Generative Robotics

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Generative design can be defined, in part, as a process of exploration spurred by the integration of codified *actions* as opposed to explicit constraints. D'Arcy Thompson provides the foundation for tools for generative design in his description of *homologies*.[1] These are understood as fields of possible outcomes emanating from geometric relationships that encapsulate the organization of physical forces into form. The evolution of this approach in computational design has focused on ever more accurate simulation—rather than representation—of form as the consequence of imposing forces, material properties, and rules of assembly.

It is this last item, assembly, that the work in this section addresses. The projects showcase a clear entrenchment of generative design in their approach towards robotic fabrication. While often confined to the exploration of virtual forms, the work in this section applies the concepts of generative design to the activities of robots themselves. The robot shifts from being the executor of the final static design iteration, emerging from a computational exploration, to one that is fully submerged within the cyclical processes of generative design. The making of material and the assembly of components become active processes of integrating agents and continually adapting to emerging aggregate behaviors. Therefore, design no longer involves the production of a static series of instructions or conceptual design intentions; rather, it entails the determination of a dynamic scientific model, which is based on the relationships of changing systems, that best negotiates design criteria, material action, and machinic operations. Here, the machine's capacity to process complex interrelations can be employed to embed material data in the form-generation process.

Of the work in this section, Brugnaro's construction strategies, driven by material behavior, exhibit a generative design space that is actively redefined as the assembly, context, and aggregate behavior emerges. Braumann, Moorman, and Vasey each present work with a similar approach, while adding feedback through human interaction as a transformational design agent of fabrication. Where Brugnaro and Vasey provide a material-specific implementation of this approach towards generative robotics, Braumann and Moorman each discuss the accessible nature of the programming environment, empowering a broader range of human-robot design explorations.

Advancing the level of intelligence in a robot-centric generative design framework also requires more highly tuned controls over material explorations that are increasingly multi-hierarchical and non-standard. Devadass's timber structure, in adapting raw timber into large-scale structural components, questions the prototypical steps for processing material. Where robotic fabrication moves from defining constraints to establishing a field of possible operations, the concept of material processing can be completely re-thought. Devadass does not simply assume a role within multiple steps of material production from sourcing to construction-grade material. Rather, sourcing, engineering, and robotic manufacturing are set at critical axes of a multi-dimensional design space. Schwinn's work in robotic sewing leverages this approach by allowing the vast hierarchies that form material-driven architectures to be a part of the generative design process. This is expressed in constructions tailored to the micro scale of material make-up, the meso scale of interacting material assemblies, and the macro scale of system behavior.

1. D'Arcy Thompson, *On Growth and Form*, abridged edition, (Cambridge: Cambridge University Press, 1961).

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