Parametric Variation Revealing Architectural Untranslatability

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This paper describes a recently concluded graduate seminar which tested how form-generative design tactics of algorithmic work could be productively brought to bear on the conceptual analysis of existing buildings. The seminar did not seek to optimize performance or aesthetic value but simply to query the mechanics and consequences of translation as an act. Seminar participants mined existing buildings as sources for parametric rule-sets which were subsequently applied to varying media fields (e. g., physical materials, text, and graphics). This application revealed that specific media resist certain kinds of translation. This peculiar resistance suggested that characteristics of architecture exist which might broadly be called *untranslatable*.

Introduction

Two distinct trajectories are discernible in contemporary architectural pedagogy and research concerning the use of algorithms: that is, finite rule-sets or procedures. I call these trajectories the *analytical* and the *form-generative*. Within the analytical trajectory, researchers rely on algorithmic formulations to analyze existing architectural form as a means of disclosing spatial, structural, or material patterns typical of a body of built work, or of deriving “design principles” specific to a body of work (Asojo, 2001; Gomez de Silva Garza and Maher, 2001). In related efforts, researchers use algorithms to analyze the performance (e. g., structural behavior, or energy performance) of a building (Clarke, 2001). Within the form-generative trajectory, algorithms are used to derive two- or three-dimensional architectural form from given parameters (Hsu and Krawczyk, 2003), or to model naturally occurring forms and processes, in turn provoking the production of novel architectural form. Genetic algorithms, for example, are capable of instigating conceptual design, of provoking a decision-making process, or of optimizing a solution space (Besserud and Cotten, 2008; Aranda and Lasch, 2006; Renner and Ekart, 2003; Caldas and Norford, 1999; Holland, 1992).

Given this context, and assuming that architectural design and architectural analysis have a tactical identity – that they share tactics though their strategies differ (Porter, 2004; Crowe & Hurtt, 1986) – the following question arises: *How could the form-generative design tactics of algorithmic work be productively brought to bear on the conceptual analysis of existing architecture?* This question formed the basis for a recently conducted graduate-level seminar led by this paper's author. The seminar staked out territory distinct from the analytical trajectory, such as those discussed by Gomez de Silva Garza and Maher, in that it did not attempt to disclose patterns specific to a designer's intent. The seminar also differed from the form-generative trajectory, for example as discussed by Aranda and Lasch, in that it was not an overt attempt to generate novel form from observations of naturally occurring behavior or patterns. Instead, the seminar sought to hybridize aspects of the analytical and form-generative trajectories. Over the course of the seminar, existing buildings were mined as sources for parametric rule-sets. These rule-sets, specifically formulated to be portable, were translated from their sources into other media, including text, two-dimensional graphics, and sculpted material. In this way, novel form was generated not in response to naturally occurring forms or processes, but in response to architecture. At the same time, the

Figure 1. Digital model of Case Study House #22. Student: Brian Glueckert.

seminar did not propose to derive "rules" for replicating the original works.

The results of the seminar, which are reported here, are relevant to both the form-generative trajectory (because novel form was generated) and the analytical trajectory (because the original works were brought into comparison in a novel way), but more importantly within a new trajectory, one which I call the *translation-limitation trajectory:* that is, a realm of architectural research and pedagogy in which algorithmic procedures are capable of disclosing the resistance of specific media to certain kinds of translation. This peculiar resistance is in turn suggestive of unique characteristics of architecture which, when considered in totality, might broadly be called *untranslatable*.

Construction of base models

To begin the seminar, each student was directed to construct a digital solid model of a house assigned by the instructor (Figure 1). This initial assignment included no limitations on the choice of software application, except that the chosen software should allow the students to quickly and efficiently model the formal properties of their assigned houses, avoiding excessive detail whenever possible. These directions prompted most of the students to choose Sketchup for the assignment, simply because it was the most familiar of the various software applications available to the students during the seminar.

