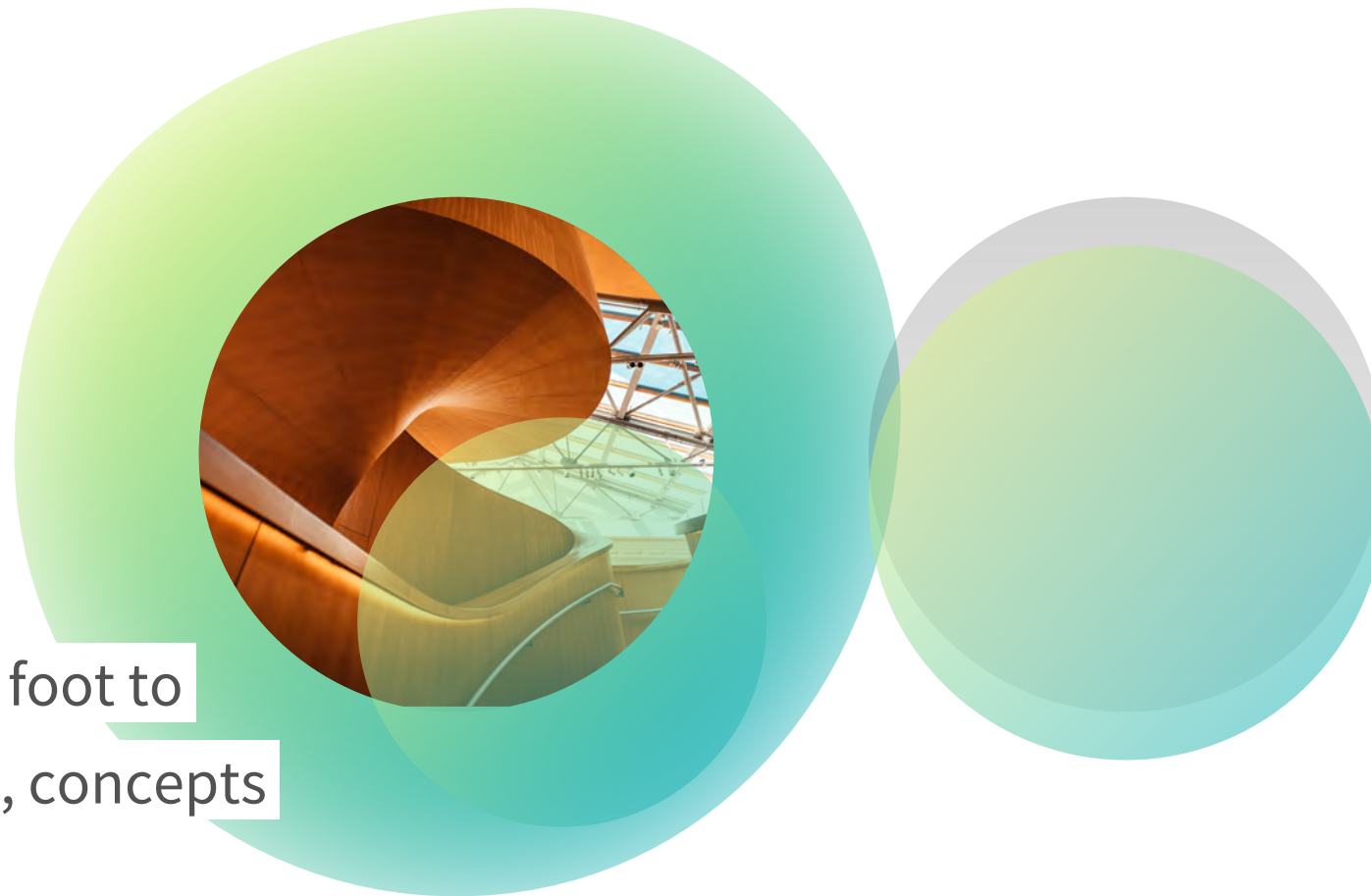


Week 4

Theory, concepts and models



This week we set foot to
relevant theories, concepts
and models.



Outline

01

Establishing current understanding

Based on the submitted week-to-week reflections

02

Theories, concepts and models

Oxman and Oxman (2014)

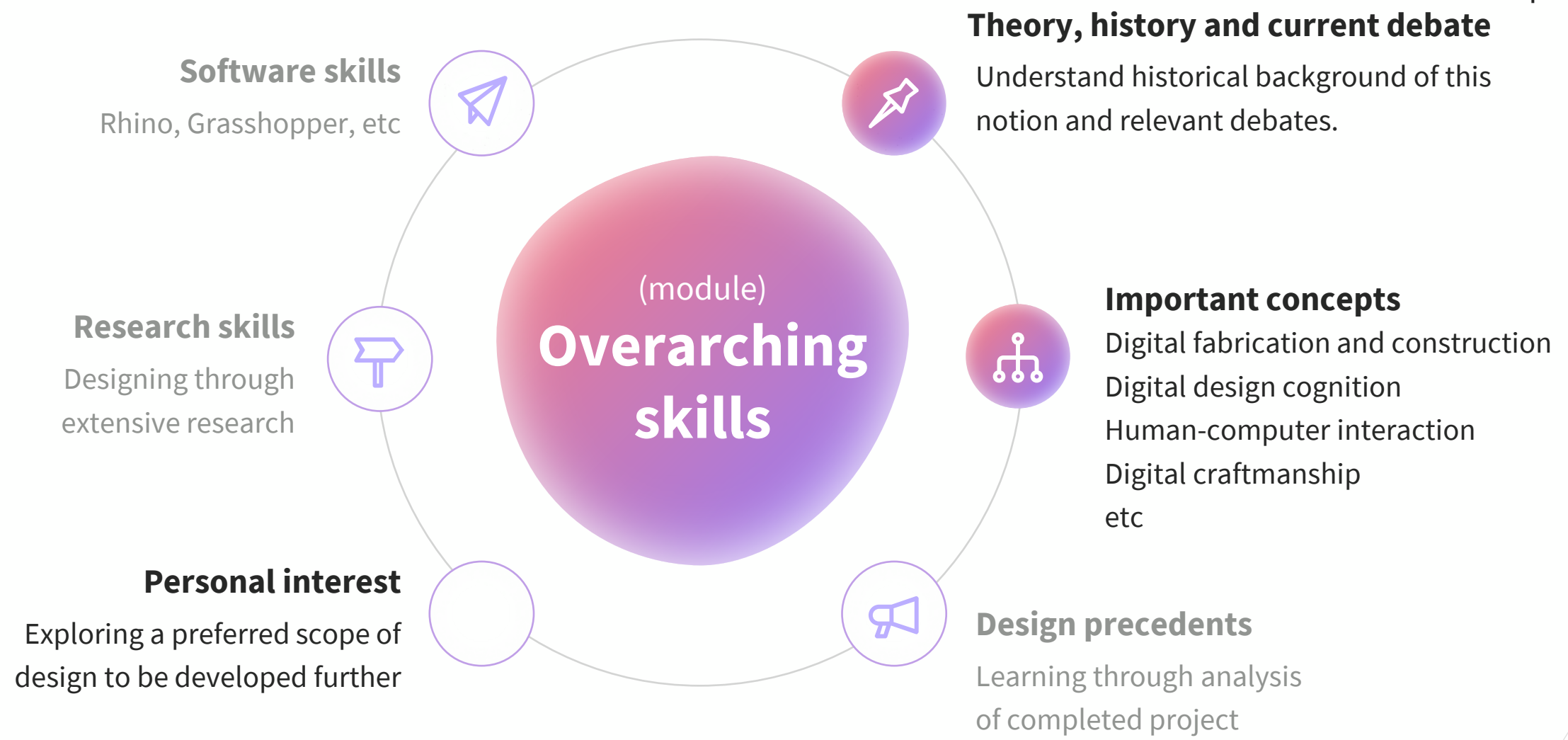
Aims and objectives

- To **relate** the current understanding with relevant theories, concepts and models.
- To build **related vocabulary** in digital architecture
- To instigate **personal interests** within the field

