Framing Parametric and Generative Structures
A Framework for Parametric and Generative Analysis and Education.

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1. Introduction

With the introduction of maker-spaces and fab-labs in art and design academies, students come to realize that they don't necessarily need a factory anymore to make a showcase-ready product or prototype (Rushkoff, 2013). The ability to produce in small numbers empowers students to bring digital designs to world-scale objects. As a result of relatively limited tradition in digital fabrication, CNC-tools are often used mere as a substitute for handiwork. For instance, today, a machine can cut windows out of a piece of cardboard for model making purposes, which has made drudgery manual labour redundant to a certain extend.

As a result of evolution in parametric and generative design strategies, over the last decennia, traditions in digital fabrication have improved greatly. With a constructive approach, machines are used and tested to their physical and digital boundaries to produce new tectonics and rethought techniques for use in architecture and design. As a result, parametric design and digital fabrication have become of great importance to our spatial design education today (Kolarevic, 2008).

Due to the rapid emerging traditions in digital fabrication, combined with the shortage of fitting frameworks to contextualize the projects and techniques, the end products possess a high level of complexity in terms of their structure, geometry and materiality. On the one hand, these projects seem inaccessible for well-intentioned design students to learn from, on the other hand, they are difficult to teach.

With a focus on the understanding and teaching of digital fabrication practice, it is necessary to define a learning-environment in which constructive education can take place. For this purpose, the development of a novel tool is required to facilitate a structured evaluation of architectural construction principles, materials and production methods, as used in digital fabrication. Furthermore, there is a need for an inclusive vocabulary for categorization and instruction to make techniques and projects more accessible and teaching them more efficient.

Reflecting on the above, this study aims at the development and testing of a tool for the structured evaluation of digital fabrication in spatial design. This tool will be derived from a master-framework: the Supertypes-Subtypes Taxonomy for Spatial Design Construction as developed by the Author (2013) based on (Martin, 1996; Bucquoye, 2002; Ashby, 2007; Kula, 2009; Engel, 2007).

In this context, we will start our paper with a small introduction on the use of framing strategies in research and education and present the master-framework (Section 2). Afterwards, we will illustrate the usability of the master-framework through a survey of a wide range of cases and present a typological comparison of various identified outliers and underexposed subtypes. Subsequently, we will present the reframed derived-framework for digital fabrication (Section 3). In conclusion, we will discuss the possible reasons of recurring patterns and outliers and conclude by an elaboration on the implications of our findings on architectural design education and relevant practices.

2. Frame Alignment of the Master Framework: Supertypes-Subtypes Taxonomy and Material Families in Digital Fabrication

This research is a part of the PhD Thesis of the first author and is a continuation on the work presented during the eCAADe symposium 2013. In this presentation, a taxonomy for spatial design construction was introduced. In this paper we will situate this framework in the context of digital design and fabrication and derived a framework specifically for digital fabrication and parametric modelling. The framework will be based on a common language to integrate data into visual frames as a basis for computation.

Framing and Frame Amplification

From a wide array of conceptions on *frames* and *framing* as a theory, in this research, we limit ourselves to two of them. In the first viewpoint, frames are used in a more semantic environment. In this context, framing as a concept, originates from the work of Erving Goffmann (1974) and was further developed by Entman (1993) and Benford and Snow (2000). In *Frame Analysis* (1974), Goffmann discusses the relevance of a condition in which a concept is understood. When something is understood within a “world” or “reality”, selective attention organizes experiences and generates meaning within a certain event.

In the second viewpoint, frames are used in a more ontological environment. In this case, frames are applied to order large chunks of information (Wilensky, 1987). In these cases, frames are used to structure data for representation purposes in stereotyped or conventional situation (Minsky, 1975).

Both viewpoints bare great quality. In this research the ontological strategy is used to construct the master-frame for spatial design construction. To test the frame for robustness, completeness and thoroughness, semantic strategies like frame alignment are applied. By frame alignment processes like frame bridging and frame amplification, frame interaction and frame testing is discussed (Benford and Snow, 2000).

