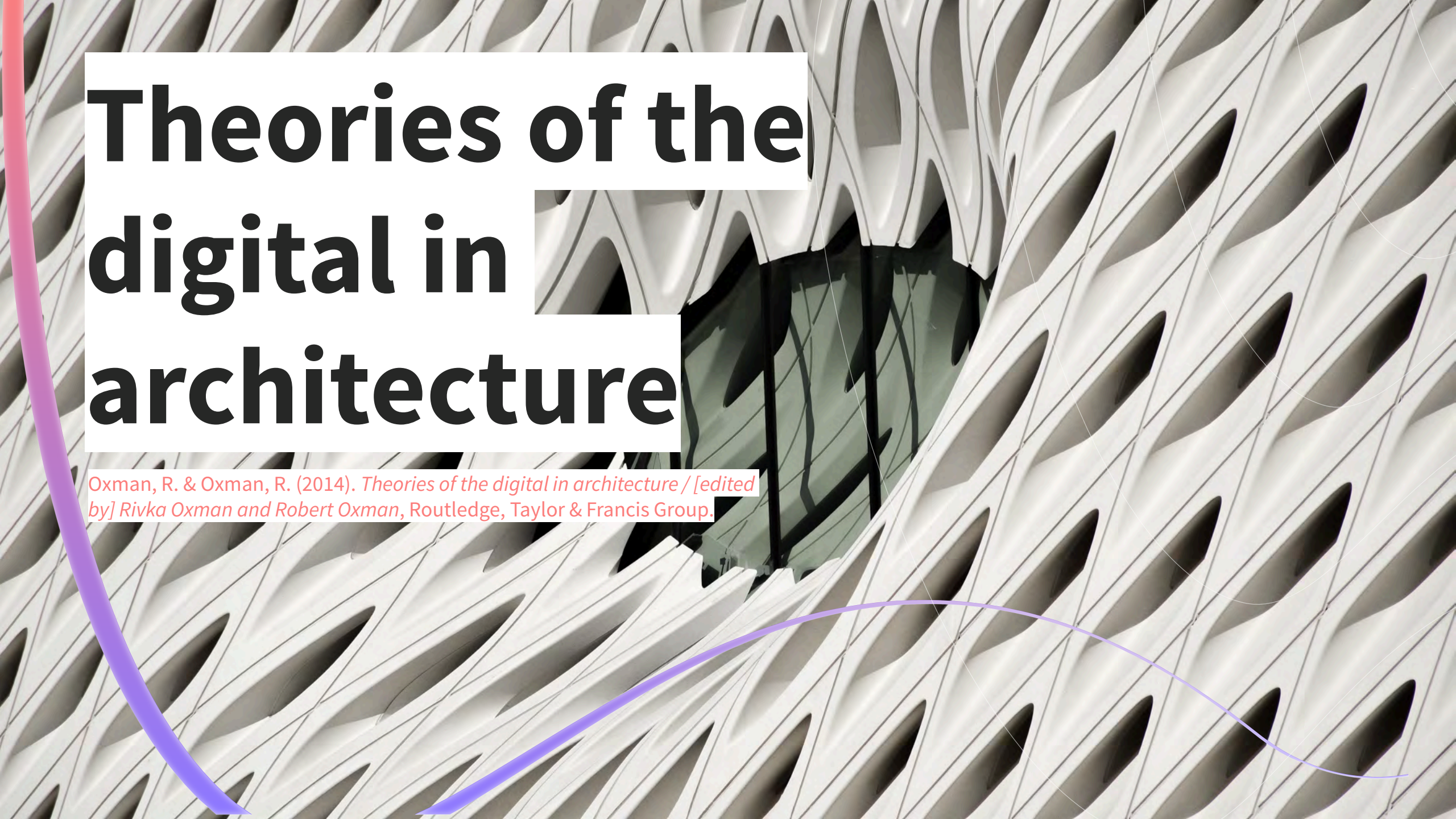
Theories of the digital in architecture



Oxman, R. & Oxman, R. (2014). *Theories of the digital in architecture / [edited by] Rivka Oxman and Robert Oxman*, Routledge, Taylor & Francis Group.

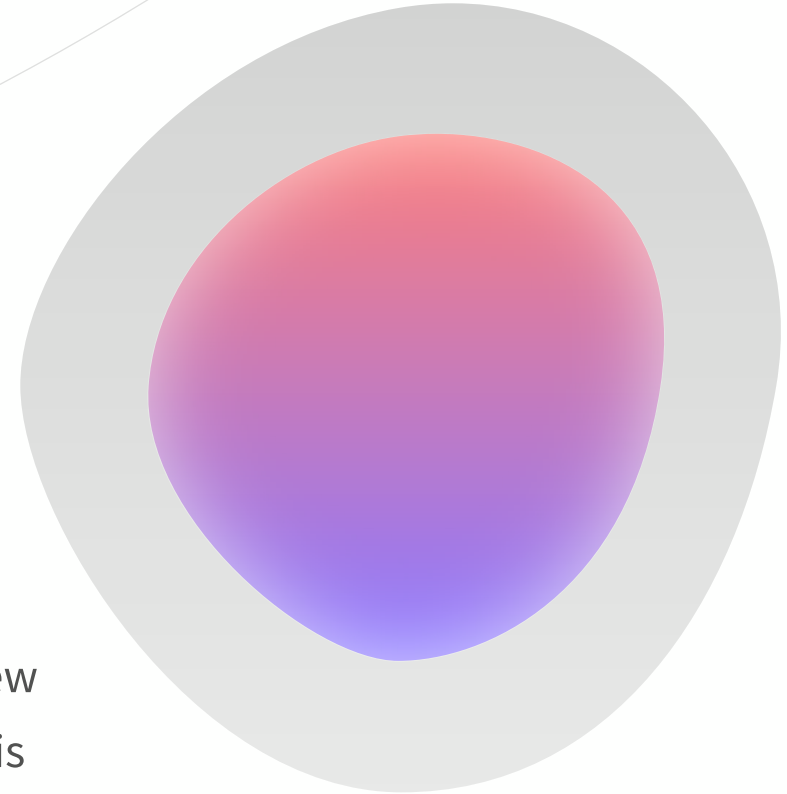
THE IMPORTANCE OF UNDERSTANDING RELATED THEORIES

To avoid using digital tools as drafting tools. Rather, **advanced holistic design thinking tools** which we have expanded from historical point of view (on week 2) and think-draw-make collaborations we discussed (on week 3).

Photo by Georgia de Lotz on Unsplash

Glossary of terminology

https://miatedjosaputro.com/2020/02/22/digital-architecture-glossary/



By now you have might be overwhelmed with new terminology. Leave comments on the page (link is mentioned above) about your unsure terminology and I will try to compile a live set of terminology for you to refer back.

