in nature and, based on these explorations, he proposed certain theoretical models (i.e., epigenesist, morphogenesis) for architecture.[80] Through such theoretical models the focus shifts from spatial forms to temporal formations in the discipline of architecture.

Stan Allen promotes this focus shift by stating that: "[f]orm matters, but not so much the forms of things as the forms between things."[81] Describing the field condition, Allen refers to the mosque at Cordoba, in Spain. In essence, the building is a typological mosque model with "an enclosed forecourt flanked with minaret tower, opening on to a covered space for worship."[82] The mosque is transformed dynamically through a discrete sequence of steps with regard to the changing programmatic factors. Therefore, in this case, the information that drives these dynamic processes of transformation is the architectural program. As opposed to static organization discussed previously, architecture achieves temporal characteristic responding to the changing programmatic conditions and, accordingly, performing transformations in time. In this regard,

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[79] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.67.

[80] See, Sanford Kwinter and Umberto Boccioni. "Landscapes of Change: Boccioni's Stati d'animo as a General Theory of Models," Assemblage, No. 19, Cambridge, MA: The MIT Press, 1992; Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002; Sanford Kwinter. "Soft Systems," Culture Lab, ed. Brian Boigon, New York, NY: Princeton Architecture Press, 1993, pp.207-228.

[81] Stan Allen. Points + Lines: Diagrams and Projects for the City, 1999, pp. 92-103.

[82] Ibid.

architectural organization is considered as an open system with indefinite boundaries in which "independent elements are combined additively to form an indeterminate whole." [83] This way, the mosque assembles an algebraic combination "working with numerical units combined one after another," as opposed to geometric combinations, "working with figures organized in space."[84] This distinction is important as it emphasizes that such architecture does not produce object in a field but a system of relationships considering the dynamics of field. Further, the unique characteristic that differentiates this mosque from other structures is that its specific "morphological transformation," which maintains the formal integrity throughout the process by preserving the relationship between elements. [85] This, on the other hand, emphasizes that this system of relationships are constructed through dynamic process of multiplication rather than mechanic processes of addition/subtraction of parts.

These interpretations emphasize an alteration in the understanding of space from static and homogeneous to heterogeneous and dynamic. This alteration in the understanding of space leads to a parallel shift in the nature of architectural organization. Incorporating the dynamics of space into its definition, architecture leaves behind the organizations determined by universal principles and moves toward spatial and temporal organizations that reveal the dynamic understanding of architecture. In this regard, these interpretations are fundamental progressions out of which the dynamic understanding of architecture emerges.

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[83] Ibid.

[84] Ibid.

[85] Ibid.

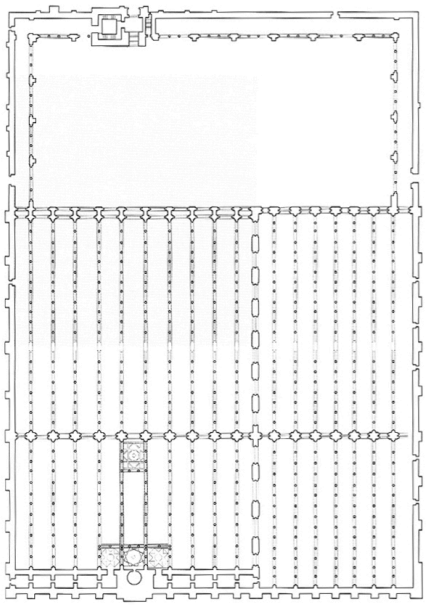

**Figure 2.12 The plan of the Great Mosque at Cordoba, c785-800**

Source: Stan Allen. "Field Conditions," Points + Lines: Diagrams and Projects for the City, New York, NY: Princeton Architectural Press, 1994, pg.93.

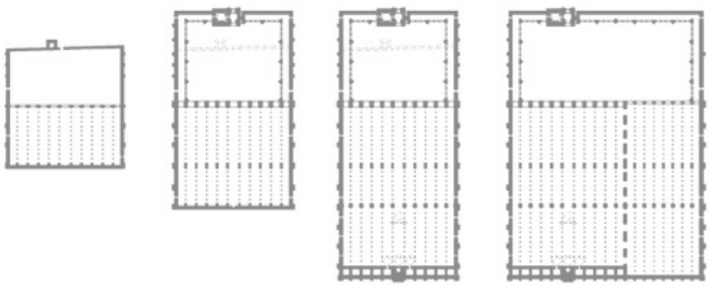

**Figure 2.13 The four phases of floor plans showing the development of the Great Mosque at Cordoba, c785-800**

Source: ArchNet. 22 October 2015.
<http://archnet.org/collections/843/publications/1237>.

### 3.2.2. Difference, Differentiation and Differential

Homogeneous space, with a static field of relations, displays a unified spatial process that is resistant to differentiation. In the case of heterogeneous space, these fields of relations are contextualized in a continuous differentiation. Thus, spatial processes are not unified, but unfold through time and space. Tracing of a particular line of development in the course of heterogeneous space, in their collection of essays on "Heterogeneous Space in Architecture," Michael Hensel, Christopher Height and Achim Menges reconsider "heterogeneous space" through "the concept of differential:"

> "This field of relations transforms through time and space, indeed is spatially configured through temporal transformations. Heterogeneous space therefore neither preexist diversity, nor it is simply effect of processes of differentiation; rather it is the immanent field of relations between differentials. It is not static but always in flux, and therefore might be more precisely understood as the spacing through which difference manifests and is constituted via other differentials." [86]

When architecture is defined through a space with continuously varying filed of relations, this variations ultimately lead to differentiations in architectural organization. This process of differentiation in architecture brings along a form of continuity in which differentials constitute indexical relationships between the temporal states of transformation assuring a space of connectivity.

The unfolding of architectural organization through the concept of differential emerges as part of a greater paradigm shift, one that can be traced back to

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[86] Michael Hensel, Christopher Height, Achim Menges. "En route to a Discourse on Heterogeneous Space beyond Modernist Space-Time and Post-modernist Social Geography," Space Reader: Heterogeneous Space in Architecture, eds. Michael Hensel, Christopher Hight and Achim Menges, London: John Wiley and Sons, 2009, pp. 8-36.

structuralist philosophy. "Structuralism has been criticized for generating categories that reference conventions, which obscure real differences."[87] In this regard, structuralism is predicated on a categorical thought, which reveals determinism devaluating the spacing through which difference is manifested. Deconstructivist philosophy of Jacques Derrida emerges as a critique of this categorical thought. As stated by Eva Meyer, "[i]n opposition to structuralism, it stresses the *différal* – the play and slippage of meaning- that is always at work in the process of signification."[88] Therefore, deconstructivist philosophy is predicated upon the constitutive play of differences denying determinism imposed by the categorical thought. In his seminal "Margins of Philosophy," Derrida introduces *différance*, which is formulated in order to re-contextualize the theory of signs in the field of linguistics. Derrida indicates that the *différance* is a "conjoined understanding of temporization and spacing" referring both to "the becoming time of space" and "becoming space of time:"

> "In a certain aspect of itself, *différance* is certainly but the historical and epochal unfolding of Being or of the ontological difference. The a of *différance* marks the movement of this unfolding." [89]

Derrida indicates that the being, the presence, cannot be considered as "a pure and autonomous entity;" it is "marked with the traces of the past and future,"

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[87] Pablo Lorenzo Eiroa. "Form:In:Form: On the Relationship between Digital Signifiers and Formal Autonomy," Architecture in Formation: On the Nature of Information in Digital Architecture, eds. Pablo Lorenzo-Eiroa, Aaron Sprecher, New York, NY: Routledge, 2013, pp.10-22.

[88] Jacques Derrida interviewed by Eva Meyer. "Architecture Where the Desire may Live," Rethinking Architecture: A Reader in Cultural Theory, ed. Neil Leach, London; New York: Routledge, 1997, pp. 317-323.

[89] Jacques Derrida. "Différance," Margins of Philosophy, Chicago: University of Chicago Press, 1982, pp.1-29.

the absence.[90] In this context, *différance* in linguistics challenges the certain and determinate language supporting uncertainty and indeterminacy.

Derrida's philosophical theories on deconstruction are applied beyond the discipline of linguistics and become significant in the discipline of architecture. Influenced by Derrida, Peter Eisenman states that "[a]rchitecture becomes text rather than object when it is conceived and presented as a system of differences rather than as an image or isolated presence."[91] Acknowledging differences, architecture presents an uncertain and indeterminate characteristic, just as the language. Thus, deconstructivism takes a stand against the undifferentiated space that acknowledges each site with a totalizing logic. Such approach recasts the relationship between building and site objecting the isolated presence of architecture. In this regard, "[d]econstructivism theorized the world as a site of differences in order that architecture could represent these contradictions in form."[92] This way, apart from Derrida, deconstructivism emerged as a critique of ordered rationality in architecture. In this context, deconstructive architects challenge "the values of harmony, unity and stability" that arise from "the geometric purity and formal compositions," and instead propose a different model of structure, which "exposes the flaws."[93]

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[90] Jonathan Culler. "Deconstruction," On Deconstruction: Theory and Criticism After Structuralism, New York, NY: Cornell University Press, 1982, pp.89-110.