In this paper we’ll test the framework as introduced at eCAADe 2013 by frame analysis strategies first. Next we’ll use frame amplification strategies to derive an individual framework for parametric design and digital fabrication from our master-frame.

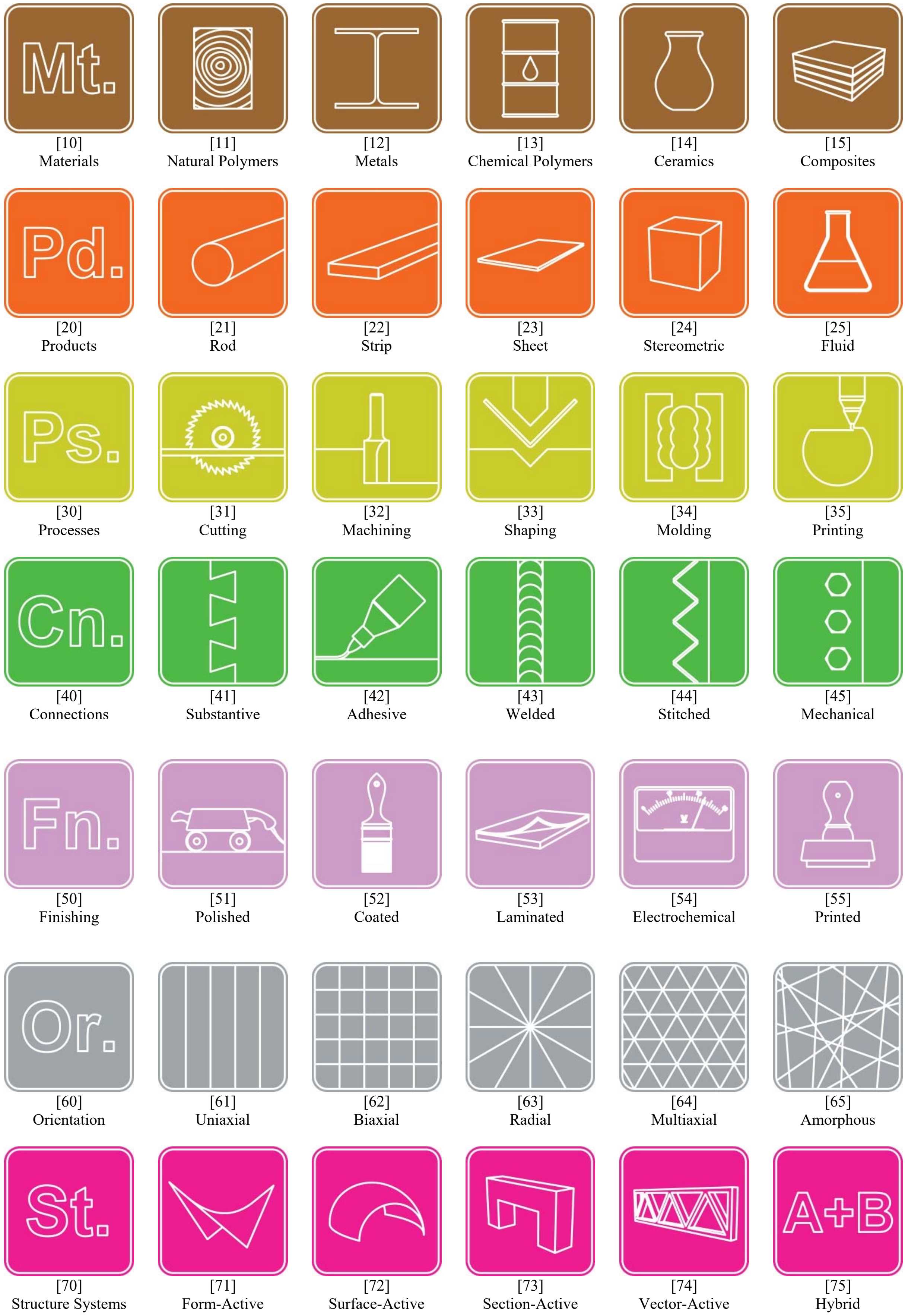

Figure 1
Master Framework for Spatial Design Construction (Author, 2013).