Theories, concepts and models

01 ONTOLOGY

Theory

02 COMPUTATIONAL PROCESSES

Form and Generation

Performative Design

Parametrics

03 CONCEPTS AND MODELS

Morphogenesis

Tectonics

04 TECHNOLOGIES

Materialisation

Fabrication

Responsive Technology

05 EPISTEMOLOGY

Disciplinary Knowledge

DISCLAIMER

Most concepts do not fit exactly to one of the schema above. Instead, you will recognise that they interlace and are combinable. Emerging concepts are consisted of a mixture of these concepts.

01
ONTOLOGY

THEORY

There are **three paths**:

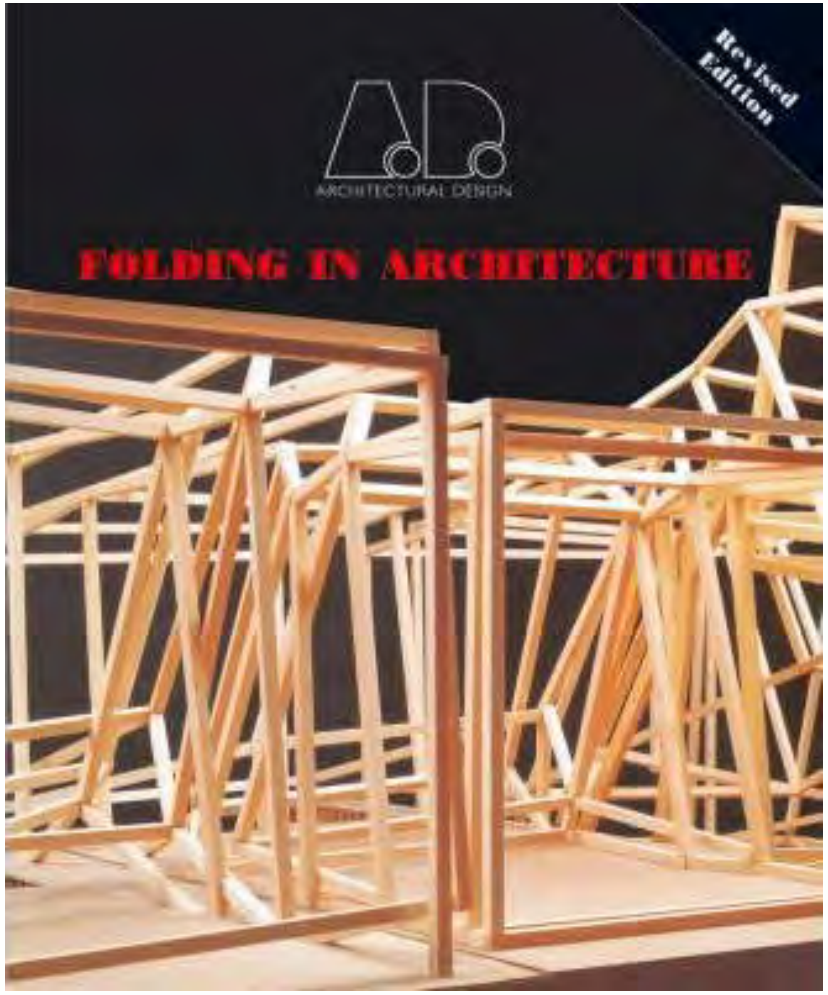
Lynn’s Folding in Architecture (1993)

Migayrou’s Non-Standard Architecture (2003)

Current theories: Picon (2010), Burry (2011) and Schumacher (2011)

Photo by Levi Midnight on Unsplash

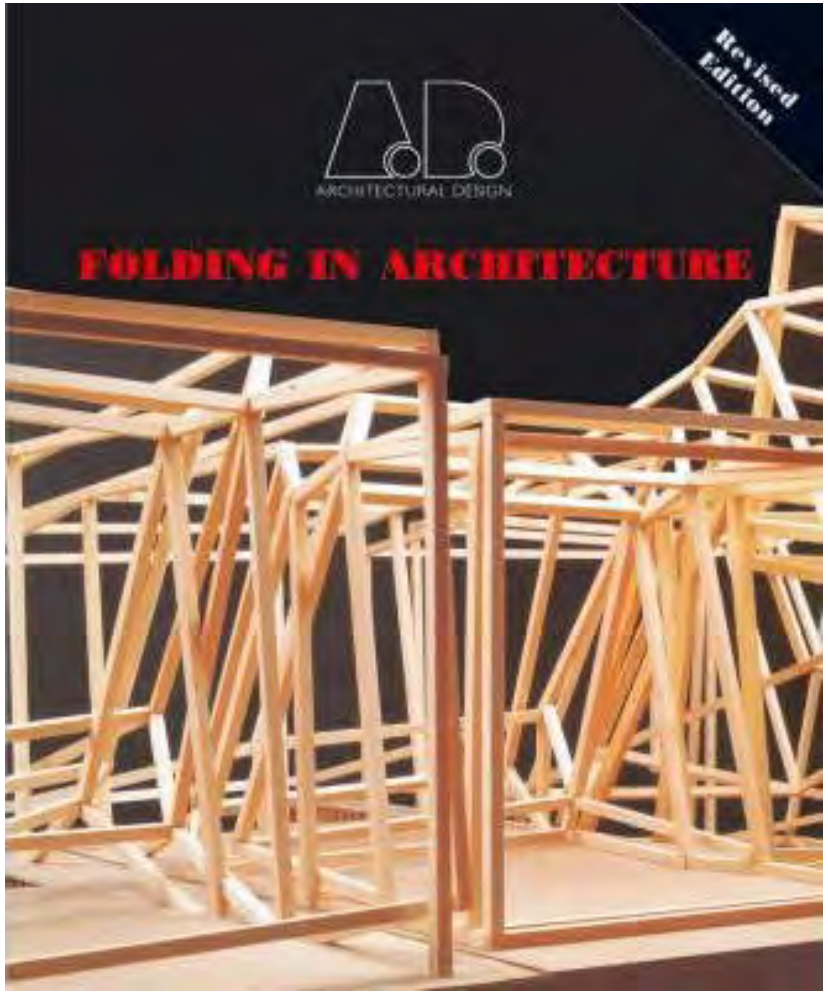
01
ONTOLOGY
THEORY



- One of the most profound architecture publication in 1990s.
- Functioned as an **antithesis of Deconstructivism.**
- Offered theoretical and operative alternative to Deconstruction.