[91] Peter Eisenman. "The End of the Classical: The End of the Beginning, the End of the End," Architecture Theory Since 1968, ed. K. Michael Hays, Cambridge, MA: MIT Press, 1998, pp.522-540.

[92] Greg Lynn. "Architectural Curvelinearity: The Folded, the Pliant and the Supple," Folding in Architecture, ed. Greg Lynn, Chickester, West Sussex; Hoboken, NJ: Wiley Academy, 2004, pp.8-15.

[93]Mark Wigley. "Deconstructivist Architecture," Deconstructivist Architecture: The Museum of Modern Art New York, eds. Philip Johnson and Mark Wigley, Boston: Little Brown, 1988, pp.10-22.

In the beginning of nineties, Gilles Deleuze's book The Fold: Leibniz and the Baroque changed the course of architecture. At the time when the book was translated in English, Architectural Design published a special issue, Folding in Architecture, which is devoted to transcode the Deleuzian fold into territory of architecture. This issue emphasizes a change in the discipline of architecture focusing on the embodiment of the difference. Contrary to deconstructivist architecture, in which the difference represented through the discontinuities in form, Deleuzian fold offers a new logic that depends on "the intensive integration of differences within a continuous yet heterogeneous system."[94] In this context, the differences are no longer considered as separate entities but rather as integrated, assuring connectivity. Therefore, while deconstructivist architecture operates through "the logic of conflict and contradiction," folding in architecture foregrounds a more "fluid logic of connectivity."[95] Following this, Deleuze's readings on differential calculus of Leibniz led him to explore a transition in "the status of an object:"

> "The new status of the object no longer refers its condition to a spatial mold –in other words, to a relation of form matter- but to a temporal modulation that implies as much the beginnings of a continuous variation of matter as a continuous development of form." [96]

This status shift reveals a new idea of object, the objectile, which is defined through its variation. From an architectural standpoint, such understanding displays a transition in the objective of design from production of objects

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[94] Greg Lynn. "Architectural Curvelinearity: The Folded, the Pliant and the Supple," 2004, pp.8-15.

[95] Ibid.

[96] Gilles Deleuze. "The Folds in the Soul," The Fold: Leibniz and Baroque, Minneapolis: University of Minnesota Press, 1993, pp.15-30.

towards an understanding of their variations. Following this, Deleuze's theories provide an influential ground for Eisenman to conduct his design philosophy:

> "Eisenman's reading of Deleuze's fold in turn retained and emphasized the notion of forms that can change, morph and move, and of a new category of objects defined not by what they are, but by the way they change and by the laws that describe their continuous variations."[97]

This shift leads Eisenman to reconsider the Deleuzian concept of object-event: "the moving and morphing images of the digital age break up the Cartesian and perspectival grids of the classical tradition, and invite architectural forms capable of continuous variation— forms that move in time."[98] Moving beyond the Cartesian order of fixed space, the concept of object-event supports the dynamic understanding of space and, correspondingly, leads to acknowledge architectural organization in a continuous differentiation.

In this context, Eisenman's implementation of folding distinguishes from the passive realization of folded form; it rather emphasizes the generative process of actualization that "contains quality of unseen."[99] Consider Rebstock Park Project, which displays Eisenman's critical approach towards folding. In general, the project was a challenge for Eisenman to reconsider the Siedlung type with respect to new urban strategy that uses fold in order to produce

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[97] Mario Carpo. "Variable, Identical, Differential," The Alphabet and the Algorithm, Cambridge, MA: The MIT Press, 2011, pp.1-51.

[98] Ibid.

[99] Peter Eisenman. "Visions Unfolding: Architecture in the Age of Electronic Media," Written into the Void: Selected Writings, 1990-2004, New Haven: Yale University Press, 2007, pp. 25-34.

conditions of a singularity of place and time.[100] Eisenman explains the project through diagrammatic procedures that brings the design process into light. This process reveals the deformation of the gridded configuration through sequential operations. Herein, the differences inherent in site are the currencies that drive all these operations, the process of differentiation. As Micheal Speaks indicates, "[t]he differences are derived from the morphology of the site and integrated into homogeneous typologies of the housing and office blocks."[101] It is the homogenization, of the site and of the buildings that Eisenman attempts to overcome through folding. The differences, which are derived from the morphology of the site, produce fold deforming the gridded system. Therefore, the ground is no longer approached as a neutral Cartesian grid but "as a membrane which becomes topological event-structure is also simultaneously the building form." [102] As opposed to classical modes of organization in which buildings are considered as isolated figures on a ground, in the emergent mode of organization the figure dissolves into ground subverting the rigid boundaries in-between. In other words, the building and the site are no longer bounded by static conditions; they articulate each other through a generative process. This is the point where dynamic understanding of architecture emerges.

In this regard, Eisenman sets up a substructure for the emergence of new organizational strategies in architecture. These emergent strategies present a particular concern to overcome what Eisenman calls "the mechanics of

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[100] Peter Eisenman. "Folding in Time: The Singularity of Rebstock," Written into the Void: Selected Writings, 1990-2004, New Haven: Yale University Press, 2007, pp. 25-34.

[101] Michael Speaks. "Folding Toward a New Architecture," Earth Moves: The Furnishing of the Territories, ed. Bernard Cache, Cambridge, MA: The MIT Press, c1995, pp. xiii-xix.

[102] Ibid.

vision."[103] This concern explicitly reveals itself in the generative processes of organization that contextualize architecture, as well as space, in a continuous differentiation. This brings argument back to Hensel, Hight and Menges:

> "These differentiations could be sudden or gradual, or both at different locations. Indeed, a heterogeneous space could have no differentiation, which would mean it simply had zero information or energy, or might be at a time zero."[104]

As it is understood, the information is what makes differentiation possible and it requires time to be processed. The acknowledgement of differences in architecture emphasizes a spatial precision. Differentiation, on the other hand, predicated on "the intensive integration of differences."[105] Therefore, the acknowledgement of differentiation in architecture emphasizes the temporal precision. As stated before, this process of differentiation in architecture brings along a form of continuity in which differentials constitute indexical relationships between the temporal states of transformation assuring a space of connectivity. Through differentiation the concept of differential emerges. In this equation, the differential emphasizes the information, through which the heterogeneous space is defined and architecture is generated.

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[103] Peter Eisenman. "Visions Unfolding: Architecture in the Age of Electronic Media," 2007, pp. 25-34.

[104] Michael Hensel, Christopher Hight, Achim Menges. "En route to a Discourse on Heterogeneous Space beyond Modernist Space-Time and Post-modernist Social Geography," 2009, pp. 8-36.

[105] Greg Lynn. "Architectural Curvelinearity: The Folded, the Pliant and the Supple," 2004, pp.8-15.