Assigning houses

The instructor selected a group of existing houses, based on the criteria that the houses should be small, reasonably well-documented, and not likely to be familiar to the students. The selected houses were as follows:

- The Koehler House (2001), in New Brunswick, Canada, designed by Julie Snow;
- E.1027 (1929), in Roquebrune, France, designed by Eileen Gray;
- Case Study House #22 (1960), in Los Angeles, California, designed by Pierre Koenig;
- Casa Gaspar (1991) in Zahora, Spain, designed by Alberto Campo Baeza.

Suspension of familiar influences

To promote conditions for subsequent assignments (beginning with the generation of discrete formal sequences), the instructor proposed to challenge or subvert the students' assumptions concerning familiar influences in the analysis and design of architecture. For example, participants were assumed to hold as an *a prori* assumption that a program (i. e., an expression of the proposed or actual use of spaces) and a site (i. e., a specific locus of proposed or actual construction) are necessary components of architectural design, and as such, are commonly addressed with familiar tactics such as the systematic gathering and ordering of site-specific information or the production of proximity diagrams derived from a given program. For the initial construction of digital models, students were asked to suspend or set aside these *a priori* assumptions and their associated tactics as far as possible, and to instead focus their attention on formal manipulation. Stated differently, the initial assignment required no attempt to associate the modeled forms with any significance whatsoever beyond their geometrically measurable, formally legible properties; in fact speculations about such significance was actively discouraged.

Concerning program, the students were directed to avoid speculation about the social significance of their modeled architecture, in particular as such significance could be inferred through assigning specific activities to spaces or areas. In most cases this was practically difficult because the existing documentation of the houses tended to identify rooms with labels (e. g., "Kitchen," "Bedroom," etc.). Concerning site, students were directed to avoid speculating on how the orientation of the house or its placement on the site could be architecturally significant (e. g., to inhabitation, usefulness, the internal organization of spaces, etc.), and to avoid modeling the specifics of site topography. Finally, seminar participants were asked to suspend any attempt to model materials "realistically" or to endow them with any kind of

Figure 2. Parametric transformation sequence, Koehler House. In this exercise, the student begins with a "generic cube" (at left). He designed a parametric transformation sequence through which the cube is transformed into a complete model of the Koehler House. Student: Brett Barry.

parametrically encodable behavior.

Initial formulation of parametric rule-sets

On the basis of the digital models produced in the first few weeks of the seminar, the students were asked to develop, using their selected modeling application, a sequence of parametric rules transforming a generic "cube of unit volume" into the model of the house. An example of student work resulting from this assignment is shown in Figure 2.

The seminar emphasized the topological nature of these transformations to focus attention away from any attempt to model real-world behavior of material, light, etc. Mathematically considered, it was not necessary that two subsequent steps in the parametric transformation should be limited to topologically equivalent forms, or that a specific step in the sequence be topologically legal. Thus, to undergo a "topological transformation" was not to work within a finite set of transformations as such but rather to restrict attention to only those formal properties which the software could register. The assignment was not an attempt to construct a model of the house as an analogue for the making of the house in the real, but for promoting instead precisely those kinds of manipulations and transformations which topology encourages.

Articulating and transforming the rule-sets

After modeling and illustrating a parametric transformation sequence for their assigned house, the students were asked in a series of assignments to apply the sequence against different fields. These assignments were designed to test the robustness of the sequence as it was applied to different kinds of "material" (physical and digital). By *robustness* here is meant the ability of a specific sequence to maintain its integrity as it is ported from one medium to another.

