Multiperformative Efficient Systems (MES) Towards System Thinking

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ABSTRACT
In order to address the demands of an ever-increasingly data-driven architectural practice, the designer must become an interdisciplinary specialist. Employing data-driven techniques requires a solid understanding of not only digital design tools, but also material performances and the manufacturing process. Therefore, it is necessary to rethink new strategies in order to establish a robust connective tissue between disciplines and specializations.

In a data-driven architectural practice, an aptitude for exploration and advanced experimentation in generative techniques is needed for the entire design process, from the earliest experiments to the final production phase. Therefore, bringing new digital productions to the scale of a real building implies the need for radical innovation in non-standardized building solutions. This paradigm shift implies rethinking buildings as systems rather than the juxtaposition of optimized and monofunctional layers.

One of the main challenges of data-driven architectural practice is maintaining consistency from design to materialization. Thus, by pursuing a holistic, nonlinear approach and an interdisciplinary practice, designers can move away from a traditional linear production workflow based on a succession of fragmented processes. Through the pursuit of data-driven architectural practice, the boundaries between the specializations of architect, engineer, and designer become blurred.

This paper is rooted in a personal research agenda based in Systems Thinking, currently under development at Hyperbody, the research group guided by Prof. Ir. Kas Oosterhuis. Systems Thinking is at the core of the research initiative, Performative Design Processes for Architecture ([P]a), pursuing the development of Multiperformative Efficient Systems (MES) as one of its possible catalysts.

KEYWORDS
Systems Thinking, efficiency, differentiation, material performances, mass customization, form finding, digital fabrication, design intelligence, computation, and parametric-associative strategies for design and manufacturing.

INTRODUCTION
There are several questions and assumptions steering the research behind MES, such as: What disciplines and specializations are contributing to shape the new intellectual framework motivating design innovation? As the move towards mass customization of production systems hosts the potential for a decisive break in materializing novel design processes and efficient production techniques, what effect does this have on architectural praxis? The challenge for today's designers lies in the shaping of a new design intelligence, whereby the process of development by experimentation through every stage of the design process becomes significant to the success of the final result.

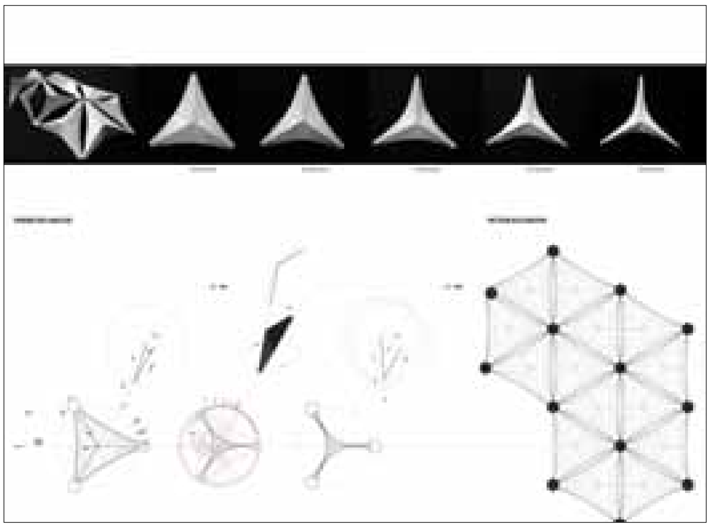
[M]SYSTEMS
[M]SYSTEMS is a study case of the research agenda on Performative Design Processes for Architecture. [M]SYSTEMS is an experimental demo project that aims at developing MES through morphogenetic design strategies. At the core of the project is the exploration of an integral design strategy that is capable of catalyzing material behaviors in a real-

time adaptive system, as well as catalyzing manufacturing and assembly logics. Parametric Associative Strategies for Design and Manufacturing are instrumentalized in order to first pursue a generative strategy, and second to explore performative capacities of the outcomes.

The first phase of development targets the exploration of physical prototypes. The research aims at finding a simple performative component as a possible candidate for proliferation in a larger system. From a very early stage, the integration of assembly and manufacturing logics informs the empirical research of the physical genotype (fig. 1).

The second phase points at generating the adaptive digital system. First, the behavior of the physical system is analyzed and abstracted by a set of mathematic, geometric, and parametric topological relationships. Then, the system (phenotype) is built according to those principles, and developed further through the exploration of parametric associative software (fig. 2).