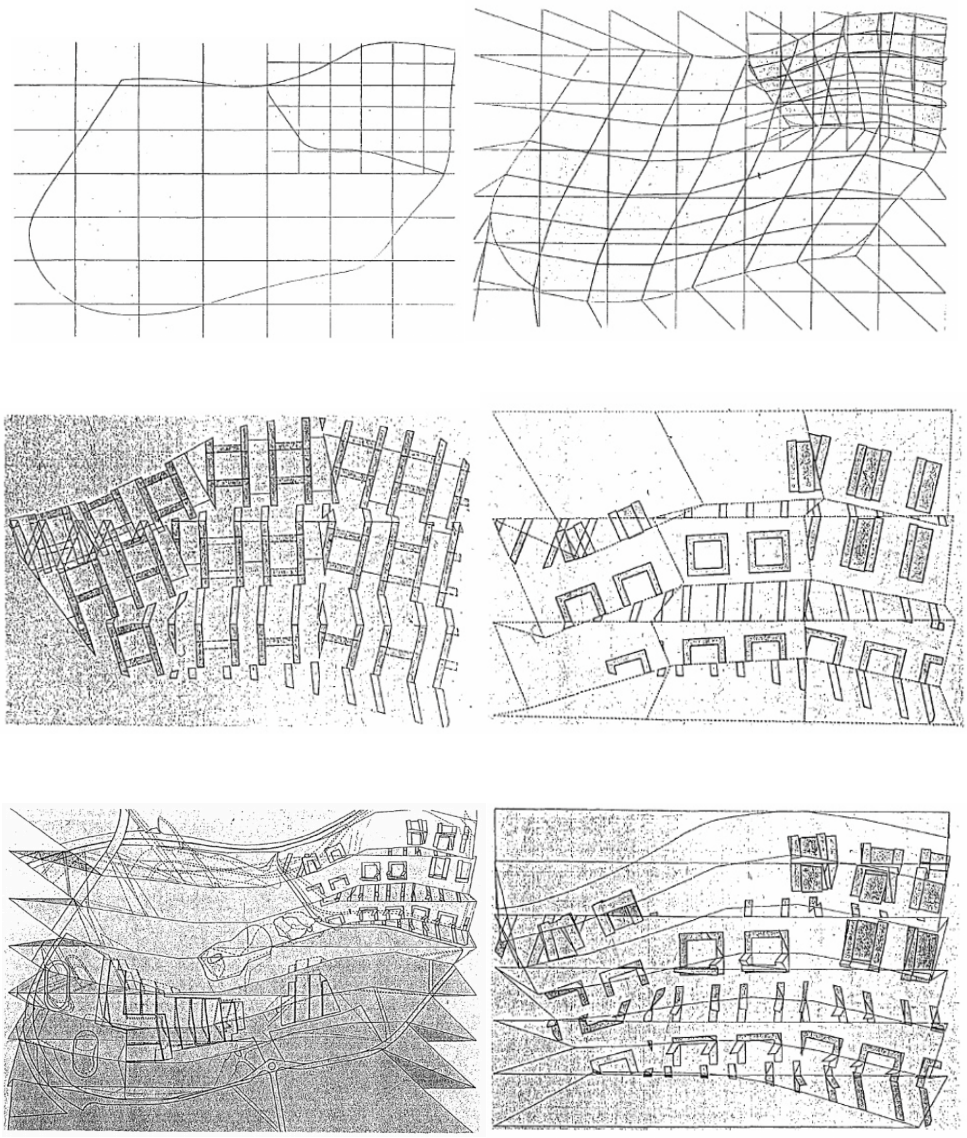

**Figure 2.14 The concept drawings of Rebstock Park Project, Frankfurt, Peter Eisenman, 1990-1991**

Source: Peter Eisenman. "Folding in Time: The Singularity of Rebstock," Folding in Architecture, ed. Greg Lynn, Chickester, West Sussex; Hoboken, NJ: Wiley Academy, 2004, pp. 42.

# CHAPTER 3

# INFORMED MATERIALITY: DYNAMIC AND KINETIC

## 4.1. Informed Materiality and Information Flow

> "In these Kymatic images by Hans Jenny, standing waves are generated by sinus tones emitted across steel plates by crystal oscillators (in much same manner as Ernst Chladni's eighteenth century Klangfiguren). A mixture of sand and superfine lycopodium powder forms the outlines of the resultant shapes as it is transported across the plate surface into virtual troughs between the more highly activated areas of the field. One can discern a specific and uniform underlying pattern or texture "beneath" the resultant figure that is a joint property of the metallurgy of the sounding plate and of the tone that moves through it. This underlying pattern is itself never reproduced, but remained virtual. The actual pattern (the sand-lycopodium figure) always expresses a variation or development of its virtual form –built on the template but continuously variable and varying. Both the actual and the virtual structures are legible in the same image, though their ontological status remains perfectly distinct." [106]

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[106] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.9.

**Figure 3.1 Hans Jenny's study of wave phenomena, cymatic image, 1967**

Source: Hans Jenny. Cymatics, A Study of Wave Phenomena and Vibration, Newmarket, NH: MACROmedia Publishing, 2011, pg.40.

Adhering to the previous chapter, materiality becomes informed when architecture rejects the recognition of static and deterministic organizations and, correspondingly, acknowledges the dynamic and evolving organizations that emerge through unfolding of the generative processes.

> "From the moment a system is understood as evolving over time, what becomes important are the transformations it undergoes, and all transformation in a system is the result of energy –or information- moving through it."[107]

Therefore, transformations become indicative of the processes in which a given system evolves through "the information flows." Once learning the driving force behind these processes, understanding how systems transform becomes central to architectural discourse. The answer to such question leads directly to the "act of computation," which stands as a particular concern of diverse fields, such as mathematics, science, arts and biology.

> "The manifest form –that which appears- is the result of a computational interaction between internal rules and external (morphogenetic) pressures that, themselves, originate in other adjacent forms(ecology)." [108]

In the most general sense, computation refers to "the information processing" in which a given system "processes information through a discrete sequence of steps by taking the results of its preceding stage and transforming it to the next stage in accordance to a recursive function."[109] Computation then is a discrete

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[107] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.23.

[108] Sanford Kwinter. Far From Equilibrium: Essays on Technology and Design Culture, ed. Cynthia Davidson, Barcelona; New York: Actar-D, 2007, pg.147.

[109] Karl Chu. "Metaphysics of Genetic Architecture and Computation," Building Codes, Perspecta, No.35, eds. Elijah Huge, Stephanie Tuerk, Massachusetts, MA: The MIT Press, 2004, pp.74-97.

sequence of operations in which a given system transforms through processing information flows. In order to understand this process, the following part focuses on an individual operation considering the initial state as "state1" and emergent state as "state 2." As its fundamental, the information processing includes three basic stages: reception, organization and distribution.

Information x (state 1) = (state2)

(1) Reception. "That information from outside of the system will pass to the inside."[110] This stage involves the detection of information and the introduction of this certain information with the system.
(2) Organization. "That information from certain levels in the system is transported to other levels, with result that may be very dramatic."[111] In this stage, the system assesses information, which is receipted in previous stage, through changing its organization.
(3) Distribution. "That energy or information also carried from inside the system to outside, producing these same effects now in reverse."[112] The system gives information back to environment.

In general sense, this process from receiving to distributing information, can be referred as the information processing. Generated in a field of continuous information flow, systems maintain information processing in discrete sequences considering the output of preceding state as the input of the next iteration. In architectural perspective, during this iterative process, the

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[110] Sanford Kwinter and Umberto Boccioni. "Landscapes of Change: Boccioni's Stati d'animo as a General Theory of Models," 1992, pp.50-65.

[111] Ibid.

[112] Ibid.

materiality of architecture gets structured and destructed simultaneously by processing information. This way, information flows through the system causing changes in organization over time.

As the next step, this thesis divides "informed materiality" into two subcategories as "dynamic materiality" and "kinetic materiality."[113] In general, both dynamic and kinetic materiality is associated with their ability to generate information and, to be generated by information over time. This condition unifies both categories under informed materiality. However, focusing on their response to information flow, the difference appears.

> "The equations must perpetually feed information back into themselves, information that can be made available only *in time,* not in advance, and *across* temporal scales, never within a single temporal plane."[114]

Both dynamic materiality and kinetic materiality occur in time, across multiple temporal planes. However, embracing a certain static organization one state at a time, dynamic materiality is conserved within a single temporal plane. To put it in different way, in the case of dynamic materiality, while the design process operates through time, the emergent organization suggests timelessness. Therefore, dynamic materiality restrains the information processing in a periodic duration of design process. Unlike dynamic materiality, kinetic materiality is predicated on continuous information processing by emphasizing gradual redefinition in real time in real space. Consider Hans Jenny's study of wave phenomena. While the figure presents a dynamic materiality, indicating a

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[113] Here, "dynamic materiality" is introduced as a specific category classified under informed materiality differentiating from the term "dynamic," that used in general sense throughout the thesis.

[114] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.24.

specific organization, the activity performs a kinetic materiality, an organization that is redefined across temporal states.

The study concerns the organizations of sand particles produced through their interaction with the sound waves that are generated in a medium.[115] The activity is a generative process that operates over time. Specific organizations are direct reflections of the vibrations, the information flows. Differentiations in information flows, the change in the frequency or amplitude of vibrations, results in different organizations through this generative process. The specific organization of the figure is achieved through the momentary stoppage of a dynamic process. (See Fig.3.1) Therefore, the specific organization suggests timelessness, embracing a static organization, while it is originated in time through a dynamic process. (See Fig.3.2) Referring this specific figure, Kwinter states that the organization, the actual structure, and the information, the virtual structure, are both legible in the same figure.[116] From it follows that the emergent, static, organization leads to a specific set of information flow that is processed in a specific period of time. Therefore, dynamic materiality supports the continuity of information processing to a certain extent; accordingly, it can never be projective in real time and in real space. Controversially, kinetic materiality is predicated on the continuity of information processing displaying dynamic process of transformations in real time and in real space.

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[115] Hans Jenny. Cymatics, A Study of Wave Phenomena and Vibration, Newmarket, NH: MACROmedia Publishing, 2011, pg.9.

[116] Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.9.