Into written rule-sets

First, students were asked to transform their parametric transformation sequence from digitally modeled form into written rule-sets. Students were directed to use active verbs where possible, to focus specifically on the act of transformation. Most of the students identified several steps within their own sequence which, while easily modelable, did not easily translate into written rules. Such occurrences prompted students in some case to reformulate steps within the sequence. These occurrences constituted the first appearance within the seminar of a consequence relevant to the *transformation-limitation trajectory.* Stated differently, when the

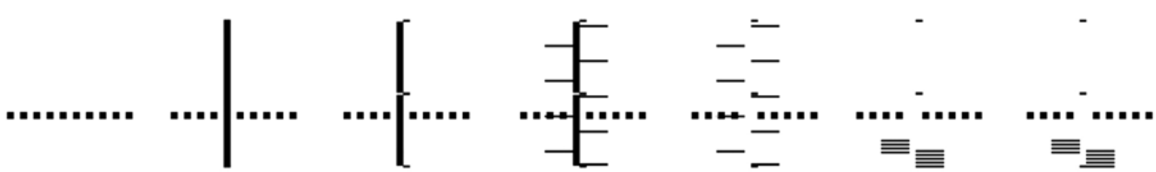

Figure 3. Parametric transformation sequence, Koehler House. In this exercise, the student begins with a "generic field" of ten dots (at left). Then, restricting himself to operations possible in the established field, he attempts to apply the parametric transformation sequence from the first exercise. Student: Brett Barry.

Figure 4. Parametric transformation sequence, Koehler House. In this exercise, the student begins with a “generic object” (at left). Once again restricting himself to operations possible in the established field, he attempts to apply the parametric transformation sequence from the first exercise. Student: Brett Barry.

students attempted to translate their sequence from a group of digital models into words and rules, unique difficulties emerged: some of the “steps” in the sequence simply did not lend themselves readily to translation into written form. At the time, several students remarked on this lack of robustness without attaching any particular architectural significance to it.

Against a generic field

Next, students were asked to apply the written rule-sets to an abstract repetitive field such as ten dots or ten lines. Figure 3 shows the result of applying a rule-set originally written for Case Study House #22 to a field of four vertical lines. The resulting diagrams, from left to right, show the transformation of an original set of ten dots (analogous to the original cube of unit volume) into a set of dots with one dot selected and expanded, and on through several more steps involving additions and shifts – each of which is analogous to a corresponding shift within the original parametric transformation sequence. Several students confronted difficulty in this assignment, in particular in those cases where the written rule-set simply proved to be far too specific to be easily translated to a coarse-grained, scaleless field of dots or lines. Again, as in the previous assignment, some of the students reacted to this apparent lack of robustness by rewriting