3. Framing Parametric and Generative Structures

A wide range of cases from the proceedings of the ACADIA and eCAADe conferences (2003-2013) served as a test-bed during the development and customization of the tool introduced in the previous section. Since our space in this abstract is limited, we will only share a few significant cases as representative examples reflecting the potentials and challenges of the master-framework. In the examples below, images of the described object are presented first. Second, the object is framed by the subtypes of the master-frame. Then, a short textual description is added to the image description.

Case 1:The Nuit Blanche Pavilion (Riether, 2013)

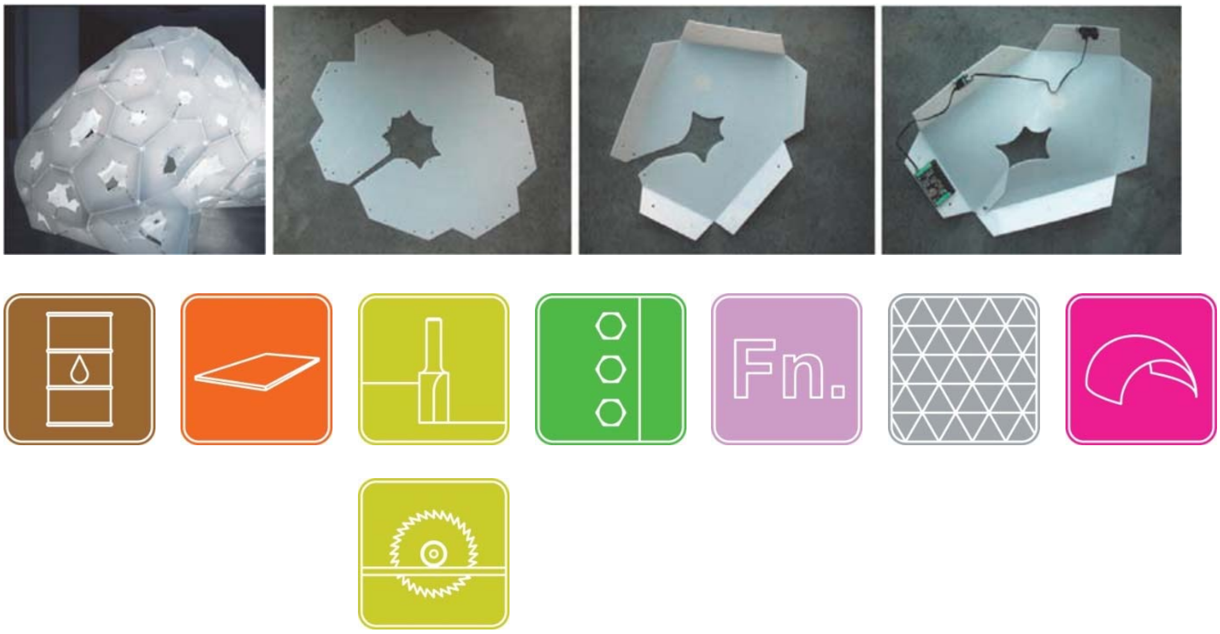

Figure 2.
Surface-active construction of chemical polymer sheet, processed by machining and cutting, connected by chemical fasteners in a multiaxial geometry.

Case 2: Spatial Extrusion (Hack et al., 2013)