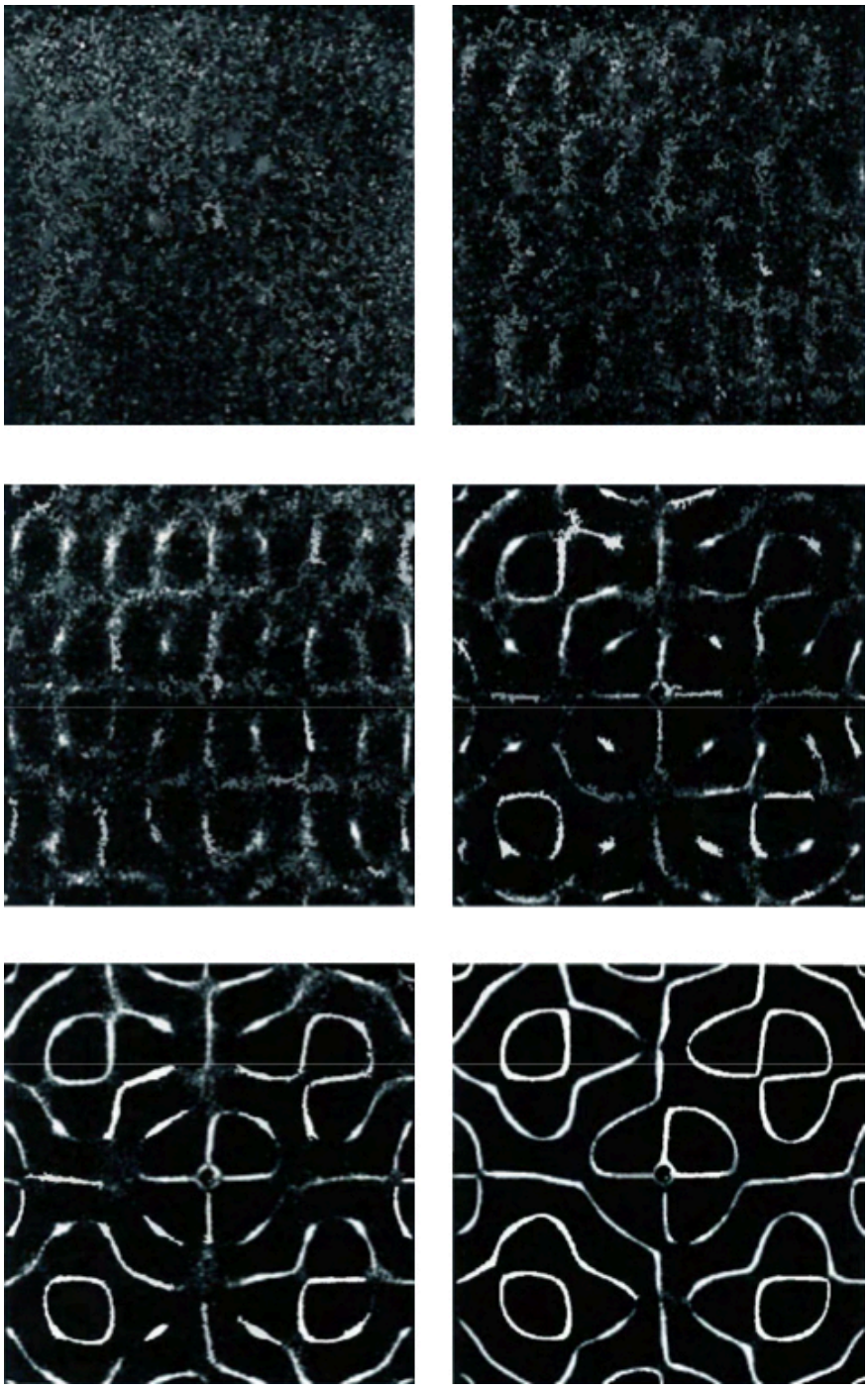

**Figure 3.2 Hans Jenny's study of wave phenomena, cymatic images, 1967**

Source: Hans Jenny. Cymatics, A Study of Wave Phenomena and Vibration, Newmarket, NH: MACROmedia Publishing, 2011, pg.22.

### 4.2.1. Dynamic Materiality

Based on the previous discussion, dynamic materiality restrains the information processing in a periodic duration embracing static organization at certain state of a generative process. In order to place the dynamic materiality within the context of architectural practice and theory, this section focuses on the animate design strategy of Greg Lynn. Lynn states that animation is a term that implies "the evolution of form and its shaping forces" suggesting "animalism, animism, growth, actuation, vitality and virtuality."[117] Emphasizing the evolutionary processes in architectural organization, animate approach interiorizes organic system as a basis for its design strategy. Acknowledging abstract space of design, "conceived as the ideal neutral space of Cartesian coordinates," the desire for timelessness is intricately related with "formal purity and autonomy in architecture." [118] Through animate design strategy Lynn proposes an alternative model for architectural organization:

> "Instead of a neutral abstract space for design, the context for design becomes an active abstract space that directs form within a current of forces that can be stored as information in the shape of the form. Rather than as a frame through which time and space pass, architecture can be modeled as a participant immersed within dynamical flows."[119]

Stored as information in the shape of form, these dynamical flows have capacity to generate limitless variations in architectural organization. In this context, unlimited iterations derived through this generative process reveal an informational continuum. Herein, the concept of animate form indicates a

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[117] Greg Lynn. "Animate Form," Animate Form, New York, NY: Princeton Architectural Press, 1999, pp.8-44.

[118] Ibid.

[119] Ibid.

particular state in this continuum, existing in relationship to past and future iterations. Lynn defines animate design as "the co-presence of motion and force at the moment of formal conception."[120] Thus, the recognition of motion and force remains bounded by limits of conception. To put in a different way, the informational continuum is not conceived through physical motion in time but is represented through formal expression that embraces timelessness. Kostas Terzidis refers to this particular state as "frozen moment" and states that it expresses unique characteristic of architecture asserting both dynamic and static condition:

> "It is dynamic when viewed as the design process which has its roots in historical precedents of culture and the arts and which manipulates entities that are typically of an elastic character. It becomes static when it has to freeze at a certain state so that it may be built." [121]

From that it follows that the processing of information flow is restrained in a periodic duration of design process. Addressing dynamic and static condition simultaneously, dynamic materiality indicates a static organization of stored information. Thus, the information is embedded in the organizational system.

Applying the principles of animate design, Greg Lynn's Embryological House Project provides an influential ground for the discussion of dynamic materiality. In general, the project emerges as a critique of "the concept of ideal villa" that is formulated by Colin Rowe and Rudolf Wittkower. In this regard, the project rejects the recognition of "the modernist idea of form, based on modules or kit of parts," and rather acknowledges an alternative form of organization, "based on potentially unlimited iterations derived through from a basic form, or

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[120] Ibid.

[121] Kostas Terzidis. "Kinetic Form," Expressive Form: A Conceptual Approach to Computational Design, London, New York: Spon Press, 2003, pp. 33-45.

primitive."[122] Therefore, the importance is placed on the dynamic processes of formation rather than the ultimate form. Following this path, the project traces the evolutionary process of embryonic development. In this context, Lynn designs a formula consisting a set of parameters, ranging from functional needs to climate conditions, that leads to unlimited variations in this generic form. The generic form is chosen as a pure sphere and a set of control points is assigned on the surface of this generic form. These control points are manipulated with regard to the changes in the parameters. As a consequence, the materiality is driven by the deformations in the vector-based surfaces. These deformations reveal the dynamic design process, consisting of sequential operations, in which the organization evolves from one state to another processing information. As stated by Lynn, such organization process "marks a shift from modernist, mechanical technique to a more vital, evolving, biological model of embryological design and construction." [123] As a continuation of this work, Lynn's Embryological House was exhibited at the 7th Venice Biennale, in 2002. Lynn states that, "[f]or the prototyping stage, six houses were developed, exhibiting a unique range of domestic, spatial, functional, aesthetic and lifestyle constraints." [124] Each prototype indicates a specific instance within a dynamic design process. The processing of information remains restrained in the design process, since these prototypes do not exhibit generative formation in real time. However, their static organization becomes indicative of this dynamic process.

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[122] Howard Shubert. "Preserving Digital Archives at the Canadian Centre for Architecture: Greg Lynn's Embryological House" Architecture et Archives Numeriques Natives, Paris: Cite de l'architecture & du Patrimoine, 2008.

[123] Greg Lynn. "Embryologic Houses," Contemporary Processes in Architecture, Architectural Design, ed. Ali Rahim, London: John Wiley Sons, 2000, pp.26-35.

[124] Ibid.