Lynn, G. (1993). Architectural Curvilinearity, The Folded, the Pliant and the Supple. *Architectural Design*, 8-15.

01
ONTOLOGY
THEORY

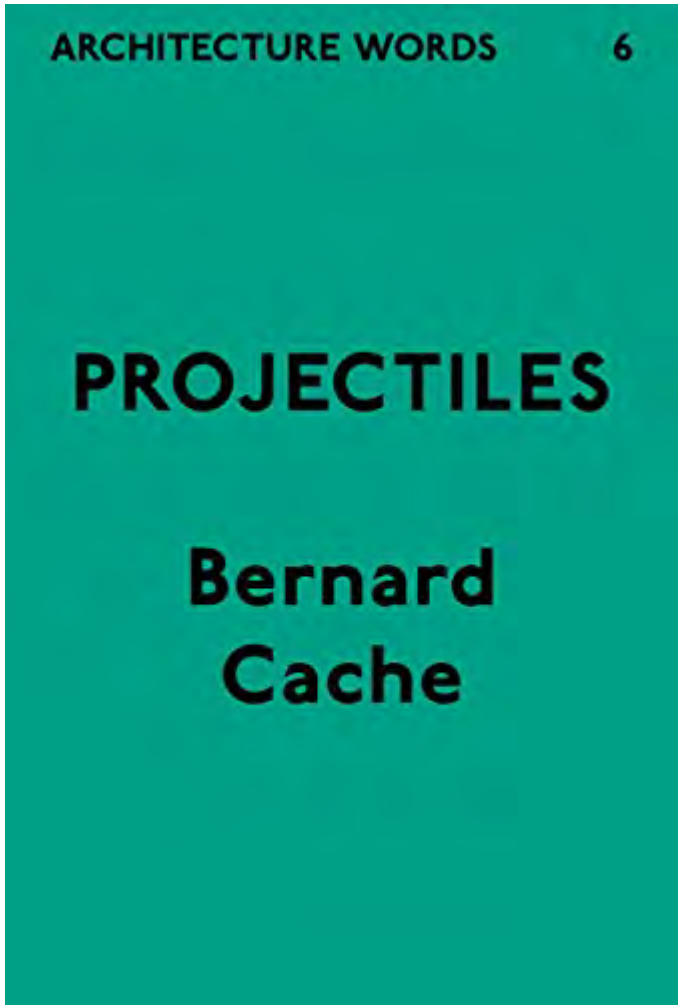


- Architecture's response to complex, disparate, differentiated and heterogeneous cultural and formal contexts were:
  1. Conflict and contradiction, or
  2. Unity and reconstruction
- Lynn suggested an alternative: **smoothness**.
- Smoothness accommodates both contradiction and unity.
- **Architectural Curvilinearity.**

Lynn, G. (1993). Architectural Curvilinearity, The Folded, the Pliant and the Supple. *Architectural Design*, 8-15.

01 ONTOLOGY

THEORY

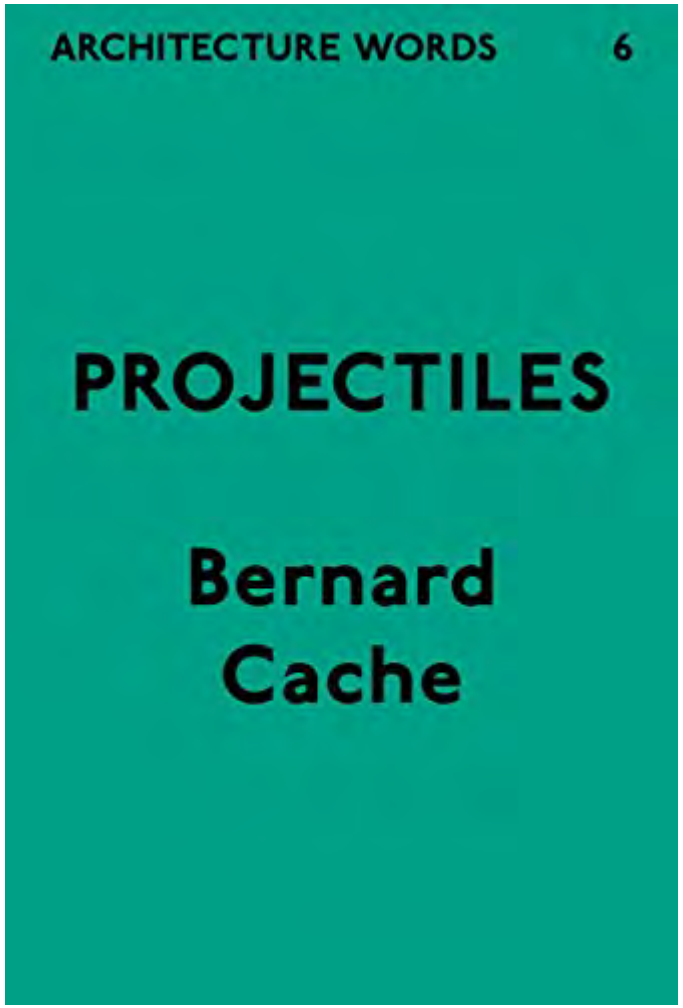


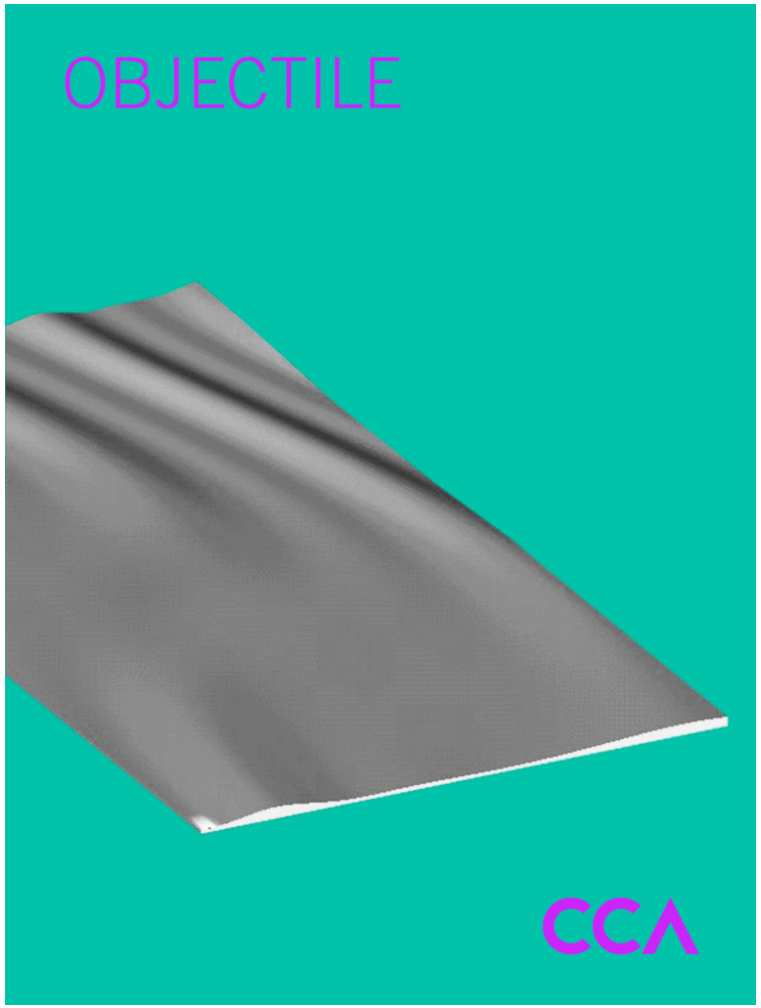
- A concept in **non-standard architecture,** is called "**Objectile**".
- Precursor research in computational architecture.
- Further developed by Gilles Deleuze in Fold (1988).
- Cache was the **first to theorise** that custom-designed and fabricated, can be future architecture.
- He predicted architecture- towards a seamless integration of concept, algorithm, software, machine language and production.

