Articulate Objects

hard processes and soft effects

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If the design of environments and experiences has become a key concern for many contemporary designers and artists, then what is the medium that becomes most prevalent? Light. Although elusive (one might even say ‘withdrawn’) and transitory, light can be seen as both objective and subjective content that is being explored by contemporary artists, designers, and architects. In addition, the very ephemeral quality of human experience means that light (although it is a condition which is made visible, objectified and transformed through its interactions with form and surface) is often, and strangely, disassociated from objective criteria. This paper uses two recently completed projects to outline an approach to overcoming tendency to separate the objective and subjective. It describes an approach which is positioned within contemporary theory and explored through processes, methods and outcomes. The work outlined explores how effects are theorized and instrumentalized through design processes not only as subjective or ‘soft’, effective, atmospheric conditions, but as affective drivers of objective or ‘hard’ processes.

INTRODUCTION

If the design of environments and experiences has become a key concern for many contemporary designers and artists, then what is the environmental medium that becomes most prevalent? Light. Although elusive (one might even say ‘withdrawn’) and transitory, light can be seen as both objective and subjective content that is being explored by contemporary artists, designers, and architects (Author’s Note 1). The very notion of effects (re: the production of sensorial and subjective outcomes) could seem out of place when framed within the context of computational design and architecture. However, emerging from the critical speculative work of the 1970s and 80s on into the early digital explorations of the 1990s, the question of the effects has been critical if not core to contemporary spatial practices including architecture, interior design, and installation art. Bernard Tschumi (1997, p107), literally the Dean of Digital 1.0 (Author’s Note 2) said, “Sensuality has been known to overcome even the most rational of buildings...Carry it to excess and it will reveal both the traces of reason and the sensual experience of space. Simultaneously.” Tshumi’s statement rings true in that he is articulating complex, nuanced sets of relationships which emerge between effects and objects, or as he says “reason and the sensual experience of space”. Similarly, Antoine Picon (2010, p147) has described an interior/exterior relationship between “…phenomena and noumena; that is, between objects and events as we perceive them and objects and events as they truly are.”
Building upon this basic foundation, the primary assertion of this paper is that ephemeral and subjective visual effects (emerging primarily through relations between light and form) can either be the result of, or inform and drive the design, fabrication and installation of objects (Author’s Note 3). This assertion frames two recently realized projects: Waller Phantasm (WPh), installed in Austin, Texas in 2015 (see Figure 1), and Flowering Phantasm (FPh), installed in Amsterdam, The Netherlands in 2016 (see Figure 2), and Enghien les Bains, France in 2017. These particular works use existing, environmental conditions of light as well as numerically controlled artificial light in combination with material, surface and form which is organized, fabricated, and assembled parametrically to generate a range of visual and optical effects.

There are three basic premises which are important to consider relative to both the works’ underlying assertion and the eCAADe Conference. First, contemporary works of architecture and design, most likely sparked by the rise of digital computation and fabrication regimes, have moved beyond the smooth, un-articulated surfaces of the early digital into articulated surfaces and objects (Authors Note 4). Second, novel outcomes and approaches to design and fabrication can be generated from basic design operations and programming methods afforded by accessible software packages. And finally, observations of outcomes, processes and methods may be selected from individual projects and projected forward as basic codes for new project instantiations and iterations. Fundamentally, the paper uses the projects as examples which help to synthesize questions and outline novel approaches to the generation of effects.

In this process, effective conditions which are generated through the computational design, fabrication, assembly, and contextual installation of complex, or articulate, objects are foregrounded (see Figure 2).

FOUNDATIONS OF EFFECTS
As a primary effects generator, light is certainly a complex and extensive topic. It may be understood through many lenses including science, art, architec-
ture, interior design, art history, phenomenology and perception to name a few. Although the norm for many architects and designers, is to explore light primarily through digital rendering processes, yielding pixels or raster images or photos of the project after-the-fact, there are certainly contemporary examples of more complex entanglements of form, material and effects. A few projects and practitioners which have been foundational to the prioritization of effects include the ‘Blur Building’ by Diller Scofidio from the early 2000s, and more recent works by installation artists Anish Kapoor, Tomas Saraceno, and Olafur Eliasson. Although not necessarily associated explicitly with ‘the digital’ or ‘computational’, each of these works employ highly complex design and fabrication processes to realize works where effects and subjective experience are prioritized.