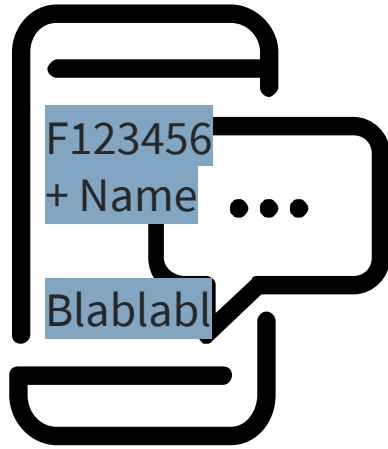
Learning outcomes

Students will be able to..

- 01** Describe their **current understanding** in relation to digital architecture.
—
- 02** Enumerate important **theories, concepts and models**.
—
- 03** Formulate **understanding** of the theories, concepts and models.



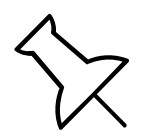
Discussion



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

One **biomimetic principle** to be translated to your hypothetical design and elaborate on that. For example: *Mimosa Pudica*, the sensitive plant.

Note: Keep it short and concise



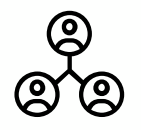
WEEK 1

IMPORTANT NOTIONS TO VIEW THE FIELD



WEEK 2

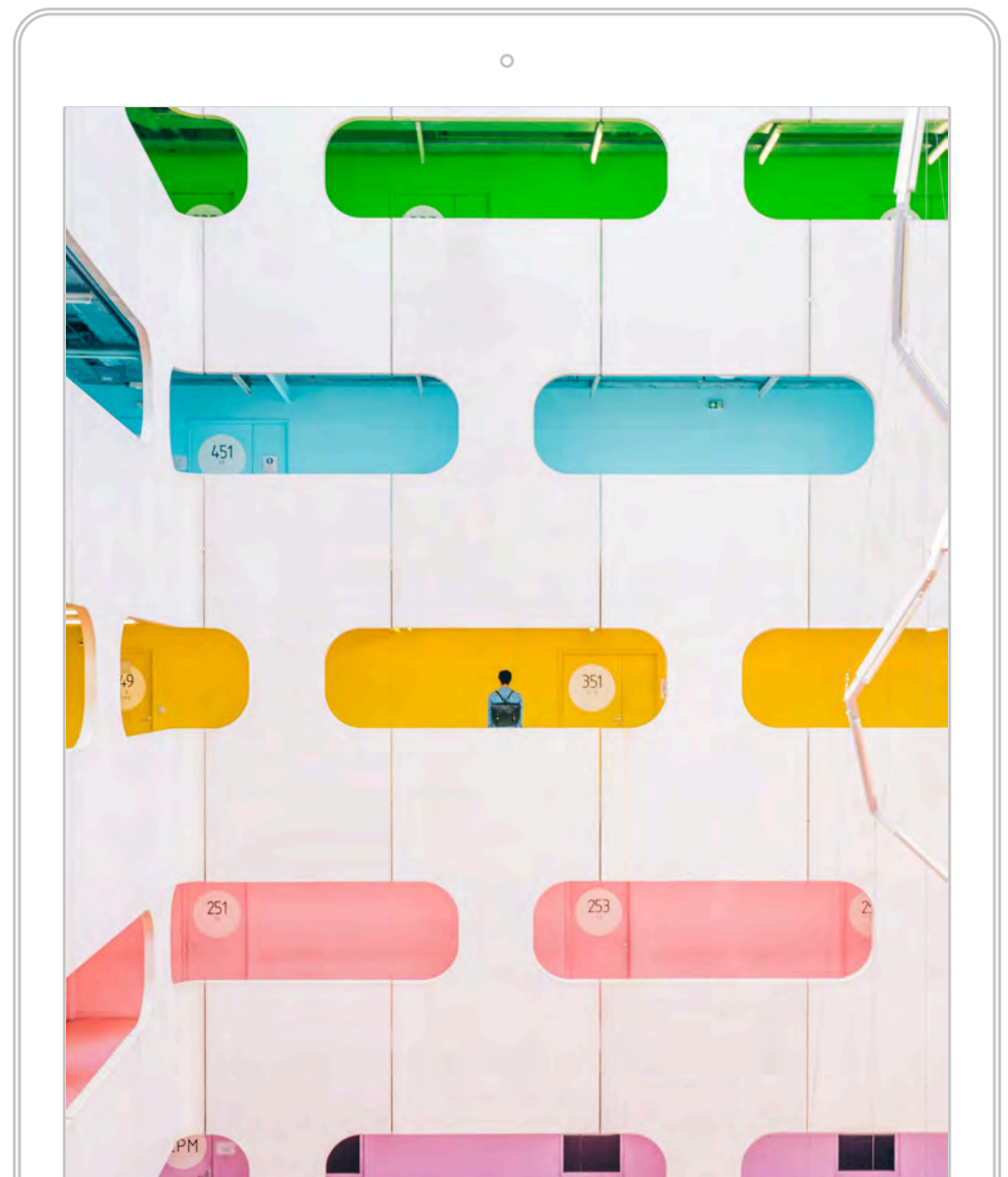
HISTORICAL BACKGROUND



WEEK 3

ACADEMIA AND INDUSTRY DIALOGUE

Photo by Victor Lam on Unsplash





**What kind of
understanding have
we established?**

**With regards to digital
architecture**

The understanding

Think-draw-make

Changes on the way architects think-draw-make in computational design have presented benefits to design stake holders (clients, collaborators and public) and improve quality of built environment. Architecture practices are also shifted.

New possibilities

Creativity is pushed further with the help of computational design tools, which addressed critiques that they hinder creativity. Strategies to address environmental issues are also in the main agenda of this emergent way of designing.