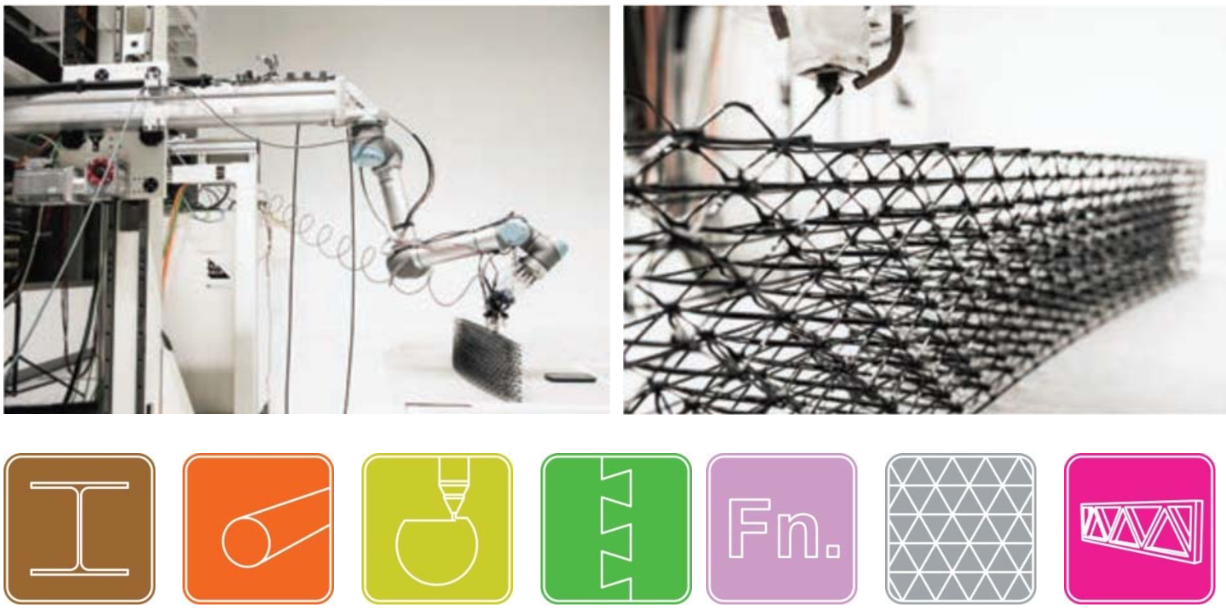

Figure 3.
Vector-active construction of chemical polymer sheet, processed by printing, connected substantively in a multiaxial geometry.

Case 3: Adaptive Structure (Kontovourkis, Phocas and Tryfonos, 2013)