Building on these references, a set of projects were developed as investigations of this relationship between form, surface, materiality and effects. The projects used a combination of light-weight materials with reflective surfaces in combination with catenary forms and light projections to generate immersive atmospheres. The most important effect produced by this system was the caustic (see Figure 3). A caustic is a visual effect produced by the convergence of light rays which is generated by material and form. In short, “…the effect results from a discrete manipulation of phenomena that is facilitated by the material but not determined by it.” (Addington, p203) The intricate caustic effect is produced by rays of light reflecting off of a formally manipulated surface with reflective material properties. This does implicate questions surrounding embellishment and ornament within design. More importantly, interrogating the caustic effect yielded the realization that light can be understood as vectors which may become instances of geometry (see Figures 1 and 4). In addition, we can explore and visualize the interaction between this ‘geometric’ light and geometric form through thin membranes, or surfaces (see Figure 3). However, as a visual effect, light may also conceal or blur the surface or formal delimitation. Once a range of interactions between light and form is created, we have effectively developed parametric light and form. The interactions between these conditions generate effects which typically fall into the broad category of optics. (Authors Note 5)

Figure 3 Parametric diagram of caustic effect, and image of caustic effects captured and generated by a formal installation. Diagram and image from previous project, Tesseract 4.0, by Author.

SCRIPTING PROCESSES
Within WPh and FPh, light is understood as both an effective and affective condition, as both acting and being acted upon. This understanding buttresses the primary assertion of the work related to the relationship between objects and effects. In previous projects (see Figure 3). Light was observed to have two key characteristics. It consists of parametric and geometric relationships (associated with objective form and materiality) as well as sensorial and spatial properties (associated with atmosphere and subjective experience). Certainly behaviors prompted by material and form drive the emergence of effects within the projects, but formal considerations and processes of design had to be developed to maximize these qualities. For Waller Phantasm (WPh) and Flowering Phantasm (FPh), project specific requirements such as contextual durability and fabrication constraints (inflected by the desire to expand complex optical and visual effects) drive much of the technical development.
Each of the projects are developed as armatures that are located within contextual conditions and host numerically controlled LED lighting elements. The productions, or effects, in their deep relation to underlying armatures as well as form and surface, cannot be de-coupled from the development of the tools, and thus, the development of the tools and techniques are critical. (Authors Note 6) The projects are organized, developed and resolved primarily through parametric, node-based programming. In these cases I have used readily available software Rhino by McNeel with the visual programming plugin, Grasshopper. This program allows me to easily build programs which both allow for form and for the development of surface. Being parametric, the software affords the development of subtle variations which may be quickly tested through visualization methods. Ultimately, the information from this design process is captured, organized, and fed directly to computer controlled machines for fabrication. (Authors Note 7)

**Scripting Waller Phantasm**

For the project, Waller Phantasm (WPh), the technical development built first on the conceptual understanding of light as a form of vector based geometry. This geometry was developed into a material armature which was both structural and linked to a materialization of light by using LED Neon strips. The formal armature was made up of a networked set of linear elements which, as all networks, converged at points in space. Elements were laid-out initially as loose wire frame models which established overall formal character (see Figure 4). These linear elements would ultimately host linear LED Neon lights, and the 3d printed nodes also allowed for the attachment of nylon cabling which spanned the site to attach to other critical points in the existing context (Authors Note 8). Ultimately, points of convergence within the network became defined as a series of nodes which, if designed properly, would become a jig which would maintain precise coordinate locations for the assembly of each linear element. These nodes were ultimately scripted to also allow for watertight, solid .stl format output which would facilitate fabrication using cloud-based 3d printing services (see Figure 5). Most importantly, the development of the programming focused on how to maintain unique geometric and contextual requirements and create a variable thickness of shell to meet structural and cost parameters. The use of Grasshopper allowed for the creation of a parametric definition which used standard components such as Pipe Variable and Surface Difference and Surface Union (see Figure 6). This definition afforded for the creation of nodes which not only provided for the connection of a network of linear aluminum tubes, but also created support. In addition, each node contained a point for connection a cable element which would span and link to larger contextual conditions.