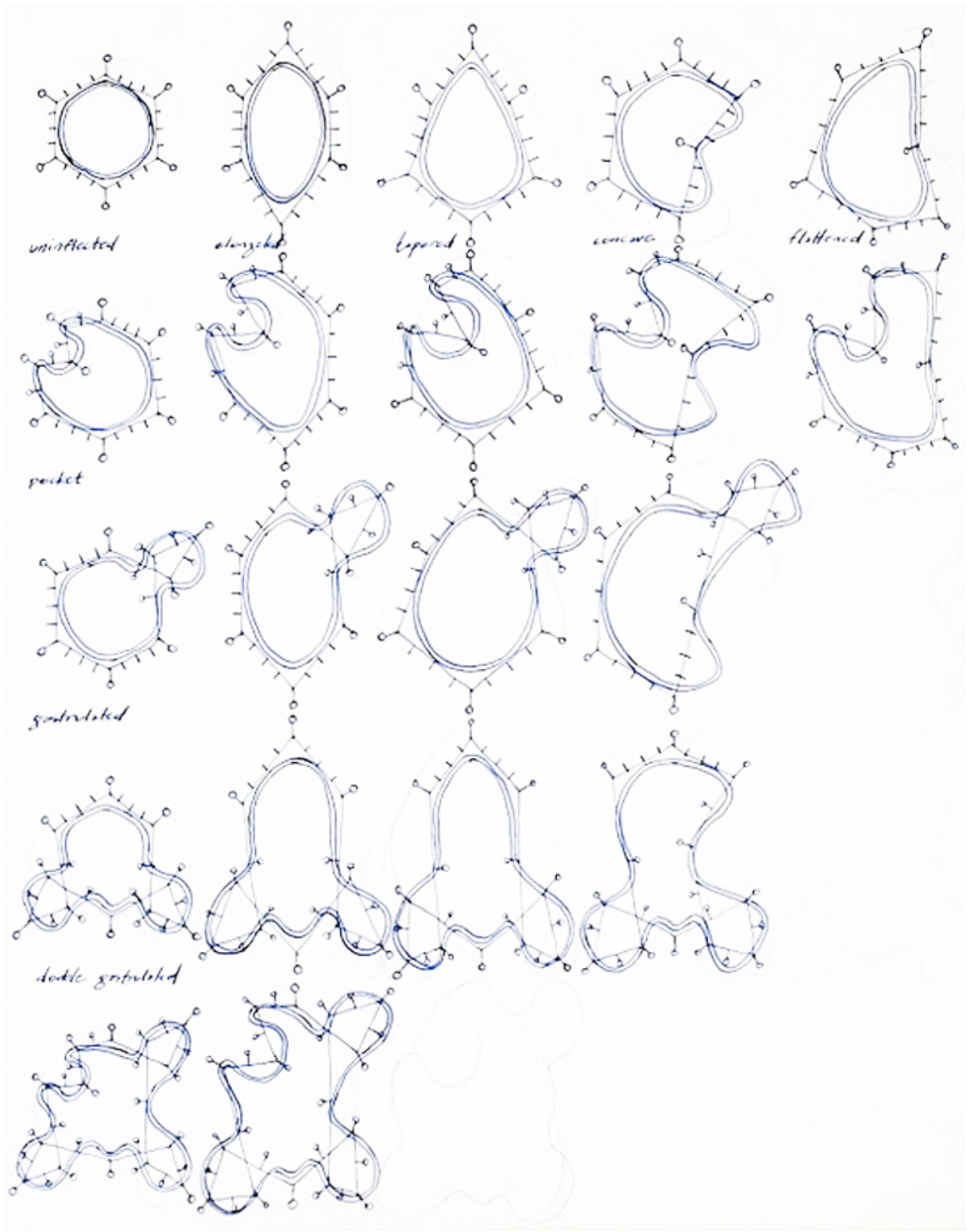


**Figure 3.3 The concept drawings of Embryological Houses, Greg Lynn, 2000**

Source: Art Tattler International, 14 January 2015. <http://arttattler.com/architecturetakenote.html>.

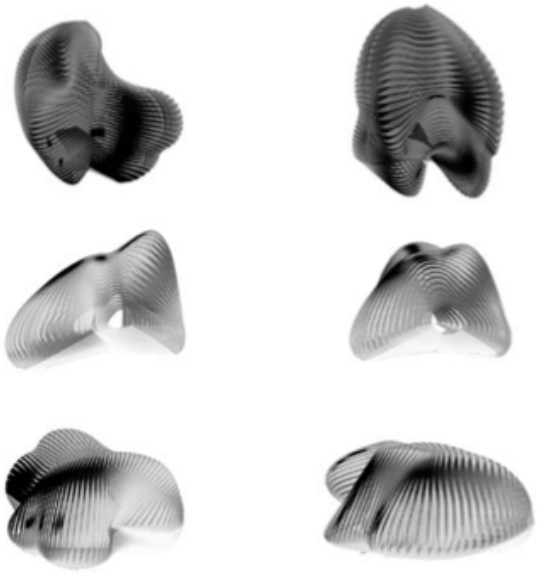

**Figure 3.4 The prototypes of Embryological Houses, Greg Lynn, 2000**

Source: Therese Tierney. Abstract Space Beneath the Media Surface, New York, NY: Taylor and Francis, 2007, pg.143.

**Figure 3.5 Embryologic House Pavilion, Greg Lynn, Venice Biennale, 2000**

Source: Therese Tierney. Abstract Space Beneath the Media Surface, New York, NY: Taylor and Francis, 2007, pg.11.

Explaining the contemporary approaches to architectural design, Branko Kolarevic indicates that the attention is placed on indeterminacy rather than determinism imposed by traditional design practices.[125] Although such processes lead towards "a dynamic, highly non-linear, indeterministic systems of organizations," as a matter of fact, the urgency for the selection of individual instance calls for the determination in architecture.

### 4.2.2. Kinetic Materiality

The context in which architecture generated is a field of continuous information flow. Such context, that architecture needs to engage, requires for adaptation to these variant conditions that is by no means in the state of equilibrium. The difficulty in engaging with such context lies in the fact that it requires an architectural project to operate itself beyond the static organization. This condition requires the introduction of a system that can consistently transform, continuously process information, in real time and in real space.

> "Surely, our present task is to unfreeze architecture- to make it a fluid, vibrating, changeable backdrop for the varied and constantly changing modes of life. An expanding, contracting, pulsating, changing architecture would reflect life as it is today and therefore be part of it."[126]

Back in 1970, William Zuk and Roger Clark made a major move introducing the term "kinetic architecture" providing an alternative way for the suppression of determination in architecture. Taking their approach further, Zuk and Clark divide kinetic architecture into eight categories. In order to clarify kinetic

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[125] Branko Kolarevic. "Digital Morphogenesis," Architecture in the Digital Age: Design and Manufacturing, New York, NY: Taylor & Francis, 2003, pp.17-46.

[126] Jan Rowan as referred in William Zuk and Roger H. Clark. "Quotations," Kinetic Architecture, New York, NY: Van Nostrand Reinhord, 1970, pp.2-4.

materiality in architecture, this section focuses on the two categories of Zuk and Clark. One of these categories is the "reversible architecture," in which the structure is synchronously constructed and deconstructed "at the same or different locations, essentially in the same configuration," in order to fulfill the needs for the changing modes of life.[127] In the case of reversible architecture, the organization emerges through a mechanic process of "movement." The other category is the "deformable architecture," in which the structure responds to a range of functional changes with deformations in its body.[128] In the case of deformable architecture, the organization emerges through a dynamic process of "transformation." This distinction between the mechanic and dynamic processes of organization is particularly important as it forms a basis for kinetic materiality. While reversible architecture generates a formed materiality referring to a closed system of organization, deformable architecture generates an informed materiality referring to an open system of organization. In this regard, deformable architecture generates a kinetic materiality. Although reversible architecture is considered as a kinetic architecture, it does not generate a kinetic materiality.

In the case of dynamic materiality, the information remains embedded in the manifold variations that are generated in the dynamic design process. When it comes to realization process of architecture, these products fail to address the generative formations in real time and in real space, insisting on the selection of a specific instance. Such critique forms the basis for kinetic materiality.

As opposed to dynamic materiality, kinetic materiality maintains the information processing during the complete lifecycle of architecture. Thus,

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[127] William Zuk and Roger H. Clark. "Architectural Applications," Kinetic Architecture, New York, NY: Van Nostrand Reinhord, 1970, pp.33-143.

[128] Ibid.

kinetic materiality rejects the recognition of static architectural organization displaying a dynamic process of transformation in real time and in real space.

In this regard, ONL (Oosterhuis and Leonard) and Hyperbody's (Research Group at the Delft University of Technology) NSA Muscle Project provides an influential ground for the discussion of kinetic materiality. The project was built for the "Architectures Non-Standard" exhibition at the Centre Georges Pompidou, curated by Zeynep Mennan and Frédérique Migayrou, in 2003.

