**Digital Prototyping as a tool for architecture design + making**

**An advanced educational experiment**

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**Introduction**

The present experiment overall aims:
- at having students discovering and exploring design issues from the first stage of virtual (parametric) and physical model elaboration including fabrication possibilities.
- producing a functional large-scale prototype.
- exploring and practice space and tectonics matters.

To perform this aim, we focus on new curriculum skills:
1. mastering numerical computation as a material to inject into the core of the 'traditional' architectural design process.
2. being able to develop a hybridization of the fields of architectural design and computer science (Couwenberg).
3. using prototyping: as a specific way of thinking that can extend design possibilities (such as versatility, complexity integration and manufacturing) to support the practice of architectural design.

These foundations are extended and articulate another new and decisive subject to embrace in digital design experimentation: the "design-to-fabrication continuum".

In this way, we explore:
- the extended possibilities offered by prototyping techniques as feedback.
- the way these possibilities are generated and how they can be integrated into the design process resulting in new material considerations, also new to be reflected on by students.

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**Methods**

Our teaching integrates a few elementary theoretical principles. As a first step, we sketch the historical background in which parametric modeling appeared and was developed. We highlight the concept of parametric (which existed long before the arrival of the computer).

1. Discover and analyze teaching of parametric role based modeling structures as a network of relationships (model as an algorithm, implementation, data representation, etc.).
2. Mastering true form generative processes (associative geometry) and versatility possibilities by introducing fundamental axioms in topology and surface.
3. Define, manage and integrate heterogeneous (geometrical, physical, code) parameters in the design process.
4. Discover a way of reasoning, based on constraint solving vs. geometry solving and apply resolving tasks with Kangaroo, etc.
5. Exploit new design behavior of "kinetic" architectures.
6. Learning and experiment versatility by discrete surface modeling and pattern studies.
7. With the use of perception of space variation and fabrication possibilities.

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**Results**

We present the results of the 2018 learning-by-doing workshop experience (Conception Numérique et Approche Matérielle).

The specific topics in this year experience are, in parallel:
- the design and the building of a prototype of kinetic and adaptive architectural skin (comfort and ambient control device for light self regulation and space modification),
- the experiment and the refinement of a design frame based on the method using the "synoptic schedule" as a guide line along the whole approach.

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**Conclusions**

- the proposed method is overall accurate for its purpose: Designing and building architecture elements prototype.
- the pedagogical and didactic means (time and tools disposal) we have had need to be increased to achieve a level of (high) complexity like the one we have targeted (autonomous device),

The limits the students encountered are mainly due to:
- the difficulty to integrate knowledge from "engineering" methods (be able to associate process with creative design thinking).
- the lack of knowledge in mechanics and motion devices.

The benefits we have are:
- the discovery and exploration of methods for complexity integration in the design space,
- the discovery of the ability for the architects to be close to the matter while designing.
- Especially, the use of constraint solving vs associative geometry as a novel and useful method for architectural design.

We demonstrate how it can be an accurate help for creative thinking, especially to manage a kinetic architectural object.

Furthermore, we can confirm that the extended way of design we explore in this workshop is not only relevant but is becoming inherent to the design requirements for production of architecture.

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