Cache, B. & Beauce, P. (2011). Towards a Non-Standard Mode of Production. *Projectiles (Architectural Words), Londres: Architectural Association*.

01 ONTOLOGY

THEORY





A new definition of object, it is a mathematical function that takes its place within a "continuum through variation"; rather than having an essential or definitive form.

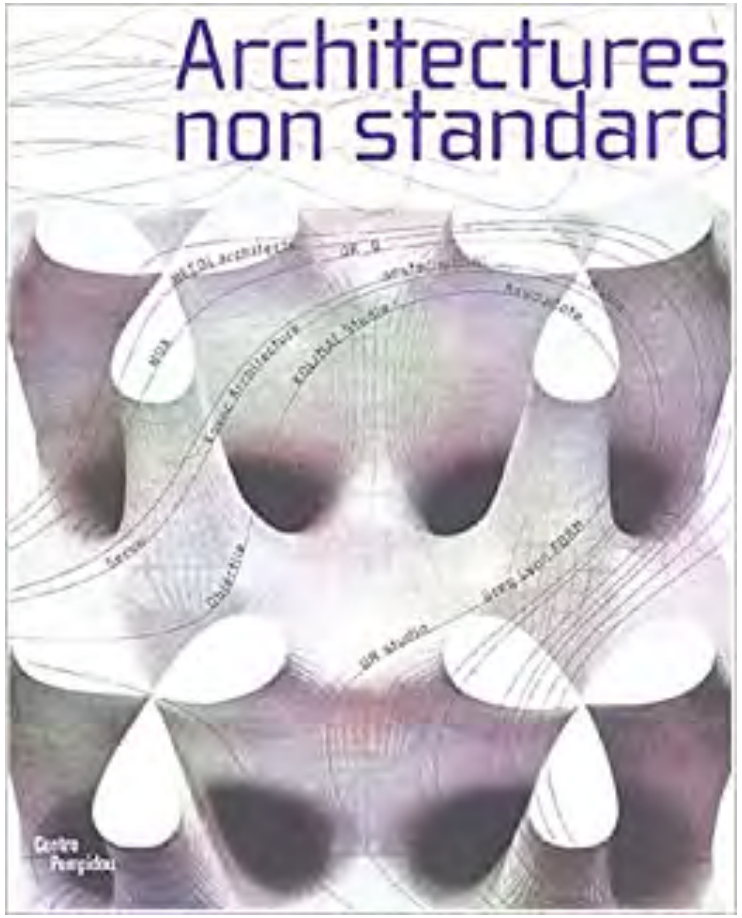
(Left)
Cache, B. & Beauce, P. (2011). Towards a Non-Standard Mode of Production. *Projectiles (Architectural Words), Londres: Architectural Association*.
(Right)
https://www.cca.qc.ca/en/events/34442/objectile

01
ONTOLOGY
THEORY

In Objectile software, forms are not drawn, but **calculated.**

www.archilab.org/public/1999/artistes/obje01en.htm

01
ONTOLOGY
THEORY



- **Non Standard Architectures exhibition** (2003-04), curated by by Frédéric Migayrou and Zeynep Mennan; at the Centre Pompidou.
- Works of **12 contemporary architects**.
- Innovative use of digital technologies.
- The exhibition tried to break boundaries of the: traditional understanding of rationalism, rationalisation, technicism and engineering.

Migayrou, F. & Mennan, Z. (2003). Non standard architectures. Editions du.

01 ONTOLOGY

THEORY

What is non-standard?

- It has meaning in two fields of knowledge:
  1. A refusal of normalisation, standardised mass production, the determining principle of Modernism
  2. In mathematics (Abraham Robinson's publication in 1961), is related to infinitesimal calculus.
- "Mutations of matter", which geometry and production begin to occur simultaneously.
- In 2011, Migayrou said ***"the architectonic takes place in the extreme tension between algebraic and the organic".***

Migayrou, F. & Mennan, Z. (2003). Non standard architectures. Editions du.
Migayrou, F. (2014). The Orders of the Non-standard: Towards a critical structuralism. *Theories of the Digital in Architecture, London, Routledge*.

01 ONTOLOGY

THEORY

Current theory: Picon (2010)

THE SEDUCTION OF INNOVATIVE GEOMETRIES

Ali Rahim and Hina Jamelle / Contemporary Architecture Practice. Residential Housing Tower, Dubai, UAE. Courtesy Ali Rahim and Hina Jamelle / Contemporary Architecture Practice, New York.