The NSA Muscle Project is designed as "a working prototype" of the Trans-ports. Trans-ports is defined as "data-driven multimedia pavilions," which respond to web-based information by changing their configuration in real time.[129] As a working prototype of Trans-ports, Muscle NSA is programmed to interact with the contextual dynamics, namely human activities. The project is composed of a pneumatic meshwork of muscle wires, connecting spiraling tubes covered with actuators, and an inflated soft volume that is integrated within this meshwork.[130] The forces acting upon the structure stimulate the system causing changes in the air pressure. Further, these changes in air pressure lead to motion in the muscle wires. "Orchestrated motion of muscle wires change the length, the height and the width" affects the organization causing it "to constantly hop, twist, bend and rotate."[131] Thus, forces acting upon the structure reveal a deforming body that reconfigures itself through smooth transformations performing a dynamic behavior. Responding real time information, materiality displays gradual redefinition in real time in real space.

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[129] Chris Kievid and Kas Oosterhuis. "Mucle NSA: A Basis for a True Paradigm Shift in Architecture," Hyperbody, 24 Dec. 2003. Web. 20 Oct. 2015. <http://www.hyperbody.nl/research/projects/muscle-nsa/>

[130] Ibid.

[131] Ibid.

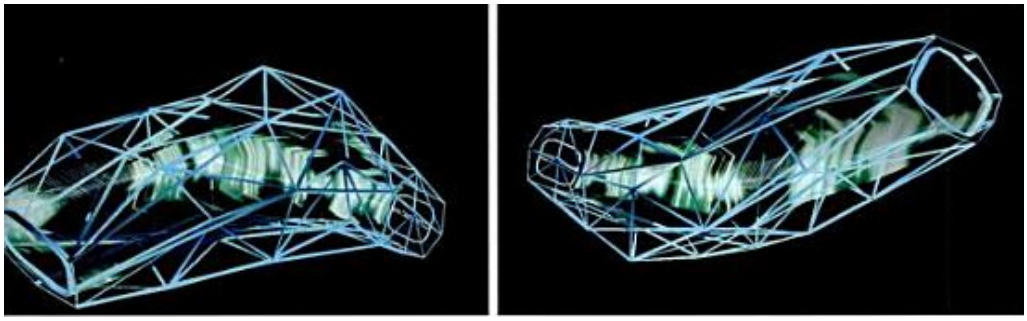

**Figure 3.6 Trans-ports, Venice Biennale, 2000**

Source: Kas Oosterhuis and Ilona Lenard. "Transports," Onlogic: Speed and Vision, Mulgrave: Images Publishing Group, 2008, pg.197.

**Figure 3.7 Trans-ports, Venice Biennale, 2000**

Source: Kas Oosterhuis and Ilona Lenard. "Transports," Onlogic: Speed and Vision, Mulgrave: Images Publishing Group, 2008, pg.197.

**Figure 3.8 Muscle Project, NSA Exhibition Pompidou, 2003**

Source: Oosterhuis_Leonard. 5 January 2015.
< http://www.onl.eu/?q=projects/nsa-exhibition-pompidou>.

**Figure 3.9 NSA Muscle Project, 2003**

Source: Archdaily. 5 January 2015.
< http://www.archdaily.com/562166/the-nsa-muscle-conversations-exploring-pioneering-projects-in-digital-architecture >.

Fixed at a certain state of a generative process, dynamic materiality remains external to ongoing particularities of time. In the case of kinetic materiality, the generative principles that operate design process expand to complete life cycle of architecture. Therefore, kinetic materiality participates in the ever-changing particularities of time. In this regard, kinetic materiality speaks more to life.

### 4.3. Trajectories of Informed Materiality in Architecture

#### 4.3.1. Dynamic Materiality: Segregated and Integrated Materiality

Materiality of architecture, as it is stated in the introduction, is predicated upon a multiplicity of domains referring to form, structure, space and material as a whole. Depending on the diverse models of relationships constructed between these domains, this thesis divides "dynamic materiality" into two subcategories as "segregated materiality" and "integrated materiality."

"Segregated materiality" refers to the dynamic organizations of architecture with a separated model of form, structure, space and material. In this context, materiality is experimented on diverse grounds. Such condition eventually leads to segregation prioritizing one asset over another. [132] In this regard, study of materiality requires the inquiry of separate grounds of analysis in which these assets are considered individually. Therefore, segregated materiality refers to "an assembly" establishing "passive relations" between these domains.

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[132] See, Achim Menges. "Material Generation: Materiality and Materialisation as Active Drivers in Design Computation," Synthetic Digital Ecologies: Proceedings of the 32nd, San Francisco: California College of the Arts, 2012, pp.21-24. Neri Oxman. "Material Computation," Manufacturing the Bespoke: Making and Prototyping Architecture, AD Reader, ed. Bob Sheil, London: John Wiley & Sons, 2012, pp.256-266. Neri Oxman. "Material Computation," Manufacturing the Bespoke: Making and Prototyping Architecture, AD Reader, ed. Bob Sheil, London: John Wiley & Sons, 2012, pp.256-266.

Consider Embryological House Project of Greg Lynn. Methodologically, the design process is dominated by a formal exploration. In this condition, material attribute is considered as a passive property in architectural organization.

As opposed to segregated materiality, "integrated materiality" is predicated on the synthesis of form, structure, space and material. Achim Menges indicates that the actualization of such synthesis requires for "the integral materialization process" that finds its conceptual roots in "the processes of becoming in nature:"

> "Natural morphogenesis, the process of individual growth and evolutionary development, derives the complex organization, structure and shape of natural systems from the interaction of system intrinsic material capacities and external influences and forces."[133]

Based on natural morphogenesis, integral materialization promotes material information to be considered as the active property in design process that originates architectural organization. In this context, architecture becomes "a material system," in which "material properties, characteristics and behaviors" operate as "the active design generators" informing and activating architectural form, structure and space.[134]Regarding this, architectural organization becomes a by-product, a derivative of natural behavioral formation.[135] In this condition,

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[133] Achim Menges. "Material Generation: Materiality and Materialisation as Active Drivers in Design Computation," Synthetic Digital Ecologies: Proceedings of the 32nd Annual Conference of the Association for Computer Aided Design in Architecture, ACADIA, San Francisco: California College of the Arts, 2012, pp.21-24.

[134] Achim Menges. "Introduction," Material Computation: Higher Integration in Morphogenetic Design, Architectural Design, Vol.82, No.2, eds. Achim Menges, Helen Castle, London: John Wiley & Sons, pp.14-21.

[135] Neri Oxman. "Material Computation," Manufacturing the Bespoke: Making and Prototyping Architecture, AD Reader, ed. Bob Sheil, London: John Wiley & Sons, 2012, pp.256-266.

the architectural organization cannot be analyzed without referring to the material. Predicated on the conciliation between form, structure, space and material, such condition leads to unification. Hence, integrated materiality refers to "an association" establishing "active relations" between these domains.

Designed by the Institute for Computational Design in collaboration with the Institute of Building Structures and Structural Design at the University of Stuttgart, in 2010, the ICD/ITKE Research Pavilion provides an influential ground for the discussion of integrated materiality. The project is "a bending-active structure," which focuses on "the material behavior of elasticity" and explores "its architectural potential."[136] Focusing on material behavior of the elastic bending, planar plywood strips are chosen as the material, active design generator, from which the genuine organization emerges. The planar plywood strips are organized in a way that the bent region of each strip supports the tensioned region of adjoining strip increasing the structural capacity of the system.[137] The location of joints that combine these strips plays a significant role since their oscillation determines the overall organization. In other words, the change in the location of joints results in completely different organizations. Achim Menges states that the emergent form is "the equilibrium state of the embedded forces" and this equilibrium state unfolds "a unique architectural organization," depending on "the behavior of a specific material."[138] The interaction between the material characteristic of the system and external forces results in formal, structural, spatial and material integrity.

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[136] Achim Menges. "Material Generation: Materiality and Materialisation as Active Drivers in Design Computation," Scaleless and Seamless; Performing a Less Fragmented Architecture Education and Practice, eds. Maria Voyatzaki, Constantin Spiridonidis, EAAE, Greece, 2012, pp.37-45.

[137] Ibid.

[138] Ibid.

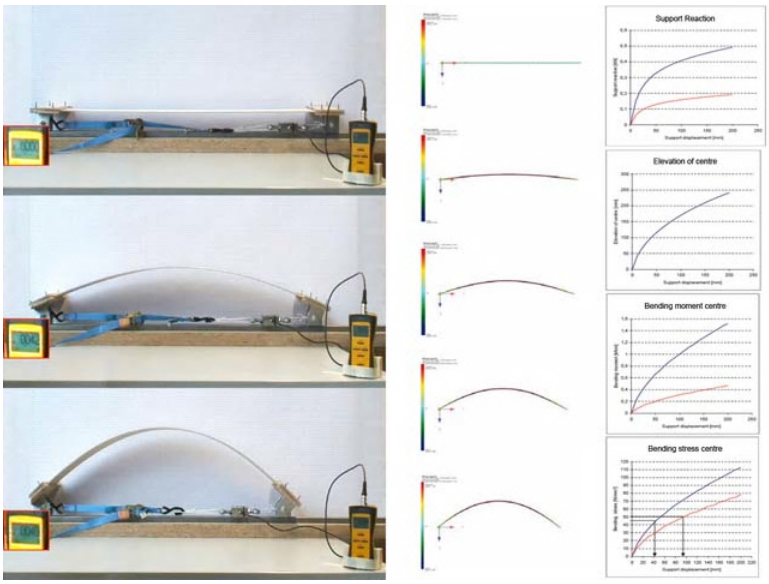


**Figure 3.10 ICD/ITKE Research Pavilion, University of Stuttgart, 2010**

Source: University of Stuttgard. 11 July 2014.
<http://icd.unistuttgart.de/?p=445>.