Figure 1 Modulation and geometric analysis of the physical components



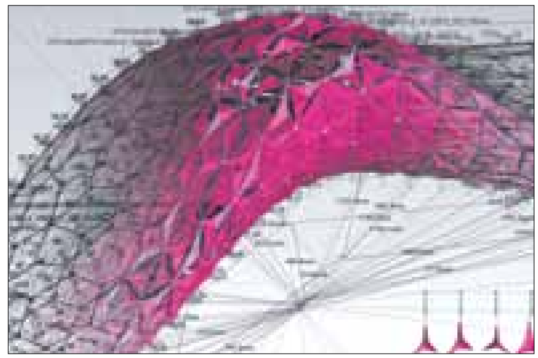


Figure 2 Parametric-Associative System. Project sponsored by Missler Italy

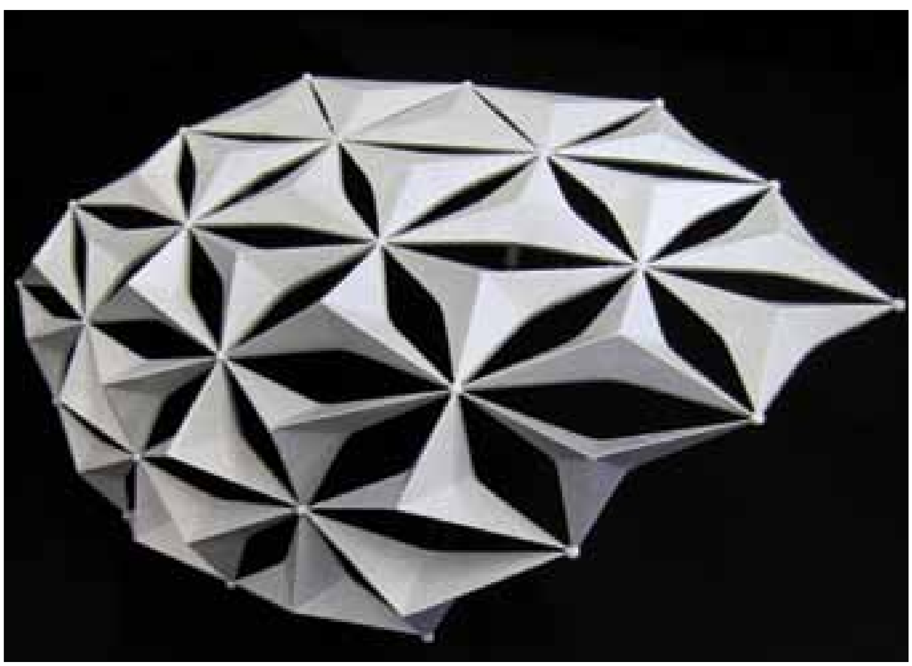


Figure 3 The differentiated porosity emerges according to the local geometric properties of the system. Prototype sponsored by ARRK Europe (BCN).

The real-time bidirectional exchange of information between the designer and the system is a reciprocal relationship that continuously changes the designer's understanding of the project as it is being developed, which, in turn, influences the decisions the designer makes.

The capacity for multiple possible futures (adaptations) is embedded in the same system. The system's adaptations are achieved through parametric-associative modulation of its performative components. The performative capacities of the components respond to the limits of maximum and minimum modulation of real physical behavior. Thus, the possible n-adaptations of the system cannot exceed established physical limits. Because of the material intelligence built into the system, the system inherently behaves according to the manufacturing and assembly features integrated into the design.

The outcome of the design strategy is a complex adaptive system. The system's complexity is achieved through the simple incremental steps of an evolutionary process. The integrated focus on material, design, and manufacturing makes it possible for the system to be manipulated and manufactured in real time. Finally, the software, according to the new configuration, immediately and automatically regenerates all technical drawings, data tables, and manufacturing layouts as soon as the system is manipulated (fig. 4).