What is digital architecture? Is it legitimate to apply the term to any design made with the assistance of a computer, or should it be reserved to productions that put to real use the capacity of the machine to be more than a drawing tool? For the past ten to fifteen years, in order to distinguish the term from the rapidly increasing use of computer-aided design, digital architecture has been often characterized by an experimental dimension more pronounced than in mainstream production. As a result, there has been a tendency to confuse digital and experimental. Because of this tendency, noticeable in exhibitions like ArchiLab or the Venice Biennale, many innovative practices that undoubtedly belonged to the latter category have been deemed digital.[1] But if the term is certainly appropriate for the productions of designers like Ali Rahim, Benjamin Aranda and Christopher Lasch, who rely heavily on the computer, does it truly capture what is arresting with the projects of Preston Scott Cohen or Jesse Reiser? Is it appropriate to interpret recent features of Jacques Herzog and Pierre de Meuron's architecture, like the accent put on surface and ornament, in relation to the rise of digital culture? The vagueness of the term has been further increased by the series of offices that have pioneered the use of computer-aided design, where the senior partners have little actual familiarity with the machine. In these offices, programs are usually run by younger designers who have benefited from an early exposure to computer culture. To what extent is their production, which closely follows the intuitions and ideas of their employers, really digital? The question has been raised by the architecture of Frank Gehry. In Gehry's office, the use of Catia (Computer-Aided Three-dimensional Interactive Application) CAD software remains external to the core of a highly personal design process that relies

1 See for instance Marie-Ange Brayer, Frédéric Migayrou (eds.), ArchiLab. Orléans 1999 (Orléans: Musée d'Orléans, 1999), and more volumes of the yearly meeting in Orléans; Kurt Forster (ed.), Metamorph. 9. International Architecture Exhibition (Venice: Fondazione La Biennale di Venezia, 2004).

60

Picon, A. (2010). Digital culture in architecture. *Basel, Switzeland: Birkhauser.*

Read on Issuu:
https://issuu.com/birkhauser.ch/docs/picon

01 ONTOLOGY

THEORY

Current theory: Picon (2010)

Questioning:
What is digital architecture?
Tendency to confuse digital and experimental.
Ambiguity with the rapidly growing computer-aided design.

In a narrow sense, DG **is *production using the computer in experimental perspective.***

Result: **Alternative geometries.**
Investigation of shapes in complete contrast with limited vocabulary of modern architecture.

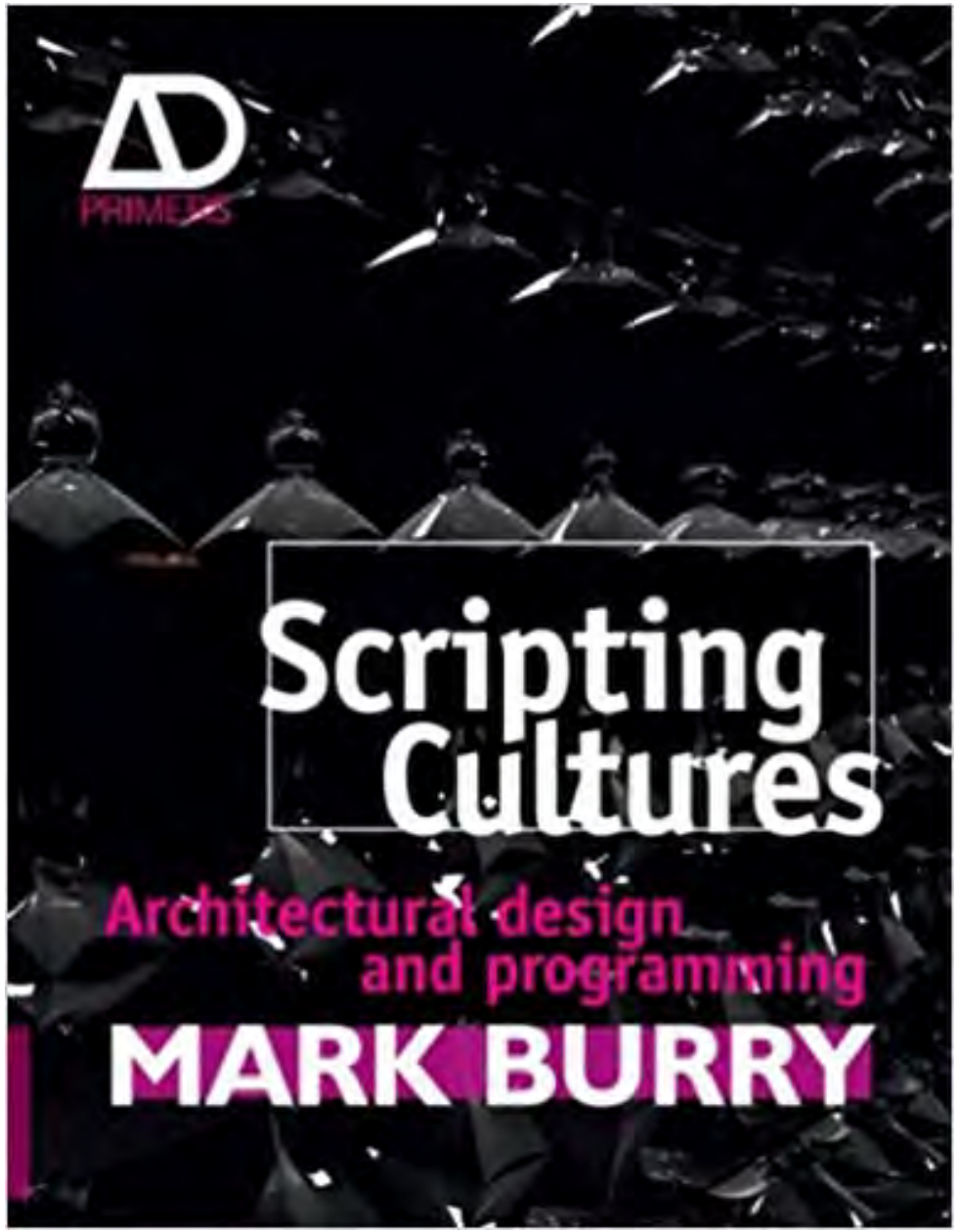
Picon, A. (2010). Digital culture in architecture. *Basel, Switzeland: Birkhauser*.

01 ONTOLOGY

THEORY

Current theory:

Burry (2011)



Burry, M. (2011). *Scripting cultures: Architectural design and programming*, John Wiley & Sons.

01 ONTOLOGY

THEORY

Current theory: Burry (2011)

