Process and Individuation: Designing for Controlled Indeterminacy

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Abstract

Through the presentation of the design of a memorial, this paper intends to introduce an iterative design process that incorporates particle-based animation, parametrically constrained operations, and a variety of rapid-prototyping techniques. This is a project rooted in the generation and interpretation of physical artifacts dependent upon both the generative potential of digital media and the subjective modifications associated with design authorship.

It is stated in the brief for this ACADIA topic node that “the maturity of design, modeling, visualization, manufacturing and collaboration tools has allowed them to be naturally and comfortably integrated into the design process at all stages.” As such, the design statement for this memorial makes no mention of the incorporation of digital media. Process is subordinate to its result. Simply, the victims’ families would not find the range of technology incorporated in this design pertinent to the matter at hand: the design of a memorial to honor the victims of the attack on the Pentagon.

Within the context of this “Digital Design” topic node, though, it is my intention to expose the digital underpinnings of this project and position it within a discourse somewhere between *ars accidentalis* and the constraints of fully parametric and geometrically-associative design.
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1 Introduction

The animation industry has developed a set of tools for the simulation of life, which is effected by a mosaic of fluctuating external and invisible forces. Although architecture has been understood as static, fixed, ideal and inert, there is a shift going on from this determinism to directed indeterminacy through the incorporation of external constraints and environmental forces. Conventional architectural design software seems not suitable for the development of topological geometries that are capable of being changed and differentiated. For researching the possibilities of computer aided process and biological models of growth and transformation, architects should therefore rather discover the use of animation software (Lynn 1998).

Within Greg Lynn’s discourse of animate form, the computer becomes a tool of indeterminacy. The abstract space of design is populated by virtual forces of deformation, with which the architect must join forces, to which he or she must yield in order to yield newness. The design process takes on certain autonomy, a life of its own (Massumi 1997). Perhaps this is not a question of authorship but rather a question of an author’s role. The sophistication of digital animation is based upon a foundation of parameters and constraints. A perceived indeterminate process begins within a controlled set of actions. Design is instigation. Authorship is relegated to the initial establishment of control, or lack thereof, through programming. The generative potential of such a process is rooted in the creation of multiple artifacts, unique in form yet bound to a common set of instructions.

At one extreme, processes invested in animation and simulation emphasize the role of chance to the detriment of that of authorship. The introduction to the DEAF98 Catalogue boldly states that “a world that is open to continuous change and to becoming different, requires an ars accidentalis” and continues to say that “the creativity and the productivity of the accident, the break and the fall, have to be understood as the potential to achieve new forms of heterogeneity and of the disjunctive synthesis” (Brouwer 1998). The Art of the Accident accepts non-conclusive answers in defiance of deterministic formal agendas. Mark Burry has rebuked this “perverse giving-up of authorship” and argues that an “an object that has been designed reflects deliberate decision-making, not a serendipitous occurrence” (Burry 1999). He proposes parametric design through associative geometry as the “anathema to the accidental formalist.” The logic of parametric design is pure formal determinism. It is deliberate and void of chance.

Perhaps a reference to the work of artists like John Cage would suffice as defense for chance-driven processes, but rather than validating or vilifying any particular design methodology, this paper intends to outline a specific process of individuation and interaction. It is a process that is purposefully open to chance and recognizes the importance of choice. It is not arbitrary, but it is subjective. It does recognize authorship, but it also recognizes process. Designing for controlled indeterminacy seeks to synthesize rather than polarize certain aspects of ars accidentalis and parametric design.

2 A Memorial to Honor the Victims of the Attack on the Pentagon

“One aspect of a nationwide bereaved community is the sense of being ‘together’ with millions of others in that expressions of mourning bypass or transcend the many ways in which people are divided . . .” (Linenthal 2003).

The attack on the Pentagon was unparalleled and is still so fresh in our minds that the event calls for a special way to hold in memory the lives lost. This memorial intends to address loss as both an individual experience and as a collective reality. To accomplish this, one hundred eighty four individual memorials totaling the number of victims of the attack will be dispersed.
throughout the world and one collective memorial (Figure 4) will remain on the Pentagon site.

Recognizing that "loss is inseparable from what remains and that what is lost is known only by what remains of it" (Eng 2002), the collective memorial stands in contrast to the seamless renovation of the Pentagon in which the physical void created by the attack was filled within a year’s time. Given that each void in the collective memorial stands in place of an absent individual memorial, a visitor is left with the indelible impression that the
The events of 9/11 reached far beyond the immediate site of the terrorist attack. Physically the individual memorials represent the positive form of a subtraction from the collective memorial. They link together in complex ways, sharing volume as they overlap, making specific niches in the wall. The subtractive interaction (Figure 2) between them results in unique forms representative of the victim’s individuality and of the inevitable convergence of personal loss experienced by the victim’s friends and families. Each victim’s family will be offered a unique piece, and we wish that each family will find a way of expressing the memory of their loved one. It is important to remember that there is no right or wrong way for the family to interpret this individual memorial. We imagine that some of the memorials will find a home within the intimate setting of a garden or yard while others will be located in more public contexts like town squares and urban centers (Figure 3). They can be inscribed with the family name, a favorite quote, or a meaningful image. They may be left anonymously in a field, by the shore, or in the woods. We cannot be prescriptive, but only inspired and taught by the many different ways that these memorials will be interpreted.