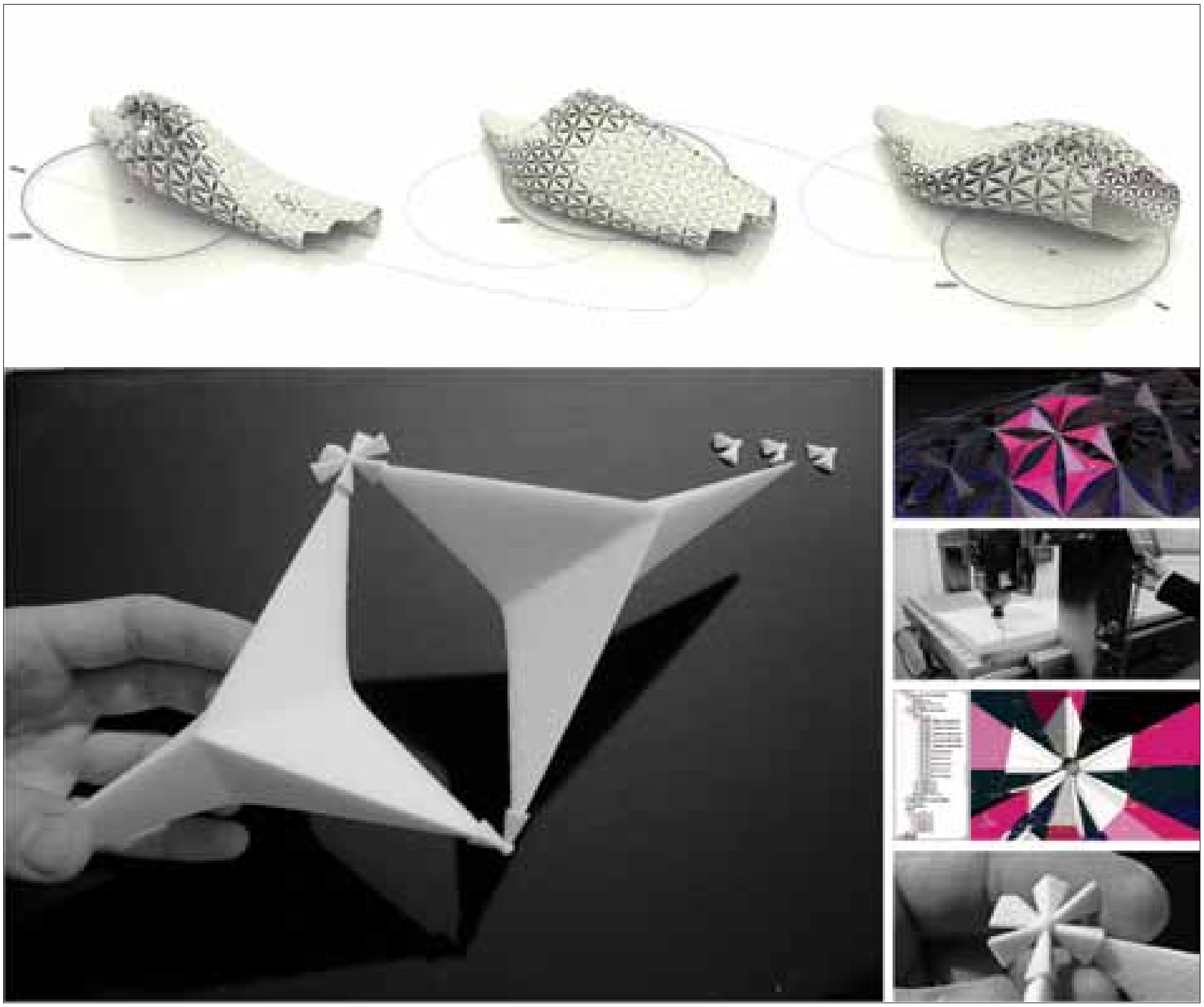


Figure 4 Data-driven, form-finding process. The generative strategy integrates manufacturing and assembly features.

CONCLUSION

The architectural domain is increasingly moving towards empirical methodologies, using strategies and processes of development rather than pre-deterministic approaches. Thus, a more experimental aptitude is replacing the processes of metaphorization that currently exist in the practice of architecture.
The research in Performative Design Processes for Architecture targets a nonlinear, holistic methodology while stressing the necessity for an experimental and interdisciplinary aptitude. In this framework, the process of design becomes a process of creating knowledge. In order to grasp and catalyze the potentialities for innovation in architectural practice, it is useful to engage in a performative design process. The development of performative design processes implies the understanding of new degrees of complexity on the part of the designer.

Working on the [M]SYSTEMS project provided the opportunity to explore some of the topics related to the [P]a research agenda. The design approach described in this paper, which is strongly informed by material processes, demonstrated the robust generative capability for the development of MES. The linkage between the processes of design and manufacturing is a strong feature of the empirically driven methodology. The qualities of the results achieved show that integrating production logic at an early stage of the design is a parameter that enriches the entire process.

As [P]a focuses on developing a contemporary discourse in the architectural domain, further improvement of [M] SYSTEMS will be necessary to cover the entire research agenda of [P]a. Therefore, [M]SYSTEMS will need significant improvements in order to achieve solid architectural qualities. Nevertheless, [M]SYSTEMS, as a demonstrative case of the wider MES concept, illustrates the pursuit of a radical innovation of the project practice, and, thus, [M]SYSTEMS represents the foundation for further, promising exploration in [P]a.

Research in [P]a is focused on the understanding of generative formation and materialization as the integrated features of a unique project development process. Rooted in Systems Thinking, [P]a takes up the challenge of exploring innovative solutions to architectural applications for full-scale buildings. Furthermore, the research agenda on [P]a promotes the experimentation with holistic approaches as a break from the methodological reductionism diffused in traditional architectural practice. Thus, this research initiative aims at laying the groundwork for the development of efficient solutions that are capable of interacting with the technical, economical, and social development of contemporary society.

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