Theories of the digital in architecture

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).
Glossary of terminology

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

By now you 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.
There are **three paths**:  
Lynn’s Folding in Architecture (1993)  
Current theories: Picon (2010), Burry (2011) and Schumacher (2011)
One of the most profound architecture publication in 1990s.
Functioned as an antithesis of Deconstructivism.
Offered theoretical and operative alternative to Deconstruction.

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.**

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.

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.


(Right) https://www.cca.qc.ca/en/events/34442/objectile
In Objectile software, forms are not drawn, but **calculated**.
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.

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”.

Current theory: Picon (2010)

What is digital architecture? Is it legitimate to apply the term to any designs made with the assistance of a computer, or should it be reserved to productions that put to real use the capacity of the machines 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 unambiguously belonged to the latter category have been deemed digital. But if the term is certainly appropriate for the productions of designers like Al Khatib, Benjamin Aranda and Christopher Leach, who rely heavily on the computer, does it truly capture what is interesting with the projects of Preston Scott Cohen or Jaea Rice? Is it appropriate to interpret recent features of Jacques Herzog and Pierre de Meuron’s architecture, like the accent put on nature and enclosure, in relation to the use of digital culture? The vagueness of the term has been further increased by the series of exhibits that have presented the use of computer-aided design, where the users’ practices have little actual familiarity with the machines. In those 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 Cats (Computer-Aided Three-dimensional Interactive Application) CAD software remains external to the core of a highly personal design process that relies


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

Current theory: Burry (2011)

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- 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.

Current theory: Schumacher (2011)

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.
Current theory:
Schumacher (2011)

Patrik Schumacher’s lecture and Q&A on Autopoiesis of Architecture:
https://youtu.be/v428Hc_nd2A
https://youtu.be/h0ztygedlvl

Three paths:
1. Form and Generation
2. Performative Design
3. Parametrics
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/
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
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

: 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.

FORM AND GENERATION: 
6 MODELS OF FORM GENERATION

5. Fabricational Form Generation

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
PERFORMATIVE DESIGN:

From analysis to informed synthesis

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

Three concepts:
1. Simulation
2. Performance evaluation parameters
3. Evaluative criteria
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.
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.
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
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.
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.”

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.
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
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.
Material structure: geometric-structural field relationship of the material
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”.
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.
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

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.
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.