Digital design pedagogy

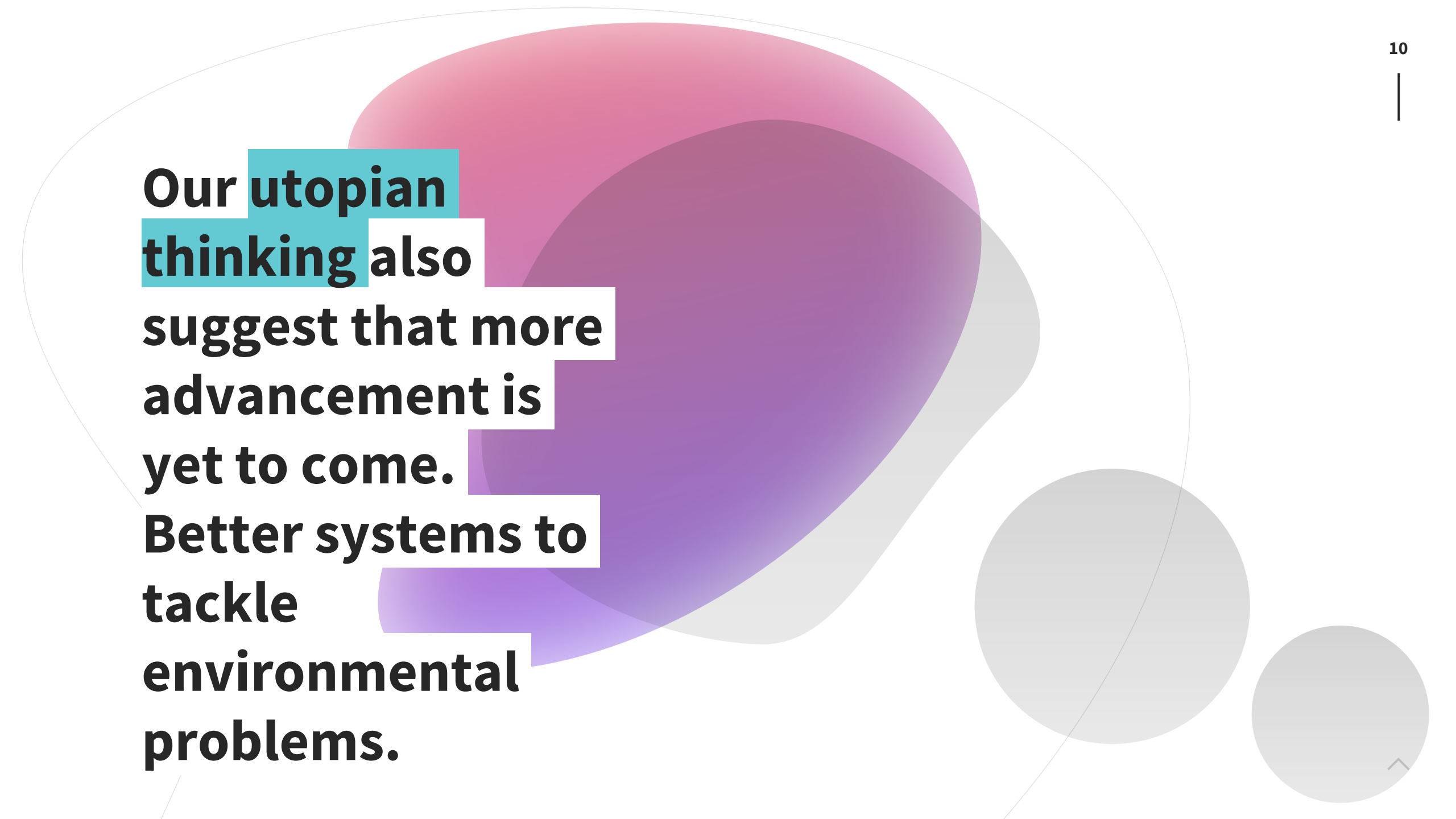
Comprehensive understanding of digital design as learners develop digital literacy is important. In their five years of digital studio reflection, Ikeda et al. (2016) posit five factors design skills can be exercised.

Ikeda, Y., Toyoda, K. & Takenaka, T. (2016). *The Pedagogical Meanings of an Experimental Full-Size Mock-Up of Computational Design*.

Digital design ecosystem

Design process is moving away from being linear and architects are at the centre of this ecosystem. Collaboration with specialists in industry, academia, local craftsman and end users provide more meaningful design.





**Our utopian
thinking also
suggest that more
advancement is
yet to come.
Better systems to
tackle
environmental
problems.**

We have seen..

01

How the area of computational design can be viewed using theoretical lenses

02

Historically how prominent architects harnessed technology

03

The pertinent needs to collaborate

04

And.. Built our common understanding about the field



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).

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)

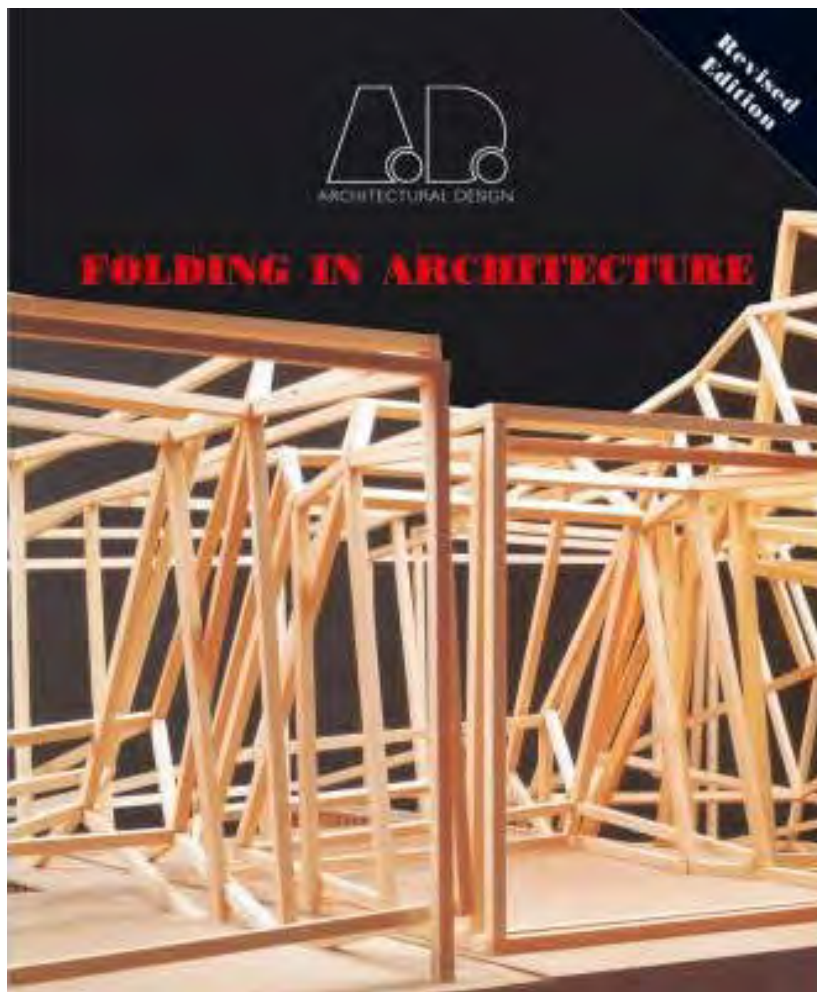
Current theories: Picon (2010), Burry (2011) and Schumacher (2011)