**Figure 3.11 ICD/ITKE Research Pavilion, University of Stuttgart, 2010**

Source: University of Stuttgard. 11 July 2014.
<http://icd.unistuttgart.de/?p=445>.

From this it follows that the segregated and the integrated materiality are predicated on different orders of response. These diverse orders of response emerge from the diverse relationships models constructed between the domains of form, structure, space and material. While segregated materiality operates through separation, integrated materiality operates through unification.

### 3.3.2. Kinetic Materiality: Predictable and Unpredictable Materiality

Usman Haque in his article "Architecture, Interactions, Systems" indicates that the interaction concerns transaction between two systems and unless this transactions are not in some sense circular it is merely a reaction.[139] Based on this definition, Haque defines three scenarios of transaction: first includes no interaction but reaction, second a single loop interaction and third a multiple loop interaction.[140] As its fundamental, kinetic materiality in architecture operates through the circular transaction between two systems, namely building and its context. In this regard, the last two scenarios of Haque provide a ground on which a further examination of kinetic materiality can be conducted. Based on the cycles of responses, this thesis divides "kinetic materiality" into two subcategories as "predictable materiality" and "unpredictable materiality."

Haque defines single loop interaction as "a process operated within a predetermined set of boundaries;" in a more detailed way, "it is a process in that each of us selects from a fixed set of possibilities and responds directly to the other from a fixed set of possible outcomes."[141] Predicted materiality in architecture operates through a single loop interaction. Architecture responds to

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[139] Usman Haque. "Architecture, Interactions, Systems," AU, Arquitetura and Urbanismo, vol.149, 2006.

[140] Ibid.

[141] Ibid.

a fixed set of information flow with a predetermined set of organizations. This results in predictable uniformity in behavior patterns of architecture.

In this regard, Chuck Hoberman's expanding structures provide an influential ground for the discussion of predictable materiality in architecture. The structural mechanisms of Hoberman perform dynamic transformations processing real time information. Greg Lynn indicates that these mechanisms develop "a system of smooth transformation:"

> "Hoberman develops adjustable structures whose differential movement occurs through dynamic transformation of flexible continuous system. The movements of these mechanisms are determined by both use and structure." [142]

The dynamic transformation of these structures is made possible through the geometric organizations of parts. As information flows through the system this geometric organization expands by maintaining its integrity:

> "When an object expands, the points on its surface move radially outwards- this is the relationship between shape and trajectory, a relationship whereby hundreds or thousands of links are synchronized by the geometric organization of the system."[143]

Such transformation results in a multiplicity of relationships constructed between geometric organizations of parts. Therefore, a certain organization in time indicates the certain condition in space. The connections between these spaces have to be understood in variable instances of these organizations.

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[142] Greg Lynn. "Architectural Curvelinearity: The Folded, the Pliant and the Supple," 2004, pp.8-15.

[143] Chuck Hoberman. "Transformation in Architecture and Design," Transportable Environments 3, ed. Robert Kronenburg, New York, NY: Taylor and Francis, 2006, pp.70-80.

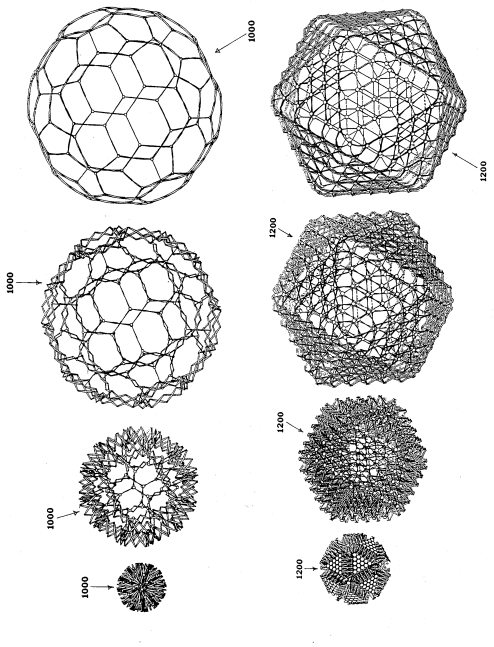


**Figure 3.12 Radial expansion/retraction truss structures, Chuck Hoberman and Hoberman Associates, 1991**

Source: Google Patents. 23 August 2014.
< http://www.google.com/patents/US5024031>.

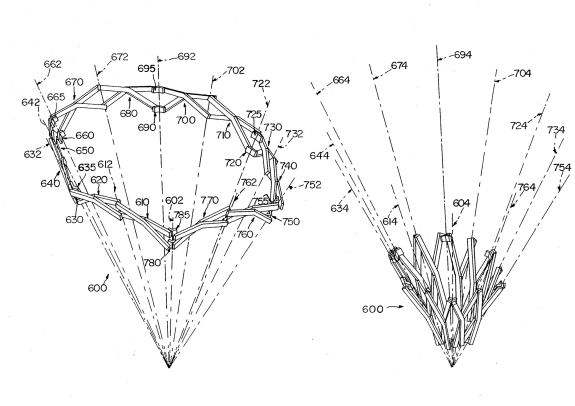


**Figure 3.13 Radial expansion/retraction truss structures, Chuck Hoberman and Hoberman Associates, 1991**

Source: Google Patents. 23 August 2014.
< http://www.google.com/patents/US5024031>.

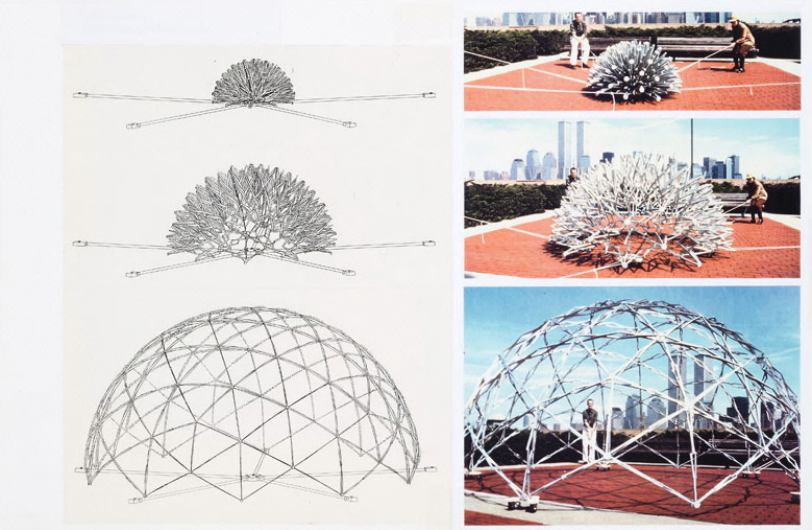

**Figure 3.14 Expanding geodesic dome, Chuck Hoberman and Hoberman Associates, 1991**

Source: Art Tattler International. 14 June 2015. <http://arttattler.com/architecturearchaeologyofthedigital.html>.

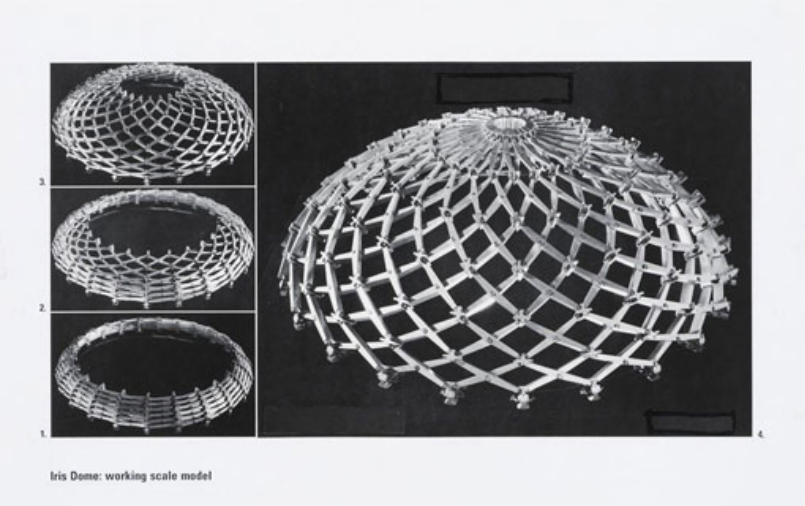


**Figure 3.15 Iris Dome Model, Chuck Hoberman and Hoberman Associates, 1993**

Source: Art Tattler International. 14 June 2015. <http://arttattler.com/architecturearchaeologyofthedigital.html>.