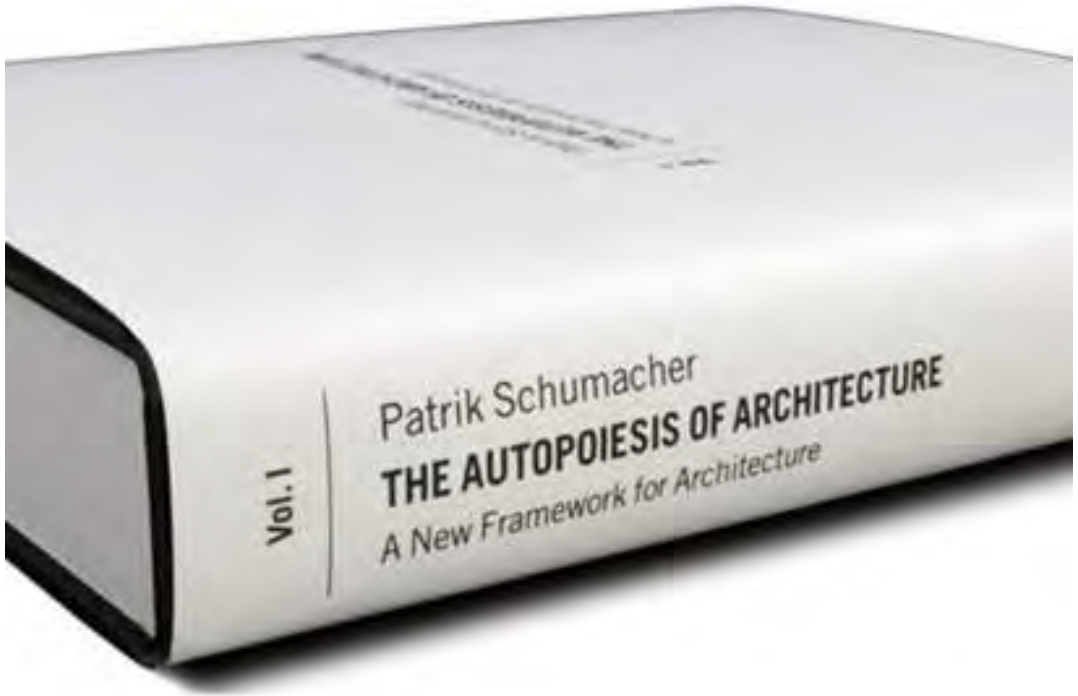
- Investigation on why designers **choose to script**
- Mark Burry argues on **two motivations: productivity** and **control**
- He discussed this through:
  1. His own work on Sagrada Familia
  2. Thought experiments
  3. Interviews of 30 experts
- He views scripting **as a conduit to enhance design process**: to iterate faster or to break free from the black-boxed drafting software.
- Scripting **as part of many cultures** of design practice.

Burry, M. (2011). *Scripting cultures: Architectural design and programming*, John Wiley & Sons.

01 ONTOLOGY

THEORY

Current theory: Schumacher (2011)



Schumacher, P. (2011). *The Autopoiesis of Architecture, Volume I: A New Framework for Architecture*, John Wiley & Sons.

01 ONTOLOGY

THEORY

Current theory: Schumacher (2011)

- *Autopoiesis* (Greek, means self-production). The concept is applied to architecture, with reference to German sociologist Niklas Luhmann (1927-1998) on “social systems theory”.
- The concept of *autopoiesis* reflects that architecture can be theorised as a distinct ***system of communications***.
- Central thesis: phenomenon in architecture is fully grasped when is analysed as **autonomous network** (autopoietic system) **of communications.**
- Communications being: drawings, texts and built works.

Schumacher, P. (2011). *The Autopoiesis of Architecture, Volume I: A New Framework for Architecture*, John Wiley & Sons.

Summary provided by Schumacher, click here

01 ONTOLOGY

THEORY

Current theory: Schumacher (2011)

Patrik Schumacher's lecture and Q&A on Autopoiesis of Architecture:
https://youtu.be/v428Hc_nd2A
https://youtu.be/h0ztygedlvI

Schumacher, P. (2011). *The Autopoiesis of Architecture, Volume I: A New Framework for Architecture*, John Wiley & Sons.
Summary provided by Schumacher, click here

02
COMPUTATIONAL PROCESSES

Three paths:

1. Form and Generation
2. Performative Design
3. Parametrics

Photo by Levi Midnight on Unsplash

02.1 FORM AND GENERATION: ARCHITECTURAL FORM

In traditional logic:
Configuration of its physical matter, apart from actual material properties (Mcleod, 2003)

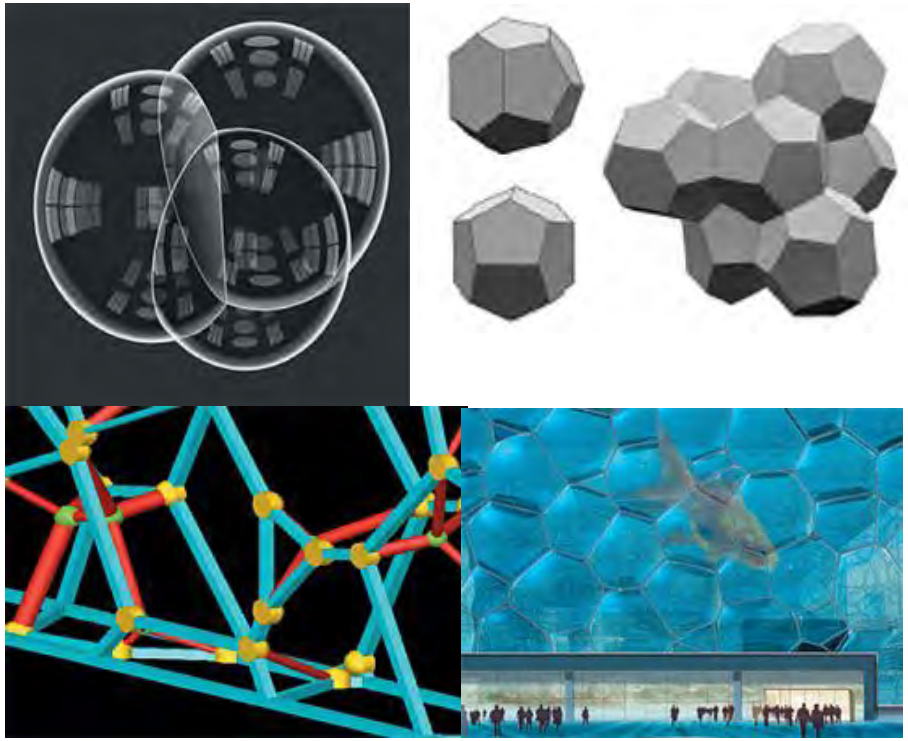
New logic:
The emphasis of procedural and generative

The shift from spatial/configurative to material/ procedural knowledge

02.1 FORM AND GENERATION: 6 MODELS OF FORM GENERATION

1. Mathematical Form Generation
2. Tectonic Form Generation
3. Material Form Generation
4. Natural or Neo-Biological Form Generation
5. Fabricational Form Generation
6. Performative Form Generation

