

Urban Formation Machines: Modeling Urban Complexity within a Parametric Environment

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Modeling Urban Complexity as Frameworks for Design (2012), 'ufm', explores the use of dynamic diagrams within digital 3D modeling to extract and control spatial behaviors in urban design. Both to understand and generate thematic urban form, the ufm project posits that multiple highlighted urban characteristics and influences can become diagrammed and synthesized into malleable, spatial frameworks initiating a design process. It promotes designing dialogues between multiple influences within an active computer model, using transformations of embedded, observed behaviors as the basis for urban formation.

PART FIELD explores aggregate architectural consistency and variation as influenced by intensive and extensive forces. A module of spatial demarcation and framing is deployed across a field. The production of difference is found by the degree to which a module or area within the field is influenced by external and internal influences. The resulting, varying field describes both the autonomy of a module and the range of thematic similarities and differences across the field, and is analogous to the tangible yet limited range of effects within a consistent urban condition.

GRID TRANSMISSIONS visualizes event and interval as urban behaviors within a field of flows, disruptions, and intensities. This series of models extends the work within *The Urban Text* (The MIT Press, 1991), and visualizes the gridded city as an interrelated network of continuities, discontinuities, influences, and trajectories. The focus is not on the car traffic of the roads, but the potential frequency and magnitude of program, storefronts, rhythm, and porosity of the built environment defining the edges of the gridded system. Built and programmatic elements are generalized as 'events', whose attributes are abstracted, and characterized in terms of frequency and magnitude. The forms of the influencing factor, like a river, highway, or neighborhood center, determine the magnitude and frequency of 'events'. Akin to Manhattan's block system, directional differences, whether planned or evolved, are modeled. Interdependent 'environmentally-scaled' influences such as the industrial riverfront might repel, while a river as urban amenity might attract the magnitude and/or frequency of events. Finally, the selective placement and

influence of nodes, as in a neighborhood center, reflect the power of local intensities to exist within the overall system.

PATHWAYS + OCCUPATIONS expands upon the principles within Frei Otto's *Occupying and Connecting* (Edition Axel Menges, 2009), in which the urban behaviors and resulting forms of attraction and pathway formation are modeled. Both that study and this examine evolutionary tendencies within the development of these pathways and dense occupations as analogous to the evolution of early urban settlements in western Europe. It explores behaviors like 'territory path networks', 'attractive occupations', and 'distancing occupations' that were evident in the rural to city development as urbanism increased. The first series scripts the development of pathways in terms of their evolutionary success and efficiency, that is, how some were used more and therefore calcify into larger roads, while others remain minor or disappear. A source of 'environmental' attraction, an abstraction of a lake builds relative concentrations of pathways in its proximity. Occupations of this environment are then modeled to be influenced by the pathway system. Pixels initially abstract rural habitation of a territory. The proximity of an intersection of strong pathways, or the edges of strong pathways attract pixels to form urban concentrations. The form, organization, and behavior of these occupations are controlled via both as overall forms of concentration as well as in local interaction between pixels.

SYNTHETIC VERNACULAR models thematic constructed, social, and spatial systems within vernacular townscapes. It re-considers the development of tectonic and typological theme and variation within these environments, extending the work of Klaus Herdeg's *Formal Structure in Islamic Architecture of Iran and Turkistan* (Rizzoli, 1990). As in the Part Field exploration, this model produces pattern and difference within a tight set of formal constraints. Urban concentrations formed without strong extensive hierarchies exhibit a 'field condition' behavior, where pertinent information is latent in each local form and the aggregate produces an endless field of thematic variation and similarity. This is especially true in vernacular settlements that propagated from an expertise within local building practices, a limitation of available material, and a consistency of cultural forms. This model addresses aspects of working within or initiating urban fields with a high degree of consistency within its aggregate formal structure. Where aspects of imagery or the prevalence of older built cultures predominate, it also offers potentials for the abstraction and transformation of spatial principles within a contemporary interpretation.

AMPLIFIED ENVIRONMENTS models basic environmental forces, influences, and forms in dialogue with topography and building density, allowing for the control of zones of compound environmental effect. A graphic language is developed to visualize the dialogues between environmental factors, and then visualize their cumulative effects. This allows for the ability to isolate each factor, overlay different factors, and initiate parametric relationships between factors. It enables the designer to distinguish between multiple possible relationships and priorities in considering the design of environmental conditions at the scale of urban or site design. It simply sets up relationships between basic environmental forces, influences, and effects in dialogue with building density, height, and forms of distribution. The current study models expose the relationships of topography, solar orientation, shadow, wind, zones of humidity, and surface watersheds. Working with the model structures the ability to control and visualize zones of compound environmental effect between natural phenomena and built structures.