![Figure 4](image1.png)

*Figure 4  Project Drawing on left with screen-capture of Rhino model showing armature with Grasshopper generated nodes and locational notations. by Author*

![Figure 5](image2.png)

*Figure 5  Grasshopper model, with baked rhino output and the array of nodes which were output using a cloud-based 3d printing service.*
Figure 6
example of simple
Grasshopper script
which was written
to generate 3d
printable nodes.
The small appendage on the
right side of the
model is the
location for cable
while the other 4
elements are
designed to accept
pipe of different
diameters.

Figure 7
diagram showing
the layered
development
process facilitated
through
Grasshopper.

Figure 8
Grasshopper
definition which
describes the
underlying proxy
surface.

**Scripting Flowering Phantasm**

Diverging from the previous project, Flowering Phantasm's supporting armature emerged from the scripting process as the by-product of set of formal/surface articulations. Where the previous work used a combination of modeling methods, here the totality of the work from the double curving proxy surface to the articulated surface units (petals) was generated using a set of grasshopper definitions.

The use of scripts and parametric definitions developed in grasshopper allowed for the development of an approach which explores the relationship between a parametrically defined form which becomes a proxy for a heterogeneous surface and structural system (see Figure 7). Further, the underlying surface is then re-used in later stages to generate areas for surface perforation and the development of additional layers of LED fiber.

With the desire to generate each part of the project through visual programming, the beginning script defined a proxy surface (see Figure 8) which becomes the basis for the development of the project which moves from smoothness to articulation. Working through a single script the project afforded both the generation of a parametric formal proxy which was smooth and double curving, and the generation of articulated heterogeneous assembly system where geometries were controlled by both fabrication and material qualities. (see Figure 7). This is at least tangentially related to contemporary questions of computational ‘excess’ where, as Mario Carpo (p81) suggests, “Subdivisions-based programs originally used to simulate continuous curves and surfaces, are now often tweaked to achieve the opposite effect, and segments or patches are left large enough for the surface to look rough or angular.”

To conserve computing power, once the form of the first surface reached desirability, it was baked and then referenced into the second part of the script which began to articulate the surface as flat panels (see Figures 7 and 9). Flat panels were desirable because, as described, the project was to be fabricated using flat sheet methods and tools. In this case, CNC Routing and CNC Water Jet Cutting were used to fabricate the pieces.

The beginning surface was panelized then each panel was given a tolerance relative to its neighbors. This tolerance was built up through successive steps with this 2mm offset being the first.

The panels, called ‘petals’ in the context of the project, were the given added tolerance by generating randomized radiused corners (see Figure 9). Creating radiused corners not only increased tolerance for assembly but also generated new figure/ground relationships which link to the conceptual approach. The petals were understood as individu-
ual entities which remained somewhat autonomous or withdrawn from their neighbors while simultaneously acting in aggregate rather than acting as discrete assemblies (Authors Note 9).

Once the base panels were generated, the proxy was superimposed into the panelized system (see Figure 10). This originally was an accidental condition which was created by turning on the proxy surface and panelized surface simultaneously. The resulting condition was clearly notable and through the development of a multi-scalar surface, the relationship was examined as a set of nested topographic lines generating a new figure on the flat panels themselves. Ultimately, these emergent geometric figures would host a set of surface perforations and would also be inflated digitally and become pneumatically controlled objects.

Once the basic petals were designed, the work had to focus on the structure and support of these elements (see Figure 11). With the goal of heterogeneous assemblage, the inner structure was developed as a three-fold set of layers which would ultimately be materialized using the same material. The outer part of this structural system had to support and locate each of the petals in space (similar to the nodal system developed for WPh). The scripts ultimately allowed for an ease of transition from digital modeling the fabrication.