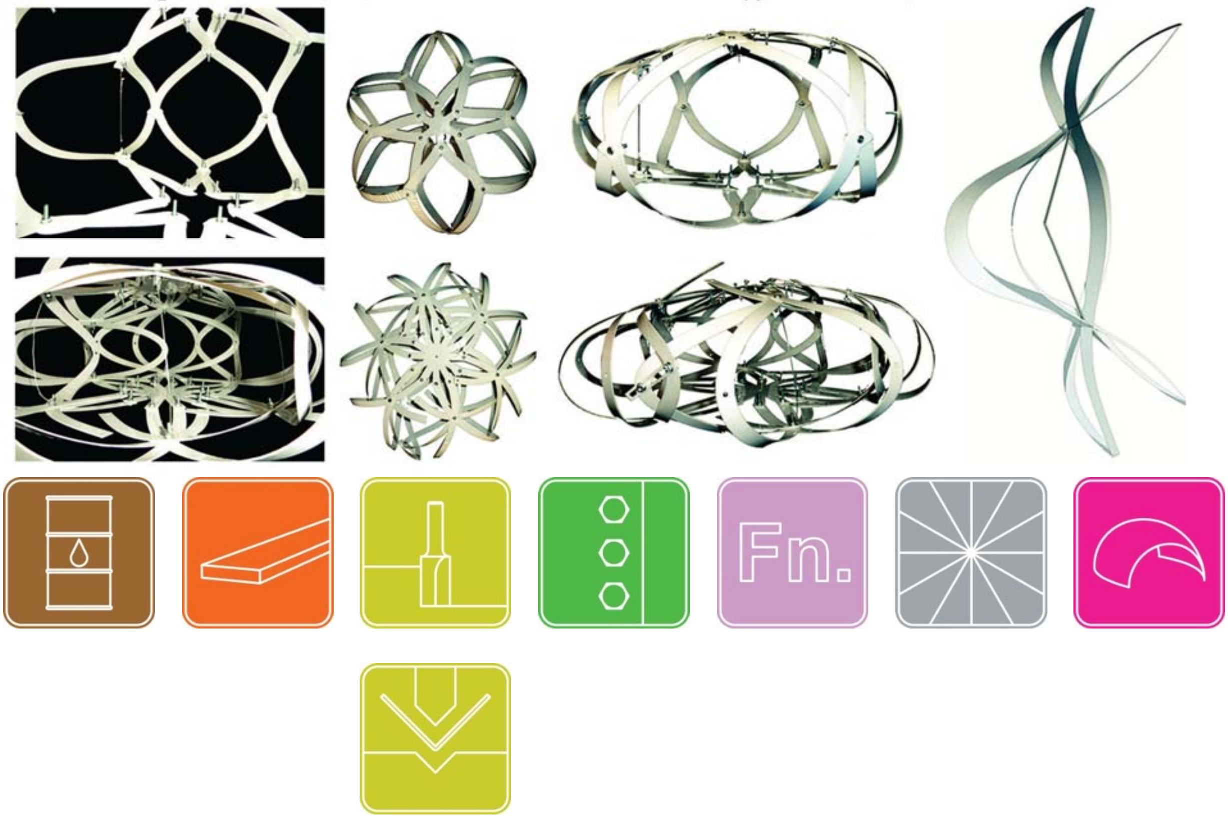

Figure 4.
Surface-active construction of chemical polymer strips, processed by machining and bending, connected mechanically in a radial geometry.

Reflection on framing exercise
Reflecting on the framing outcomes, three strategies are applied to derive the digital fabrication framework from the master-frame.

First, for both the subtypes “processes” and “structures”, in the projects a specific set of techniques are used. With regard to processes, often CNC-machinery are applied. With regard to structures, the students and designers discussed, often show a basic background in structural analysis. As a result, the structure supertype aims at a specific set of stereotypes with an altered vocabulary compared to the master-frame. For this reason, both supertypes are aligned by frame amplification. Commonly used subtypes are derived from the master-frame.

Second, in a great part of the projects, electronics play a prominent roll. In this case, frame extension is applied to incorporate electronics into the master-frame.

At last, digital designers often work with surface and solid manipulation instead of material orientation. To assist this working method, frame transformation is used to manipulate the supertype “orientation” into the supertypes “solid” and “surface”.

CNC-Processes	**Electronics**	**Structure**	**Solid**	**Surface**
Engraving	Non	Frame	Amorphous	Fluid
Cutting	Passive	Plate	Fluted	Folded/ Pleated
Turning	Active	Shell	Branched	Triangulated
Printing	Interactive	Vault	Aggregated	Tessellated
Positioning	Intelligent	Tensile	Sectioned	Woven

Figure 5.
Supertypes for the derived framework (Moussavi, 2009;Moussavi and Kubo, 2006; Di Mari and Yoo, 2013;Vyzoviti, 2011; Weinstock, 2008).

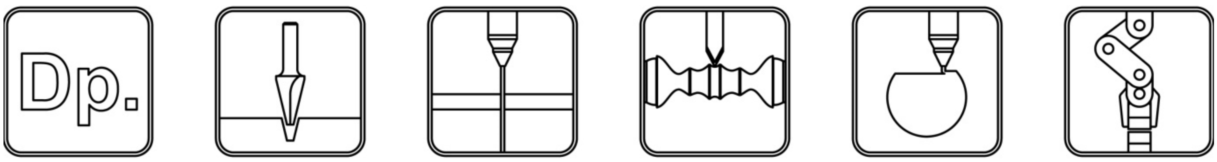

Figure 6.
Example of digital process ideograms for digital fabrication.
From left to right: Digital/ CNC Processes, Engraving, Cutting, Turning, Printing, Positioning.

4. Conclusion and Future Suggestions
The presented master-framework enabled the structured evaluation of digital manufacturing projects. In this way, outliers and underexposed subtypes of the master-framework were specified (these will be elaborated further in the final paper). Using frame alignment strategies, the specified subtypes were introduced in a context specific framework. Building a shared vocabulary provided a better understanding of the topic and made it easier to communicate.

In the full version of this paper we will discuss the possible reasons of recurring patterns and outliers. We will make an elaboration on the implications of our findings on architectural design education and relevant practices. Furthermore, we will reveal how the presented frameworks and framing strategies can serve as a constructive tool to describe a learning environment on one hand and support teaching strategies on the other.

References

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