Photo by Levi Midnight on Unsplash

01

ONTOLOGY

THEORY



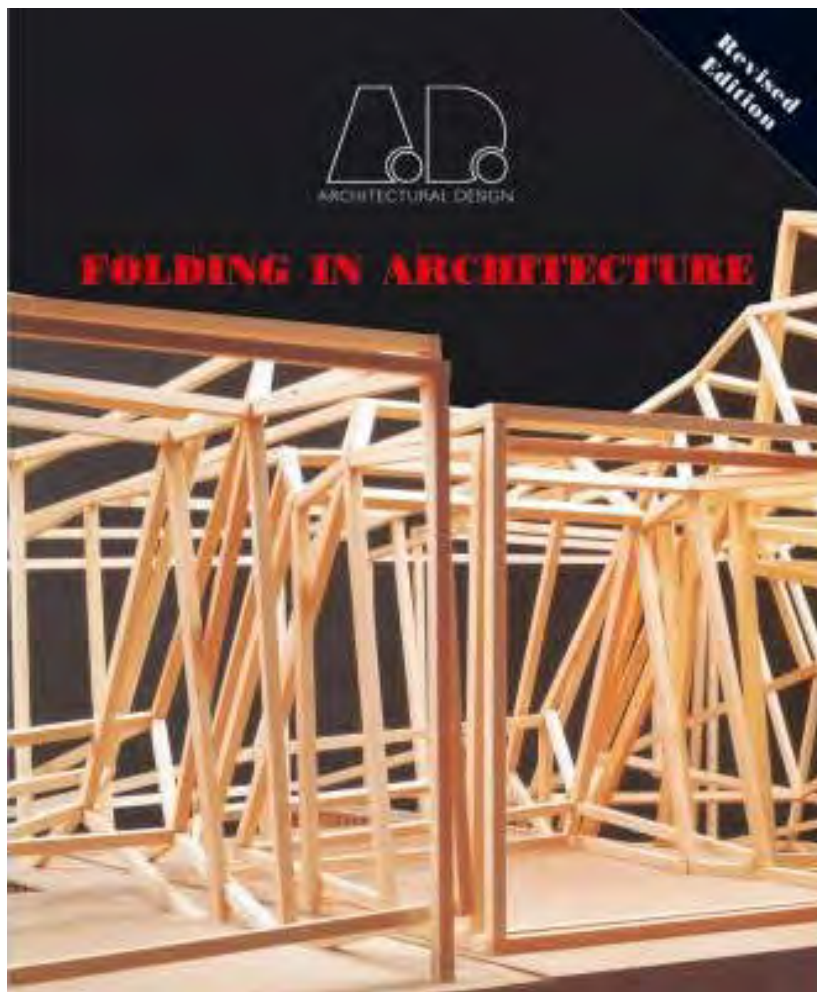
- One of the most profound architecture publication in 1990s.
- Functioned as an **antithesis of Deconstructivism.**
- Offered theoretical and operative alternative to Deconstruction.

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

ARCHITECTURE WORDS

6

PROJECTILES

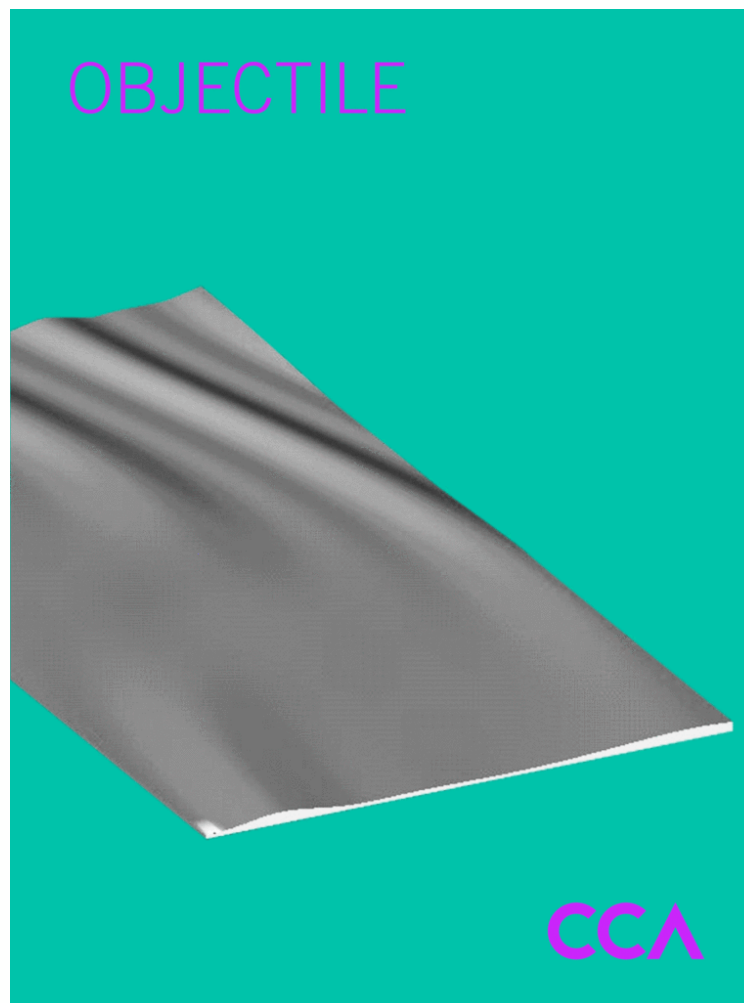
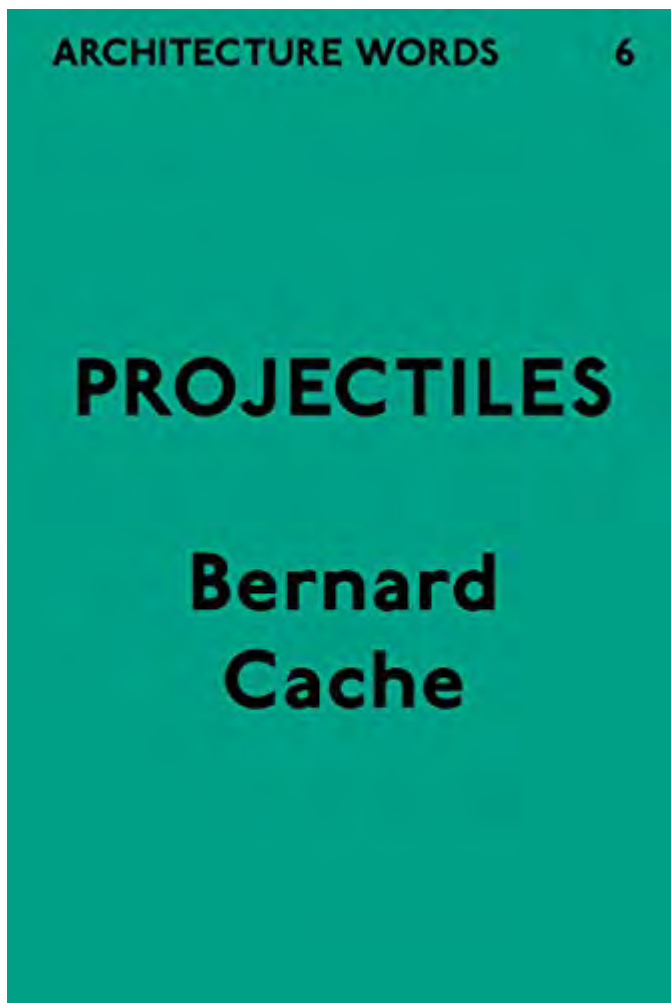
**Bernard
Cache**

- 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.**

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**.