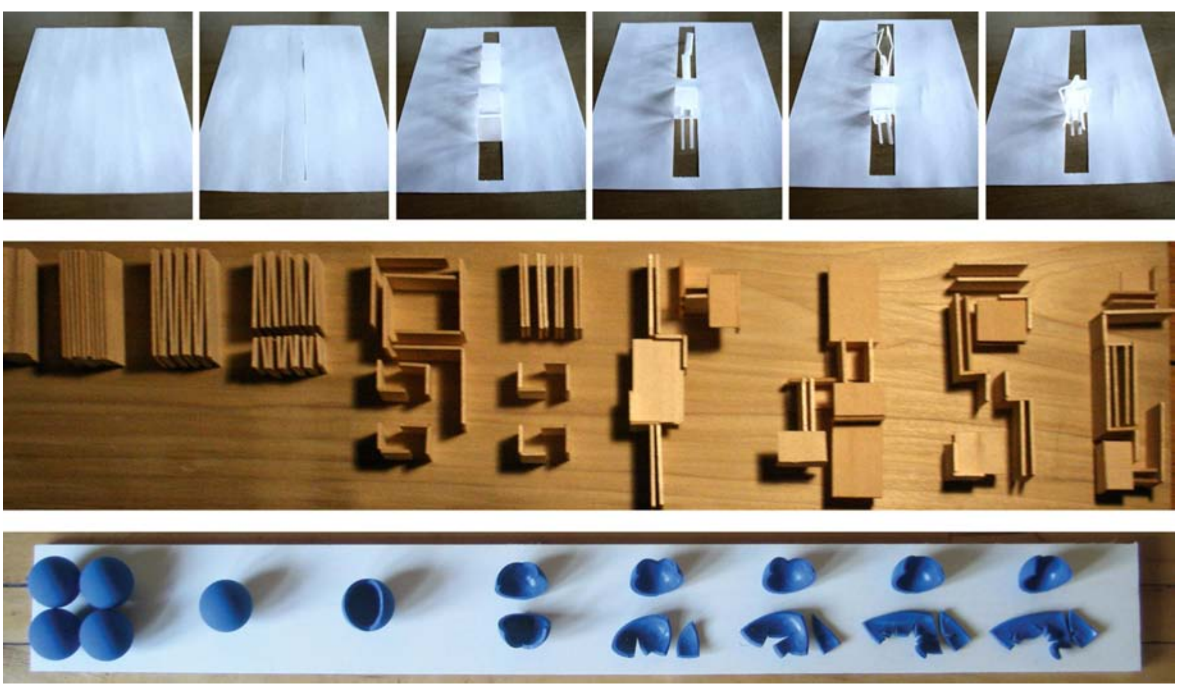

Figure 5. Translation of parametric instruction-sets to physical models. These images show the results of student work in the material field assignment. Students: Jeremiah Johnson, Tyler Johnson, Brian Glueckert.

or simplifying steps within the rule-set.

Against a materially specific field

Next, students were asked to apply their parametric rule-set to a given material or object. Figures 4 and 5 illustrate examples of work in which students selected, respectively, a potato, a piece of paper, wood strips, and a rubber ball. In response to these material translations, the seminar discussion shifted decisively away from the original works of architecture and toward an engagement with material specificity. Critically, the concern was not about the material specificity of the *original buildings,* but of the new materials introduced as testing fields. In short, it was at this point in the seminar that the parametric rule-set prompted substantive discussion of the "untranslatability" of specifically *architectural* attributes. In each of the translations from one medium to another, students faced unique difficulties of translation (i. e., a lack of robustness). For example, some students found that steps in a parametric rule-set which could be easily modeled in Sketchup were not easily described in words or drawings. Or again, a specific transformation which might be easy to suggest through the use of folded paper did not translate into wood.

Observations

Initially, when the students encountered difficulties from translating parametric rule-sets from one medium to another, they tended to characterize these difficulties as weaknesses of the original rule-set or as evidence of their own unfamiliarity with the material under consideration (folded paper in particular provoked unexpected difficulties in translation). In short the students tended to see these difficulties of translation as obstacles to be overcome. But as the seminar proceeded, and difficulties mounted with each new attempt at translation, more and more students came to acknowledge that what they had seen as obstacles could actually be unique opportunities to reflect on the limitations and capabilities of materials as well as on the specifically "untranslatable" aspects of architecture. Seen in this light, one important provocation which emerged from the seminar is the possibility of conducting similar exercises but on a finer scale of detail, as a means of testing the translatability of constructional logic. Allen and Rand's work with *detail patterns* (Allen and Rand, 2007) and Borden's recent book concerning *material precedent* (Borden, 2010) constitute important explorations of this issue, though in both cases through primarily graphic means. Another important possible trajectory for future work is the possibility of conducting similar exercises with regard to factors such as energy performance, structural behavior, or activity/program. Such factors, even if not easily or obviously expressible in formal terms such as those discussed in the seminar, may instead be expressible (for example) in written, mathematical, or geometrical terms.

Summary

The seminar's purpose in generating parametric rule-sets was not to explain or prompt the generation of works of architecture but rather to map a specific structure of thinking about architecture into new fields. Each of the test fields (such as the "generic" dots and lines, or the found objects) has its own inherent properties which are themselves made *uniquely* visible through the application of each rule-set. Ultimately, the purpose of the seminar was not necessarily to achieve insight into the intent of the original architects, nor to arrive at new architecture. Instead, its purpose was to understand the specific limitations inherent in *translation as an act,* which when considered generally, is rich in potential to disclose otherwise latent attributes in both existing architecture and material and digital fields.

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