Each mechanism responds to a diverse fixed set of information flows. While this information, which drives this dynamic transformation process, is the gravity in the case of radial expansion/retraction truss structures, it is the program in the case of Iris dome. Further, the geometric organization of parts is limited by the structural mechanism transforming dynamically from one dense organization to one loose organization. Therefore, these structural mechanisms perform a predictable materiality responding to a fixed set of information flow with a predetermined set of organizations. Further, this results in predictable uniformity in behavior patterns, namely expanding and shrinking.

As opposed to single loop interaction, multiple loop interaction is predicated on the suppression of predetermined set of boundaries. As stated by Haque, multiple loop interaction depends upon "the openness and continuation of cycles of response."[144] Unpredictable materiality in architecture operates through multiple loop interaction. In this case, architecture responds to variable sets of information flow with unpredictable set of organizations. Haque defines multiple loop interaction as the most productive scenario, which produces a constructive and continual interaction between architecture and its context.[145]

Consider the NSA Muscle Project of ONL and Hyperbody. In this case, the process is not predictable as in the previous case. While programmable system still limited by a set of functions, there are "billions of possible outcomes:"

> "Looking at the Muscle NSA in operation, one gets the feeling that it is acting out of its own free will. It is unpredictable to the people who have programmed it, and unpredictable to the people playing

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[144] Usman Haque. "Architecture, Interactions, Systems," 2006.

[145] Ibid.

> with the running system. Since the free will of people in the end is the result of a complex set of in itself simple rules being executed by human brains in close cooperation with the human body, it seems perfectly fine to postulate that the Muscle NSA has a simple form of free will itself. If it is not possible to predict what Muscle NSA will do exactly, then it can only be the running system itself that decides in real-time. This project is the prototype for an environment that is slightly out of control. It is a prototype for a building, which is pro-active rather than responsive and obedient to the participant." [146]

In this regard, the NSA Muscle produces unpredictability in real time in real space. Promoting Haque's statement Kievid and Oosterhous indicates that: "[n]ow true communication is established, where the pro-active parties involved alternately sense, process and actuate in the constant loop of mutual influence."[147]

Today, architecture still finds itself in the incipient stages of developing beyond the paradigms of predictable materiality. In this context, contemporary techniques, such as ubiquitous computing and material systems, in kinetic architecture suggest systems with greater complexity and unpredictability in real time in real space. Through such techniques architecture becomes more like living organisms by means of its information processing.

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[146] Chris Kievid and Kas Oosterhuis. "Mucle NSA: A Basis for a True Paradigm Shift in Architecture," Hyperbody, 24 Dec. 2003. Web. 20 Oct. 2015. <http://www.hyperbody.nl/research/projects/muscle-nsa/>.

[147] Ibid.

# CHAPTER 4

# CONCLUSION

## 4.1. Materiality as a Fundamental Ground for Architecture

Constituting a fundamental ground for the discipline of architecture, the concept of materiality is the central consideration of this thesis. While there have been diverse approaches towards materiality in architecture, this thesis pursues a formal approach to develop a particular concern to understand the physical existence of an architectural product. As part of this formal approach, the literal and referential aspects of materiality are distinguished. While the literal aspect of materiality emphasizes the particular set of materials by which architectural production is made out of, the referential aspect of materiality focuses on the way these materials come together. Focusing on "the different instances and modes that architectural product comes into being," [148] the referential aspect establishes a more profound way of understanding architectural materiality. This way, materiality moves away from referring to a mere material condition, but rather refers to an assembly of form, structure, space and material as a whole. In this context, throughout the thesis, materiality is discussed taking the referential aspect as its basis.

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[148] Gottfried Semper. Style in the Technical and Tectonic Arts; or, Practical Aesthetics, 2004, pp. 109-113.

Operating materiality beyond the material attribute, without attempting to deny it's architectural ingenuity, the referential aspect proposes a possibility to consider materiality through a new perspective that interiorizes a wholistic approach. Such perspective leads to consider architecture as "an organizational system" and materiality as "the substance of this architectural totality." Therefore, materiality provides a fundamental ground for studying architectural organization.

### 4.2. Architecture as an Information System

> "Reality... is a perpetual becoming. It makes or remarks itself, but it is never something made." [149]

Today, the discipline of architecture reveals an epistemological shift depending on the changes in the perception of natural phenomena, which is directly bonded with the conception of matter. The static understanding of nature that once served as an absolute accuracy is replaced with a dynamic understanding in which matter is conceptualized in a continuous differentiation. Fostered by technological progresses, this shift in the conception of natural phenomena leads to a parallel shift within the discipline of architecture paving the way for acknowledging dynamic and evolving systems of organization. "Such a system is indeed increasingly specialized due to selective processing of information that continuously modifies its very own nature and accelerates its evolution."[150] Processing information through sequential processes, architecture evolves dynamically through indexing information within its organization. Therefore, architecture converges toward a unique system of organizations that receive,

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[149] Henri Bergson as referred in Sanford Kwinter. Architectures of Time: Toward a Theory of the Event in Modernist Culture, 2002, pg.3.

[150] Atlan H. as referred in Aaron Sprecher. "Architecture InFormation :On the Affluence, Influence, and Confluence of Information," 2013, pp.22-31.

organize, and distribute various streams of information. From this it follows that the aforementioned epistemological shift brings along an ontological shift in the discipline of architecture.

Such epistemological and ontological shifts have profound impacts on the conception and production of architecture. Therefore, analyzing the dissolution of organization systems of architecture into information systems, this thesis suggests the novel means of conceiving and producing architecture.

### 4.3. Categorization of Materiality as a Method of Exploration

> "If one poses the question as to what might be a comparable ground for architecture, then one must turn to a material base..." [151]

The dissolution of organization systems of architecture into information systems results in a certain degree of formal, structural, spatial and material precision. Therefore, such dissolution directly leads to question the status of materiality in architecture. Considering information as the essential dimension in architectural organization, materiality of architecture becomes associated with its ability to generate information and, to be generated by information over time. This condition constitutes the intimate relation between information and materiality revealing a synthesis between these two dimensions.

The thesis asserts that this synthesis results in diverse modes of materiality. In the most general sense, when materiality of architecture becomes informed, rather than variable architectural organizations to "present" the materiality, the materiality "performs" itself in the interactive process of transformation in architectural production. Therefore, such transitions offer the possibility to

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[151] Kenneth Frampton. "Rappel a l'Ordre: The Case for the Tectonic," 1996, pp.516-530.

define materiality over its differentiations. In order to recognize, differentiate and organize these variable models, this thesis categorize materiality by means of information flows and relative responses:

- Materiality of architecture is divided into categories of formed and informed materiality based on the ability of response.
- Informed materiality is divided into categories of dynamic and kinetic materiality based on the continuity of response.
- Dynamic materiality is divided into categories of segregated and integrated materiality based on the order of response.
- Kinetic materiality is divided into categories of predictable and unpredictable materiality based on the cycles of response.

From Greg Lynn's formal explorations, constituting segregated materiality, to Achim Menges's material systems, constituting integrated materiality, and from Chuck Hoberman's expanding structures, constituting predictable materiality, to Kas Oosterhuis's deformable bodies, constituting unpredictable materiality, this research suggests the novel means of conceiving and producing architecture that is correlated to information systems.

Right at this moment, it must be indicated that while the separation between formed and informed materiality is definite as it is demonstrated in the categorization, the further categories can be interpenetrated into each other. For instance, revealing a deforming body of material system, the Hylozoic Series of Philip Beesley constitute not only an unpredictable materiality, but also an integrated materiality. [152] In this context, the categorization obtains a non-hierarchical structure rather than a hierarchical one. However, aiming at the

[152] See, Philip Beesley. Kinetic Architectures and Geotextile Installations, Toronto: Riverside Architectural Press, 2010.

comprehension of different modes of materiality, the categorization is remained at a certain degree of maturity.

Making comprehension and evaluation possible, such categorization indicates that materiality provides a comparable ground for architecture. Throughout the thesis, this systematic categorization is considered as a method of exploration, intending to provide a ground on which comparative analysis of materiality can be conducted. Considering the increasing prevalence and competence of computational design, the discipline of architecture is reached to a critical degree of maturity. However, it is still difficult to determine to what extent architecture proceeds. Therefore, this categorization can never be accepted as complete, or rather as true/false, by remaining open to further expansions. Considering current developments and future progresses in the discipline of architecture, such categorization can be considered as a comparable ground to comprehend, or evaluate, the contemporary processes of architectural design and production; at the same time, it can be considered as a general framework to develop further.

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