Rule Based Computation & Generative form seeking

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Since Charles Darwin theorized that all species are generated by natural selection, evolution and genetic algorithms have been powerful tools to solve biological puzzle. But they can also be effective in simulating complexity and diversity. As a cross-disciplinary research method, generative form-seeking borrows many concepts from biology such as genotype, phenotype, expression and reproduction. It has been used in architecture design to achieve a higher degree of synthesis, such as "virtual architectural models" designed by John Frazer, and the "City- Engine" developed by Pascal Mueller. After exploring several rule based form- seeking methods in several courses taught at the University of Cincinnati, it becomes obvious to the author that the understanding an abstract script (genotype) and its corresponding form (phenotype) will take parametric design to a new level, especially for the students with computation skills. (Tang. 2008)

This poster concludes several new procedurals developed in the course taught in 2012. These processes allowed students to effectively implement generative techniques in the design-orientated environment. By referencing Mannuel De Landa's theory, students discussed the logic and essential meaning of the abstract code and rules defined with parametric equations. The goal is to implement several generative tools to automatically seeking 3D forms by applying certain evolution rules to the existing spatial data. With these tools, a building model is generated as a synthetic creature, which is meaningful on various aspects far beyond its aesthetic values. In our approaches, genetic evolution (GE) in Galapagos and the L-system in Rabbits are two popular form-seeking techniques closely associated with generative methodology. With Genetic Engine of Galapagos, computer simulated evolution follows the same principle of survival of the fittest. A large quantity of solutions are generated and compared in the computer simulated environment. While the other form-seeking technique, L-system, procedurally breeds complex offspring from a single axiom by applying reproduction and mutation principles. In many experimental projects, these two techniques have been integrated with life game operated with cellular automation and voronoi mathematic methods and shown great potentials of generating a large population of variations.

At the conceptual design stage, students are encouraged to use "shared body plan" as an inspiration to think the relationship between iterations. Instead of constructing a parametric shared body plan for the entire building, students' concept design works on the abstract level (either building mass or the skin components) which operate through generative computation. Evolutionary design is an inherent element in the process of design whether it is realized or not. Everything from idea sketches to initial parti's are chosen and advanced through rules similar to biological evolution. For instance, one student project chooses to glorify this concept by using evolutionary solvers named Galapagos, a tool in Grasshopper, to drive elements of the entire design. Another student project intends to solve the parametric criteria of our studio using morphogenesis and FEA (finite element analysis) to evolve primitive geometries into complex nature based structure. Using a bone growth algorithm, this process adds information to matter as a new typology of structural rationalism. Many of these techniques require the input of abstract rules rather than spatial information. The expression of form generation is then interpreted by third party plugins in Grasshopper, which are integrated with Rhino software. The benefit of comprehensive understanding of these rule based form seeking methods for architects to explore the potential of generative design in the design-orientated environment.