**MATERIALITY, FABRICATION, AND INSTALLATION**

It is certain that materials must be considered relative to functional requirements such as stability, machinability and availability. However, materials are now also asked to retain the capacity for transformation of contextual information in the form of visual and optical effects. In discussing a transformation of our relationship to materiality, Michelle Addington (p201) goes further in her essay ‘Magic or Material’, stating that “...we should be asking about what behaviors we could manipulate...” through design processes. She follows that “…the behaviors are what matter and we should recognized that we can produce our desired behaviors...” For example, the outer material of Flowering Phantasm begins to resonate more deeply with its cultural and physical contexts. The gold finish of the petals resonates with the tradition of gold de-
tails on buildings which are found throughout Amsterdam, and the ‘hairs’ (in plants small hairs found on the surfaces are called trichomes) and systemic biological resonances fit with the context of the garden in which the project is set while also containing references to traditions of textile crafts.

Figure 12
image of Flowering Phantasm showing perforated surface ‘petals’ and inflatable textiles. By Author.

Figure 13
image of aluminum inner structure, hosting led light elements. The tubes on the right side of the image connect to Arduino controlled blower fans which inflate and deflate textile surface elements.

The perforations also host over 3000 feet of LED fiber hairs (see Figures 2 and 16). The profiles themselves are cut to allow tolerance between each unit which aids in assembly and generates a new visual pattern. The manipulations and compositing of materials such as the combination of led strands which are woven through CNC fabricated aluminum petals advance the visual atmospheric agenda. The combination helps to make the ‘hairs’ of the surface which both capture light from the interior of the project and create a feeling that the project is somehow simultaneously artificial and natural. In addition, where the outer surfaces / ‘petals’ were milled in the US, the surface supports and inner structure were fabricated in Europe.

CNC WaterJet cutting was used for the 3mm aluminum inner structure which was designed to host the computer controlled LED light fixtures (see Figure 13). Arduino controlled blower fans were also located within the structure and were programmed to expand and contract the soft, textile bags. The textile bags were also generated through the scripting process and fabricated using CNC knife cutting and sewn together by hand. Flowering Phantasm is at first a purely visual experience. People see the object, and are drawn through this visual provocation to experience an object that seems familiar without being referenced directly to anything in the world (see Figure 12). To generate this visual outcome, FPh used a range of numerically controlled fabrication techniques each with it’s particular material agenda.

CNC routing was used to fabricate the delicate, .02” gold, mirror anodized aluminum, exterior petal. Each of these units were unique and also highly perforated. The formal profile and perforations both provide for visual and functional conditions. The perforations allow light out, views in, reduce wind uplift in outdoor settings.

Rather than using materials which align with flat sheet processes, Waller Phantasm used 3d printing as its primary advanced fabrication mode. Each node was 3d Printed using the on-demand print service, Shapeways, which allowed for the use of different material from what was readily available locally. The suppleness of 3d printing allowed for a vast quantity of nodal pieces to be fabricated quickly and relatively cheaply using a material that also provided a good degree of structural capacity and robustness (see Figure 14). In addition, this material choice provided for additional joint strength without additional cost. The linear tubes were measured directly from model and cut using standard techniques. These tubes ultimately supported the linear led lighting units. Linear Units were dimensioned directly out of the digital file and cut using a standard chop saw. The LED lights were pre-fabricated by a third party and shipped to
Austin, Texas for installation onto the linear elements. The entire linear system was situated by a secondary armature which was designed and CNC routed out of plywood. This element fit snugly over an existing railing and support the primary linear, structural system which visually and structurally performs as a hybrid of rigid frame and para-textile.

**Observations on Outcomes**

Although each work described within this paper may be seen as singular project, Waller Phantasm and the subsequent work Flowering Phantasm are actually the evolutionary result of set of previous projects. Each project is a step of a process of honing and defining questions and generating new inflections. The possibilities for each novel condition are developed into new conditions as they are developed and re-instantiated. The processes, and by extension the produced outcomes, are constantly reconstituting and updating themselves. Their codes are passed forward, (a form of design-based genetic drive) and their logics and techniques are honed. It is a heuristic model for practice that is inherently speculative without being prescriptive. This mode of operation allows for accidental discoveries, such as the caustic effect described previously (see Figure 3), to become the core of future explorations. The projects as assemblages of theory, process, and outcomes present opportunities rather than didactic solutions. They ultimately provoke rather than tell.