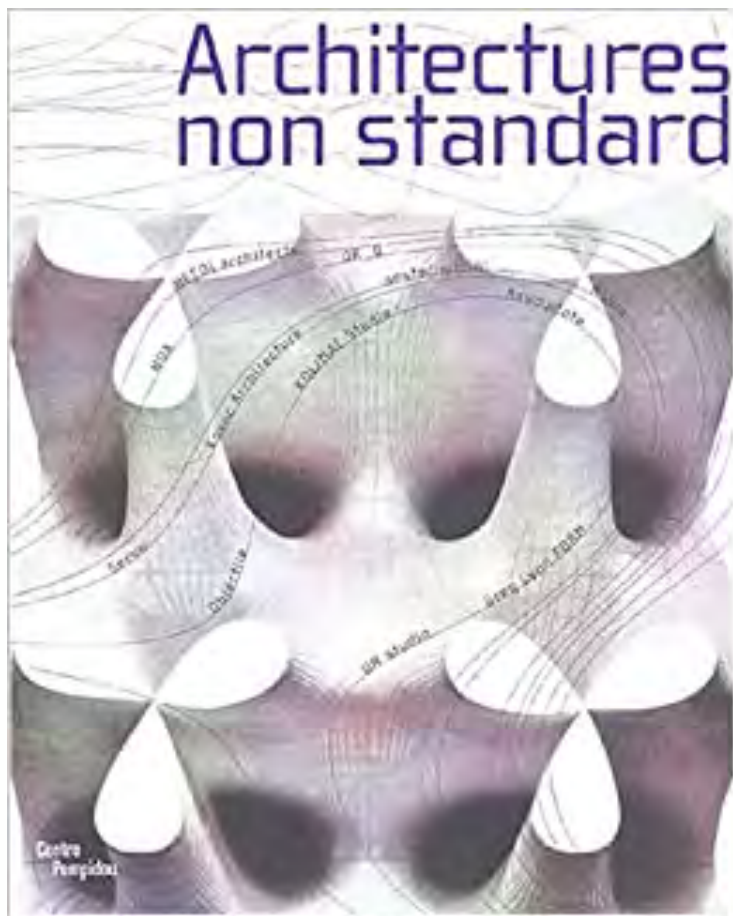
www.archilab.org/public/1999/artistes/obje01en.htm



01

ONTOLOGY

THEORY



- **Non Standard Architectures exhibition** (2003-04), curated by 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.





<http://www.flickr.com/photos/roryrory/>



01

ONTOLOGY

THEORY

What is non- standard?

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.

- 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”**. ^

01

ONTOLOGY

THEORY

Current
theory:

Picon (2010)

THE SEDUCTION
OF INNOVATIVE GEOMETRIES

Ali Rahim and Eliot
Jamele /
Contemporary
Architecture
Practice,
Residential Housing
Tower Dubai, UAE
Courtesy Ali Rahim
and Eliot Jamele /
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 Beyer, *Public-Magnum (mk)*, ArchiLab, Geneva 1997 (Oxford: Matrix/Oxford, 1999), and more volumes of the yearly meeting in Oxford: Kurt Fossé (ed.), *Metamorphosis*, International Architecture Exhibition (Venice: Fondazione La Biennale di Venezia, 2004).

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

Read on Issuu:

<https://issuu.com/birkhauser.ch/docs/picon>



01

ONTOLOGY

THEORY

Current
theory:

Picon (2010)

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

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.

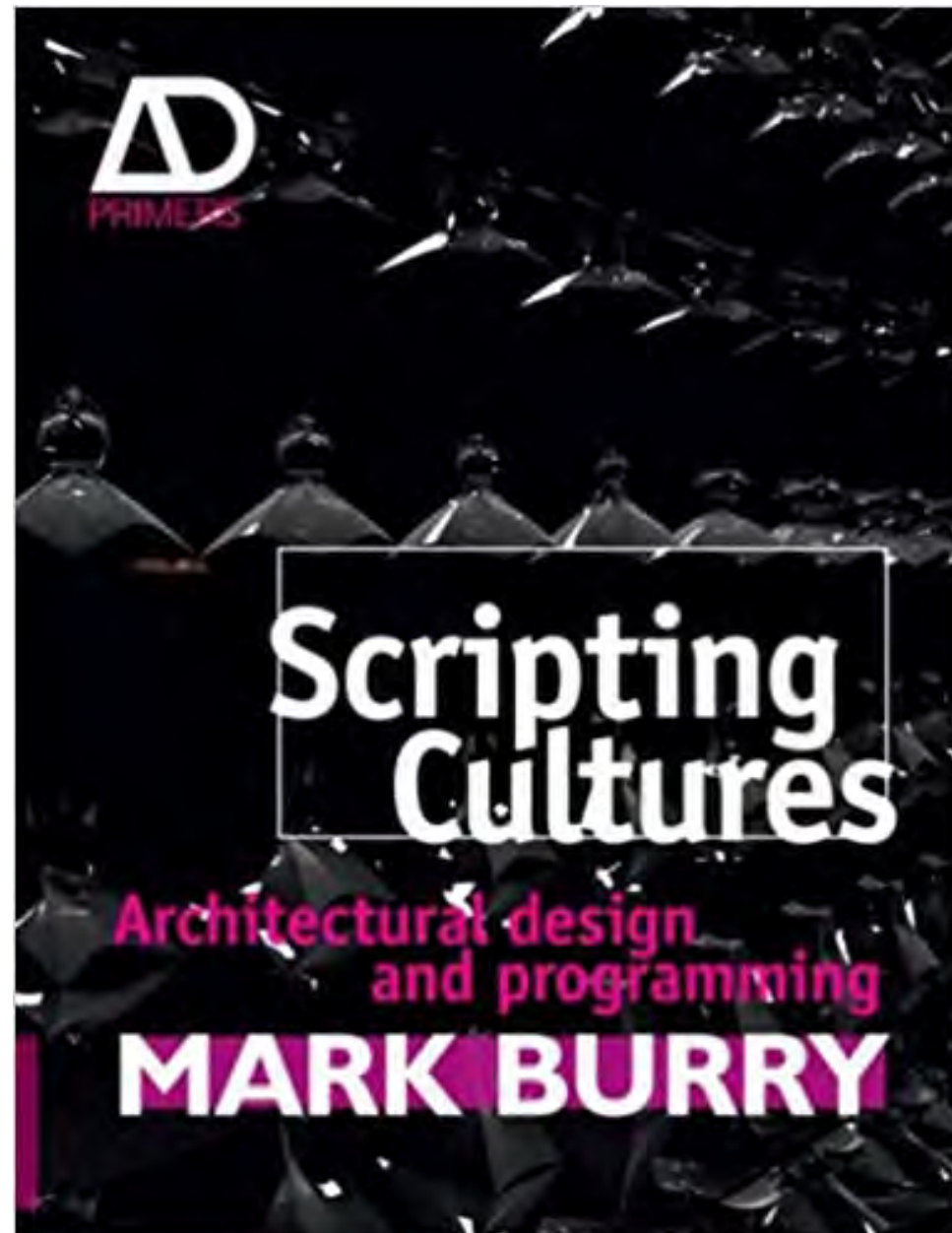
01

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)