02.1 FORM AND GENERATION: 6 MODELS OF FORM GENERATION



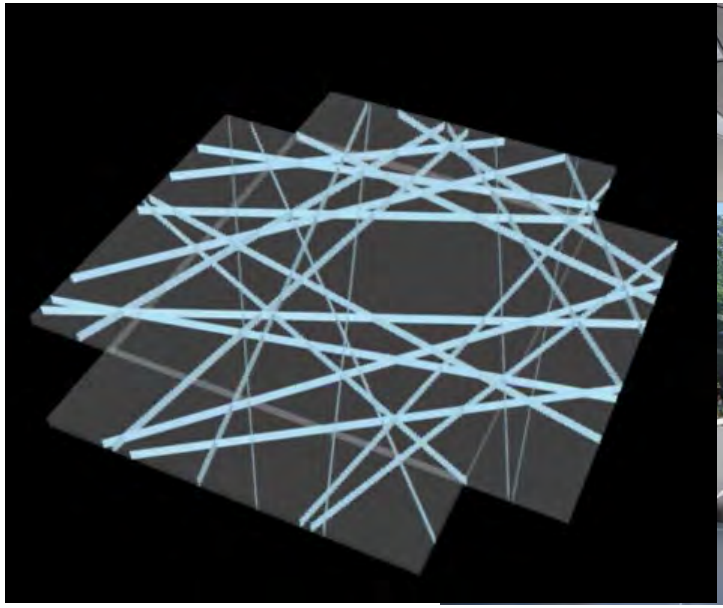
1. **Mathematical Form Generation**

: The use of mathematical formulae as the basis of generative procedures.

Example: WaterCube, Beijing.
Based on Weaire-Phelan foam geometry

https://architectureau.com/articles/practice-23/

02.1 FORM AND GENERATION: 6 MODELS OF FORM GENERATION



2. Tectonic Form Generation

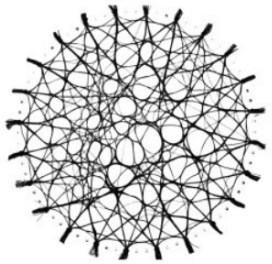
: The use of *tectonic pattern* as the basis of form generation.

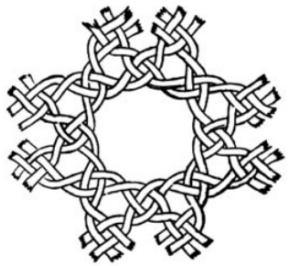
Example: 2002 Serpentine Pavilion by Toyo Ito and Cecil Balmond

https://vimeo.com/102108416
https://www.archdaily.com/344319/serpentine-gallery-pavilion-2002-toyo-ito-cecil-balmond-arup

02.1 FORM AND GENERATION: 6 MODELS OF FORM GENERATION

3. Material Form Generation





: based on three-dimensional models of material structures.

"Techniques that operate on material levels"

02.1 FORM AND GENERATION: 6 MODELS OF FORM GENERATION

Hwang, I. (2006). *Verb natures*, Actar.

4. Natural or Neo-Biological Form Generation

: exploitation of a natural form, phenomenon, process, procedure or biological principle as a basis of a model of form.

There is a developing interrelationship between the first four mentioned models.

02.1
FORM AND GENERATION: 6 MODELS OF FORM GENERATION

Contents

5. Fabricational Form Generation : the use of fabricational design logic and technique.

Iwamoto, L. (2013). *Digital fabrications: architectural and material techniques*, Princeton Architectural Press.

02.1 FORM AND GENERATION: 6 MODELS OF FORM GENERATION

6. Performative Form Generation

: ecological factors such as the physical data of the context provide input for the design process.

Computational unison of generation and analysis

02.2 PERFORMATIVE DESIGN:

From analysis to informed synthesis

Performance based design:
Analysis and understanding how environmental context may inform complex processes in design synthesis

02.2 PERFORMATIVE DESIGN:

Three concepts:

1. **Simulation**
2. **Performance evaluation parameters**
3. **Evaluative criteria**

02.2 PERFORMATIVE DESIGN:

Three concepts:

1. **Simulation**
2. **Performance evaluation parameters**
3. **Evaluative criteria**

Simulation involves: an instrumental toolset which enhances analytical procedures.

Environmental design built upon *posteriori* (backward reasoning) to suggest what building does and its effects.

02.2 PERFORMATIVE DESIGN:

Multivariate performance based design methods are complex.

Three concepts:

1. **Simulation**
2. **Performance evaluation parameters**
3. **Evaluative criteria**

Although if simulation techniques are limited to physical and environmental parameters; such as structure, climate and acoustics factors.

02.2 PERFORMATIVE DESIGN:

Three concepts:

1. **Simulation**
2. **Performance evaluation parameters**
3. **Evaluative criteria**

Evaluative criteria: how they are formulated and how they are applied in design.

Often is associated with the term **optimisation**.

02.3
PARAMETRICS

An approach to digital design founded upon: relational or associative modelling

It operates under conditions of **constraints**, to exploit parametric **modifications** as means to **generate variability** of an object (or a system) under design.

02.3 PARAMETRICS

Three important domains:

1. **Differentiation**
2. **Integrated parametric systems and informed tectonic**
3. **Continuities**

1. **Differentiation** as a medium of form generation
2. **Integration** between: tectonic design, **performative evaluations and generative procedures**
3. Information flow works **continuously** in both direction: **design to production**.

03
CONCEPTS AND MODELS

Two paths:

1. Morphogenesis
2. Tectonics

Photo by Levi Midnight on Unsplash

03.1
MORPHOGENESIS

Theoretical foundation and body of knowledge related to evolution of structure of organisms in natural phenomenon.

DIGITAL MORPHOGENESIS
Related to concepts and scientific research that have theoretical implications for form generation.

03.1
MORPHOGENESIS

BIOMIMETICS

Research and design practice of the modelling of design principles of biological organisms.
Formally emerged in 1950s, exploiting organic design as a basis of technological advancement.