The work does seek to use ephemeral conditions of light as ways of enabling the object to move beyond something that is conceptually and formally inert. Work such as Flowering Phantasm is at times is moving so slowly (either the lighting or the pneumatics) that it is difficult to discern that is doing anything. This aspect of the work engages the contemporary theory of Triple O (the OOO, or Object Oriented Ontology) which allows the work to conceptually engage and physically explore working with questions of elusiveness and natural and human engagements across multiple timescales which do not necessarily operate at the scale of human perception only. At other times, the work moves quickly with light color and speed changing through the use of algorithms which control and vary its timing. People are drawn to these displays much as we might be drawn into
natural situations with animals or plants who may only display certain behaviors or certain moments of flowering during very short time frames. The combination of heterogeneous components and effects is experienced sometimes as totality that people might describe as ‘atmosphere’ (see Figure 15). The type of atmospheric conditions produced by this variegated set of forms, materials, and effects become a pliable relational construct that engages people. It inflects our understanding of relationships between things in a more nuanced way while realizing that the invisible connects and orders as much as the material.

CONCLUSION

In synthesizing technical and conceptual approaches to effects-oriented design, the most critical effect produced is the work itself. In the conceptual and technical framework described, the object as both effect and affect is never a singular condition and therefore cannot be expressed as single, un-articulated form. Digital design and computational process provide the platforms for both the conceptual potential and the procedural development of this mode of contemporary practice. Articulate Objects are then defined as projects which engage in the generation of effects that are maximized through the development of overall form and the aggregation and excessive articulation of localized surface characteristics. These surface characteristics and by extension the visual and optical effects generated are informed by a move away from continuity and smoothness toward assemblages of surface parts and layering of surface and structural support. Within projects such as Flowering Phantasm, controlled processes which are focused on effects production yield outcomes where the function of parts works in and out of gestalt relationships. In other words, the parts and layers simultaneously work in together in contingent relationships and as autonomous units. They generate visual effects such as parallax views (which emerges subjectively through individual movement in combination with articulations of form and surface), and blur (which is generated by layered lighting, material and formal properties). The relationship between controlled geometry and materiality in relationship to the production of effects not only provides the frame for the work, but also represents a larger desire to transcend the modernist, dialectical opposition of subjective and objective within the spatial design fields of architecture and interior design.

The articulate object, because it is understood as a heterogeneous assemblage, is allowed to develop its own personality traits or characteristics. Characteristics include surface articulations such as perforations which host LED fibers, material properties such as color and reflectivity, and overall formal conditions. These characteristics then interact with people and other contextual surroundings by capturing light, projecting light, and transforming light through visual and surface conditions (see Figure 16). In this interaction, they generate both pre-figured and emergent qualities such as parallax or blur. The assemblage of parts that are articulated to operate individually and to interact together, react to generate productions as a set of visual, formal and material effects. For example, with Flowering Phantasm, the assemblage pieces, broadly structure, surface and ‘hair’, never fully join together. They operate in parallel, and by allowing them to remain somewhat independent the effects are amplified.

Finally, the work outlined within this paper seeks to explore notions of aggregated systems as contemporary design ecologies which generate effects...
through their engagement with contextual environments and interactions with people. The pieces are motivated by a set of key questions regarding complex relationships which emerge between the soft (or subjective) and the hard (or objective). This motivation drives the works’ development not only from concept to installation but also to future works. Where “space’ and ‘environment’ are ways in which objects sensually relate to the other objects in their vicinity, including larger contexts in which they find themselves” (Morton, p43), atmospheres and effects of spatiality, visuality and experience are made manifest based on multi-directional relationships with the assemblage which is also affected in the process. Ultimately, explorations seeking to synthesize theoretical and technical approaches through an effects-driven methodology are important and timely to discuss within the context of conference dedicated to research and exploration of computation. The underlying observations and questions are open, yet critical to expanding the territories of architecture and interior design as being objective, procedural and computationally driven as well as subjective, and effects-driven, spatial and formal disciplines.

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