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

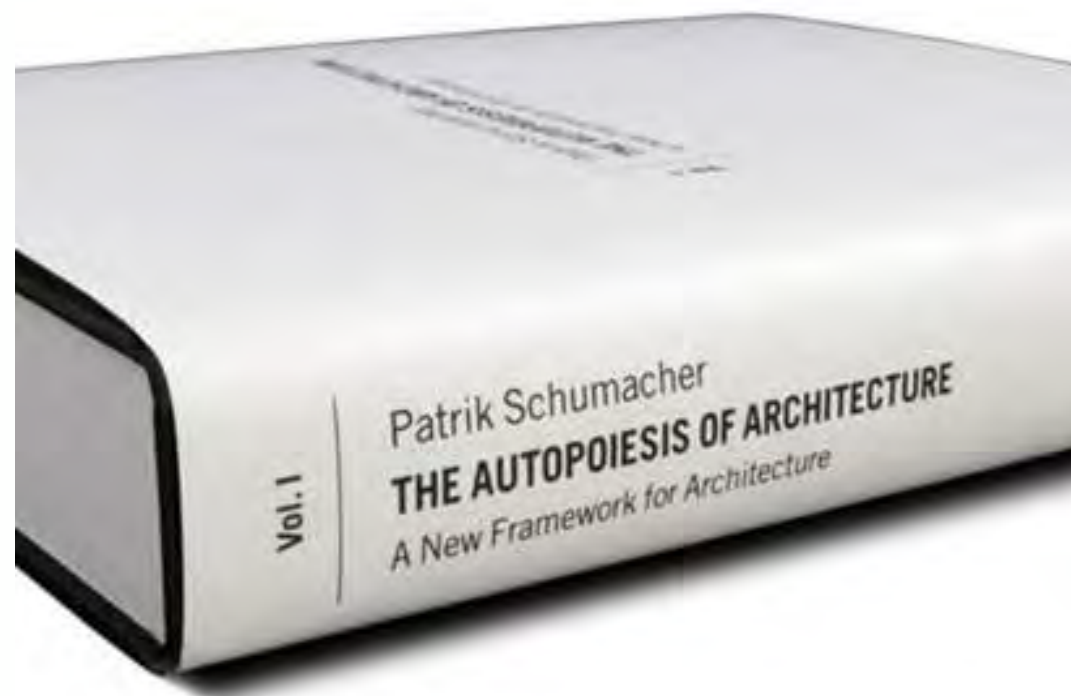
- Investigation on why designers **choose to script**
- Mark Burry argues on **two motivations: productivity** and **control**
- He discussed this through:
 1. His own work on Sagrada Familia
 2. Thought experiments
 3. Interviews of 30 experts
- He views scripting **as a conduit to enhance design process**: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



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)

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

Summary provided by Schumacher, [click here](#)

- *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.

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

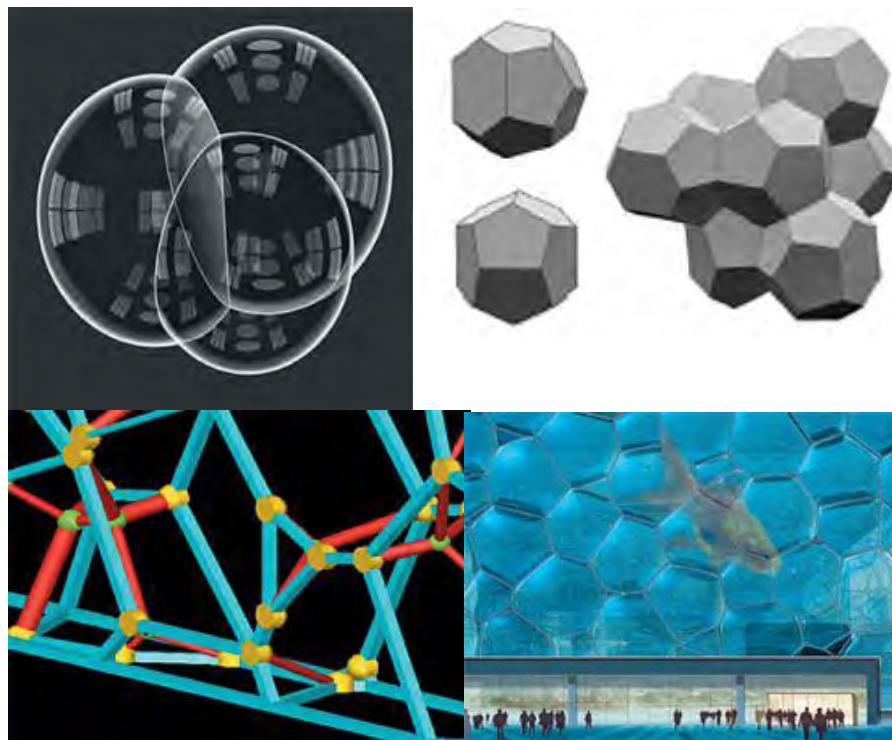
FORM AND GENERATION: 6 MODELS OF FORM GENERATION

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.