The niches and ledges (Figure 4) in the collective memorial are not only markers for the one hundred eighty four individuals, but places in which visitors can leave mementos honoring those who...
died and marking empathy for the enormity of the event. The victim's families can find the place from which their individual memorial came and leave personal reflections. The existence of the voids within the collective memorial draws people to fill them with tokens of love and remembrance.

3 The Design Process
This project began with the intention of establishing random interactions between 184 discreet volumetric forms (i.e. the individual memorials). The interaction between these forms was driven by the parameters and constraints of a particle-based system (Figure 5). Initially, this system incorporated a simplified and uniform version of each memorial. By changing the algorithmic seed of the particle system, unique and random interactions were generated.

Within this animated particle system, each volume was scripted to subtract from other volumes upon intersection. The real-time nature of these Boolean operations allowed for a quick study of the potential resultant forms of the individual memorials when subjected to the interactive nature of the particle system. Later conceptual studies saw the variation of shape and orientation of the individual memorials, but the volume of each remained unchanged prior to any subtractions (Figure 6).

Certain rules were scripted into the interactions of the volumes. For example, each volume must intersect with at least two other volumes at all times. Also, Boolean operations were restricted...
Figure 9. A few of the study models. Laser-cut (left) and FDM-based rapid-prototypes (right).

Figure 10. Lighting studies, morning to dusk (clockwise from the top-left)
to maximum depths within each volume in order to avoid the dissection of any particular volume. These rules became a primary organizational device for the positioning and hierarchy of the memorials and their respective subtractive operations. Although subtraction was a key element in the design process, it was equally important that an adequate amount of each memorial remain following each interaction. An initial volume of 25 cubic feet was set for each memorial. In conjunction with the aforementioned rules, this set volume allowed for the estimation of space required for the interaction of all 184 memorials (Figure 7).

The overall size of the larger collective memorial is driven by the cumulative volume of the massed individual memorials. The idea is that the collective memorial participates in the subtractive operations already established between the individual memorials. As each individual memorial subtracts from each other, it also subtracts from the collective memorial (Figure 8). A large singular subtraction within the collective memorial guarantees that all of the resultant voids will have an exposed niche or ledge no more than two feet from the outer surface of the memorial and provides a clearly defined interior which will be internally lit at night. The subtractions of the individual memorials occur along the
between analogue and digital worlds. Clearly, a notion of digital design does not have to preclude iterative processes based upon normative analogue methods. The capabilities of rapid prototyping provide tremendous opportunities relative to the physical production of artifacts that are no less abstract than their virtual counterparts. The oscillation between the digital and the analogue is the means by which critical subjectivity mitigates accidental occurrence.

Ars accidentalis and parametric design present a dialectic opposition. The issue is that of instigation and control, respectively, for the designer. Ars accidentalis positions the designer at the beginning of a process that otherwise runs an indeterminate course. Parametric design denies indeterminacy through the absolute control of the designer. It is in the vast middle ground between these oppositions, where the role of authorship assumes variable responsibility for instigation and control. The in-between constitutes an opportunity for chance, choice and perhaps the control of indeterminacy.

**Project Credits**
Design Team: Shane Williamson and Betsy Walker, design principals; Stephen Griffin, Ronen Bauer, Alex Horber and Steve Sestic, assistants.
Consultants: James Roche, site engineering, Dave Bowick, Blackwell Engineering, structural engineering and Gary Steffy, Gary Steffy Lighting Design, lighting design
Contributors: Stratasys Inc.
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**4 Conclusion**
The design of this memorial culminated with a synthesis of representation that included rapid prototyping for various scaled models, 3-axis milling for the site model (Figure 12), particle-based animation and parametrically constrained operations for the initial generation of form, and the study of light and shadow through image-based lighting techniques. It was a process of both chance and choice. The initial parameters set for the particle system were open-ended and the design was literally set into motion. Repeatedly, the animation was stopped for evaluation and change. Often change would come simply through the addition or alteration of parameters within the animated system. As physical models were made from the digital data, the design process became manual, in the sense that parametric changes could no longer accommodate subjective critical evaluations of the physical model. Physical alterations were digitized, and the digital model was modified accordingly. The maturity of technology permits the exchange of data
References