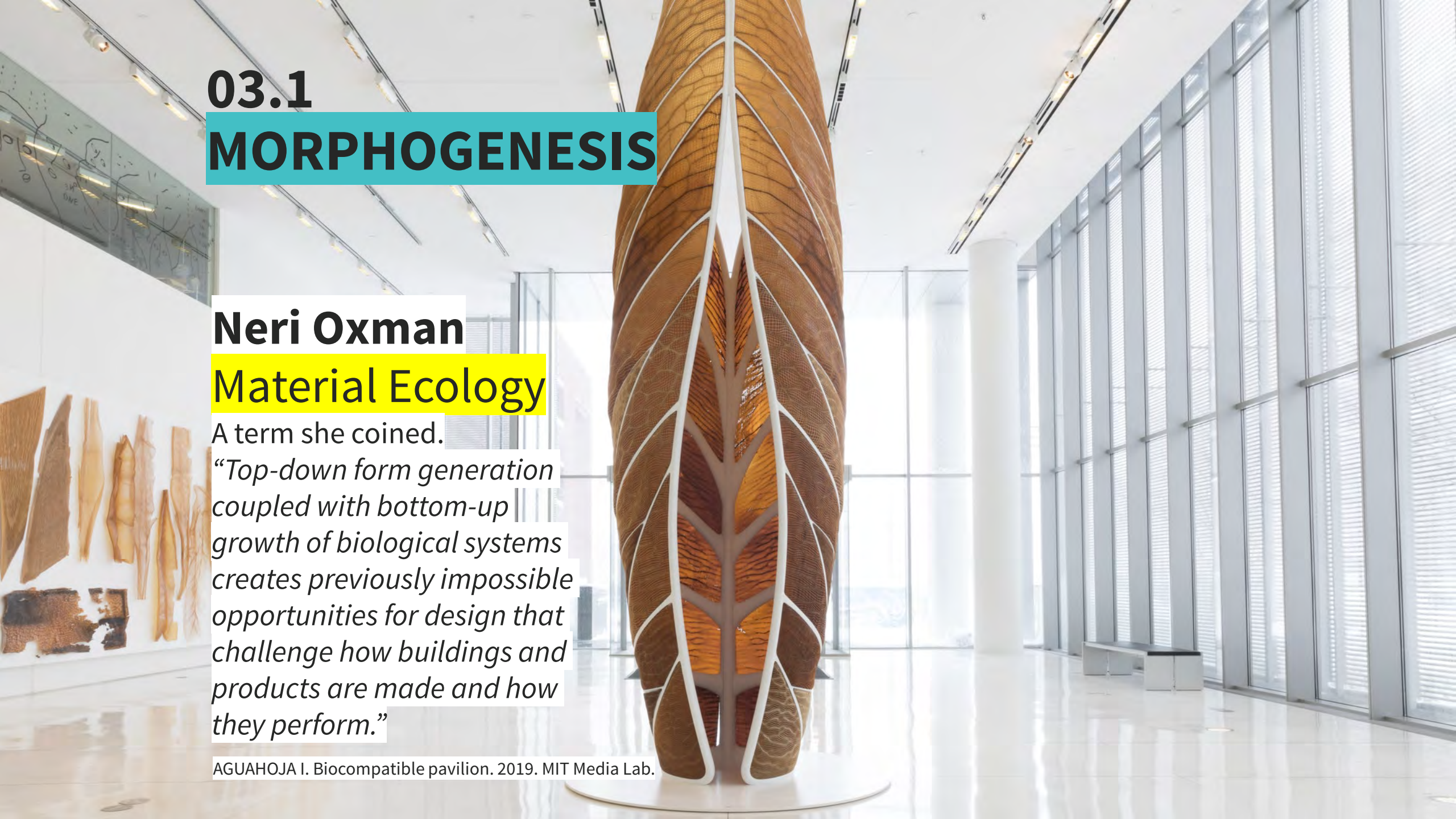
03.1 MORPHOGENESIS

Neri Oxman

Material Ecology

A term she coined.

“Top-down form generation coupled with bottom-up growth of biological systems creates previously impossible opportunities for design that challenge how buildings and products are made and how they perform.”



AGUAHOJA I. Biocompatible pavilion. 2019. MIT Media Lab.

03.2
TECTONICS

Tectonics are:
generics of a theory of structuring
Architectonics are:
generic condition of the tectonic content of architecture

Tectonics in architecture:
Between material structure and architectural form.

03.2
TECTONICS

Traditional tectonic relationship is under revolutionary transformation.

With computational processes, **relationships** between form, structure and material properties are now **capable of being explicitly informed and mediated through digital media.**

04 TECHNOLOGIES

Two domains:

1. Materialisation
2. Fabrication

Photo by Levi Midnight on Unsplash

04.1
MATERIALISATION

Previously, materialisation is: translation of an a priori design representation to its material condition

With computational processes, it became sources of the inception of design.

04.1
MATERIALISATION

Material structure:
geometric-structural field relationship of the material

04.2
FABRICATION

Fabrication, from the Latin for *making by assembly*, is a concept that has undergone an epiphany in the last decade and has rediscovered itself as **“making through computation”**

Fabrication, is generally a **computer-controlled machine fabrication processes**, consists series of technology.

04.2
FABRICATION

Fabrication design:
derivation of design formation processes through design potential of the tools

Digital materiality:
interrelationship between digital and material processes in design and construction.

04.3 RESPONSIVE TECHNOLOGY

Responsiveness: Interrelated concepts that constitute the theoretical background and technological territory of responsive system in architecture

Responsiveness is the ability of a system to **receive and react** to data input provided by the **environment.**

04.3 RESPONSIVE TECHNOLOGY

Responsiveness is the central concept of:
Responsive + interactive + dynamic

Mediated architecture:
Architecture in a symbiotic, informational relationship with both its users and its physical and cultural context

04.3 RESPONSIVE TECHNOLOGY

The Kunsthaus Graz, Austria and its media facade

https://www.arch2o.com/kunsthaus-graz-peter-cook-and-colin-fournier/

05
EPISTEMOLOGY

Epistemology is a branch of philosophy concerning theory of knowledge. Previous generation sought for epistemological foundations of architecture as a discipline in formal language and history. With the aid of emerging technologies, design thinking has also been transformed.

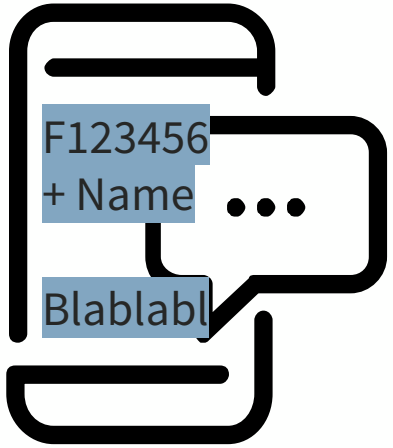
Photo by Levi Midnight on Unsplash

05
EPISTEMOLOGY
DISCIPLINARY
KNOWLEDGE

Transformation of toolset has led to:
New logic in design thinking
New research-oriented processes of design

***Design as research* view (in the context of digital in architecture) enables us to view design as a medium of knowledge production.**

Discussion



Make a short summary (min 200 words) of one chosen topic:

1. *One biomimetic principle to be translated to your hypothetical design. For example: Mimosa Pudica, the sensitive plant*
2. *Find a case study of mathematically generated form and provide summary*

https://miatedjosaputro.com/2020/03/17/week-4-discussion/

Re-iterating aims and objectives

- To infer what students have learnt during the first three weeks
- To exhibit reflective practice mid acquiring knowledge
- To elicit current understanding based on the forum posts
- To relate the current understanding with relevant theories, concepts and models.