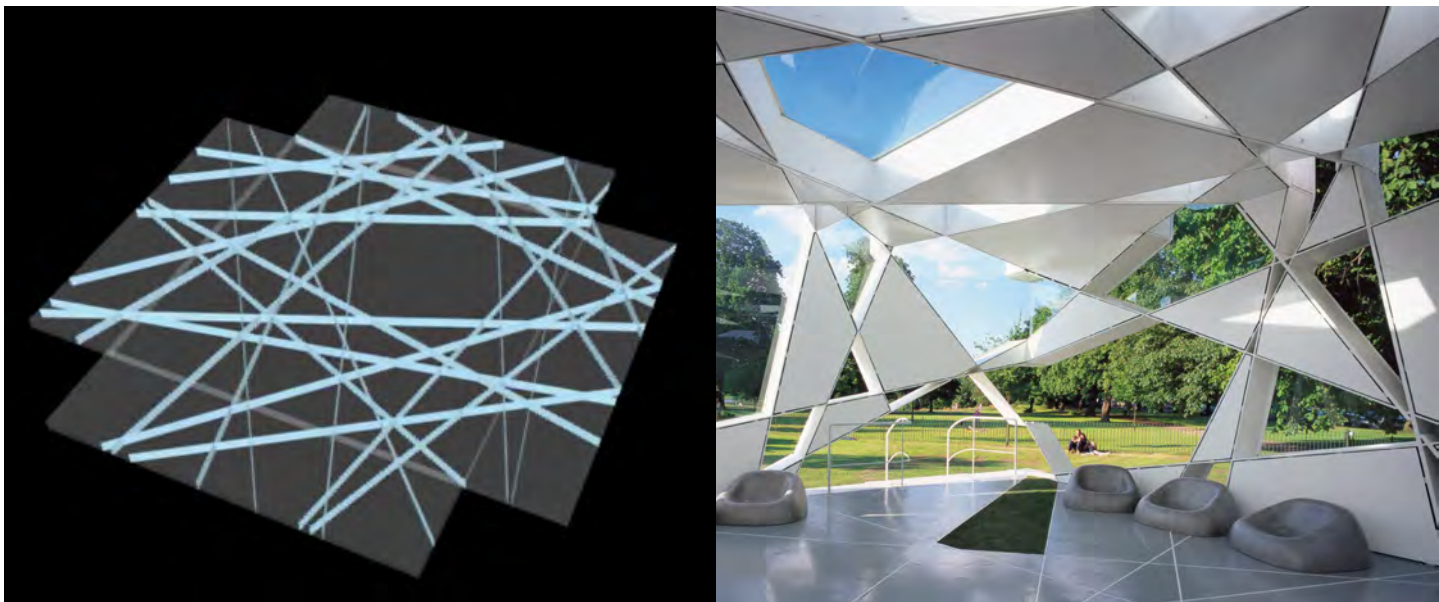
Example: WaterCube, Beijing.
Based on Weaire-Phelan foam geometry

<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>

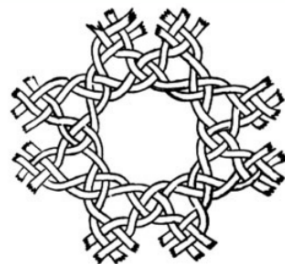
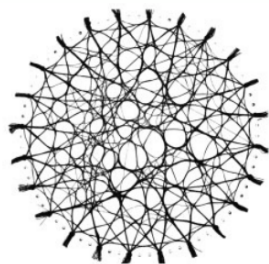
<https://www.archdaily.com/344319/serpentine-gallery-pavilion-2002-toyo-ito-cecil-balmond-arup>



02.1

FORM AND GENERATION: 6 MODELS OF FORM GENERATION

3. Material Form Generation



Textile Tectonics

An Interview with Lars Spuybroek

'Architectural design is not about having ideas, but about having techniques, techniques that operate on a material level. It's about making matter think and live by itself.' Here Lars Spuybroek of NOX talks to Maria Ludovica Tramontin about his engagement with the work of Gottfried Semper and Frei Otto and how it has led him to his own brand of textile tectonics or 'soft constructivism', in which textiles are transformed into the tectonic through conventional textile techniques – weaving, bundling, interlacing, braiding, knitting or knotting – effectively building structure through softness and flexibility.



: based on three-dimensional models of material structures.

“Techniques that operate on material levels”

02.1

FORM AND GENERATION: 6 MODELS OF FORM GENERATION

4. Natural or Neo-Biological Form Generation



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

: 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

5. Fabricational Form Generation

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

004	Introduction
008	Sectioning
017	<i>Digital Weave</i> , University of California, Berkeley/Lisa Iwamoto
022	<i>Mafoombey</i> , Martti Kalliala, Esa Ruskeepää, with Martin Lukasczyk
026	<i>(Ply)Wood Delaminations</i> , Georgia Institute of Technology/Monica Ponce de Leon
028	<i>A Change of State</i> , Georgia Institute of Technology/Nader Tehrani
030	<i>[c]space</i> , Alan Dempsey and Alvin Huang
032	<i>BURST*.003</i> , SYSTEMarchitects
034	Tessellating
042	<i>West Coast Pavilion</i> , Atelier Manferdini
046	<i>Huyghe + Le Corbusier Puppet Theater</i> , MOS
050	<i>Helios House</i> , Office dA and Johnston Marklee & Associates
052	<i>California: Stage Set for John Jasperse</i> , AEDS/Ammar Eloueini
054	<i>Airspace Tokyo</i> , Thom Faulders Architecture
056	<i>Technicolor Bloom</i> , Brennan Buck
060	Folding
069	<i>Dragonfly</i> , Tom Wiscombe/EMERGENT
074	<i>Nubik</i> , AEDS/Ammar Eloueini
076	<i>In-Out Curtain</i> , IwamotoScott
078	<i>Entry Paradise Pavilion</i> , Chris Bosse/PTW Architects
080	<i>Aoba-tei</i> , Atelier Hitoshi Abe
082	<i>Digital Origami</i> , University of Technology, Sydney/Chris Bosse
084	<i>C_Wall</i> , Andrew Kudless/Matsys
086	<i>Manifold</i> , Andrew Kudless/Mateve
088	<i>2 panels</i> , Jeremy Ficca
090	<i>r with Peephole</i> , WILLIAMSONWILLIAMSON
092	<i>lient Scale</i> , SPAN
094	<i>Hide</i> , Ruy Klein
106	Forming
113	<i>Alice</i> , Florencia Pita mod
118	<i>Prototype Pavilion</i> , MOS
122	<i>UniBodies</i> , PATTERNS, with Kreysler & Associates
124	<i>NGTV</i> , GNUFORM
126	"Dark Places," servo
130	"Housing in Vienna," SPAN
132	<i>Satin Sheet</i> , University of California, Los Angeles/Heather Roberge
135	<i>Shiatsu</i> , University of California, Los Angeles/Heather Roberge
138	<i>P_Wall</i> , Andrew Kudless/Matsys
140	Notes
141	Project Credits

: the use of fabricational design logic and technique.

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.

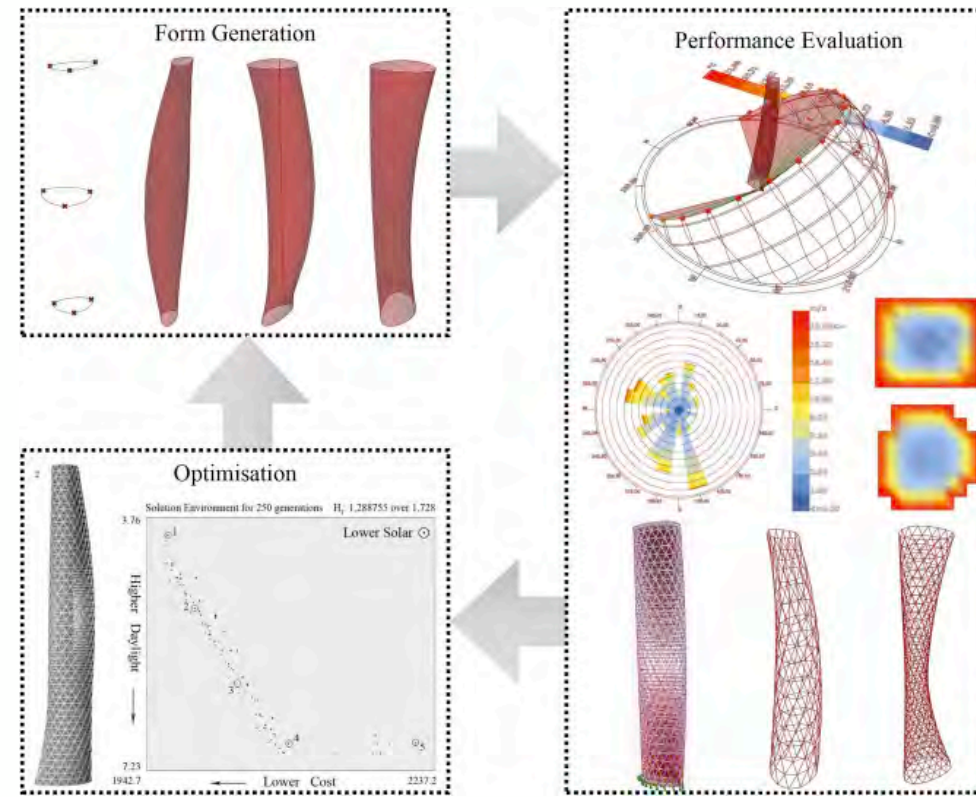
Computational unison of generation and analysis



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

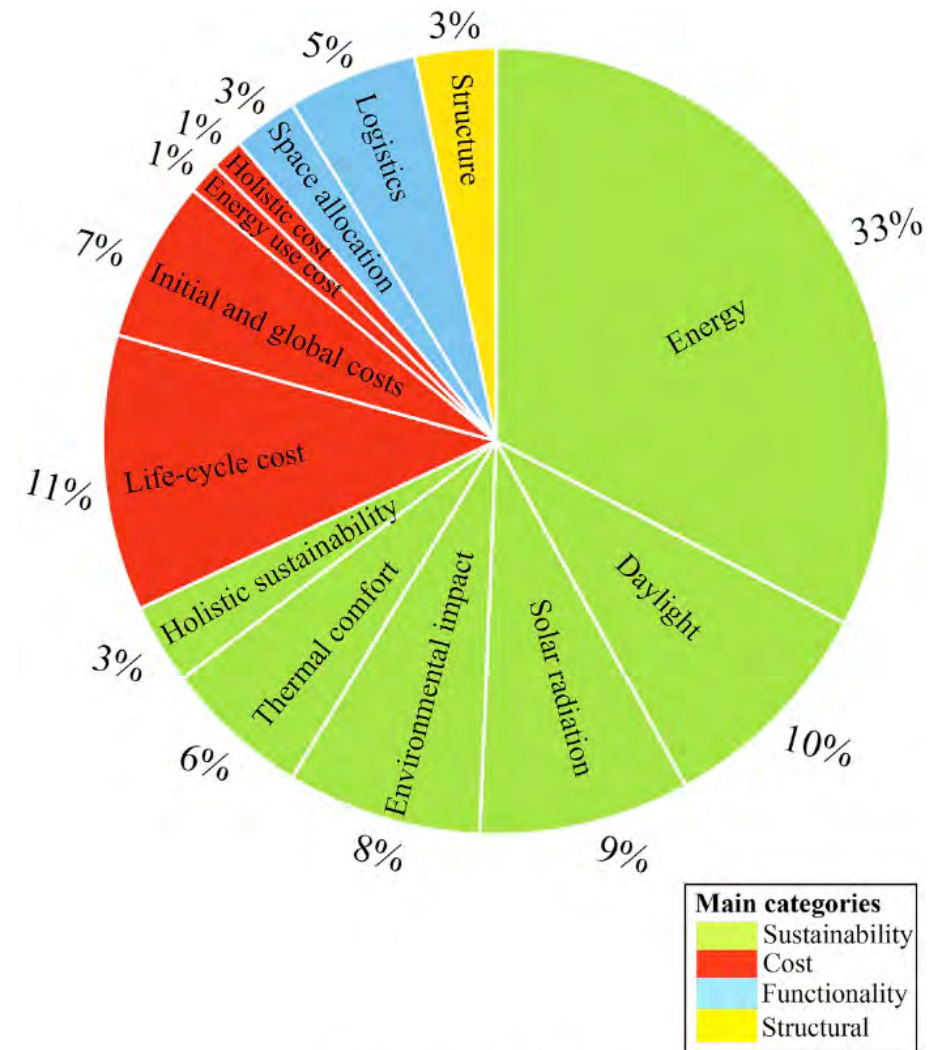


Fig. 4. Distribution of sub-categories.

Ekici, B., Cubukcuoglu, C., Turrin, M. & Sariyildiz, I. S. (2019). Performative computational architecture using swarm and evolutionary optimisation: A review. *Building and Environment*, 147, 356-371.

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:

Three concepts:

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

Multivariate performance based design methods are complex.

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



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.**

THE ARMADILLO VAULT BALANCING COMPUTATION AND TRADITIONAL CRAFT

PHILIPPE BLOCK / MATTHIAS RIPPMANN / TOM VAN MELE
ETH Zurich - Block Research Group
DAVID ESCOBEDO
The Escobedo Group

This paper describes the development and fabrication of the Armadillo Vault, an unreinforced, freeform, cut-stone vault, which embodies the beauty of compression made possible through geometry. Specifically, the paper provides insights on how a highly interdisciplinary team managed to bridge the difficult gap between digital modelling and realisation by learning from historic precedent and by extending traditional craft with computation.

The vault is the centrepiece of *Beyond Bending*, a contribution to the 15th International Architecture Exhibition - La Biennale di Venezia 2016, curated by Alejandro Aravena (Fig. 2). Wrapping around the columns of the Corderie dell'Arsenale, the shell's shape comes from the same structural and constructional principles as stone cathedrals of the past, but is enhanced by computation and digital fabrication. Comprising 399 individually cut limestone voussoirs with a total weight of approximately 24 tonnes, the vault stands in pure compression, unreinforced and without mortar between the blocks. It spans more than 15m in multiple directions, covers an area of 75m² and has a minimum thickness of



04

TECHNOLOGIES

Two domains:

1. Materialisation
2. Fabrication

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



[Material Performance: Fibrous Tectonics & Architectural Morphology by Harvard GSD - issuu](#)



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/kunsthau-graz-peter-cook-and-colin-fourrier/>



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

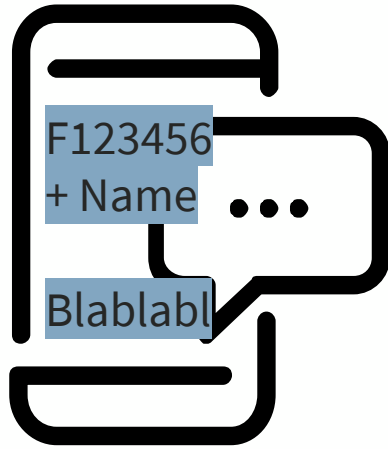
Transformation of toolset has led to:

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:

One **biomimetic principle** to be translated to your hypothetical design and elaborate on that. For example: *Mimosa Pudica*, the sensitive plant.

Note: Keep it short and concise

Aims and objectives

- To **relate** the current understanding with relevant theories, concepts and models.
- To build **related vocabulary** in digital architecture
- To instigate **personal interests** within the field