Animate Form (Lynn 1999)

DRAWING FROM THE PAST : DESIGN TOOLS AND THEIR IMPLICATIONS IN FORM

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THESIS

Figure 10:
An example of a composite curve using the same logic of regional definition and tangency as the ellipse described in Figure 5. Each section of the composite curve is defined by a fixed radius. The connection between radial curve segments occurs at points of tangency that are defined by a line connecting the radii. Perpendicular to theses lines, straight line segments can be inserted between the radial curves.
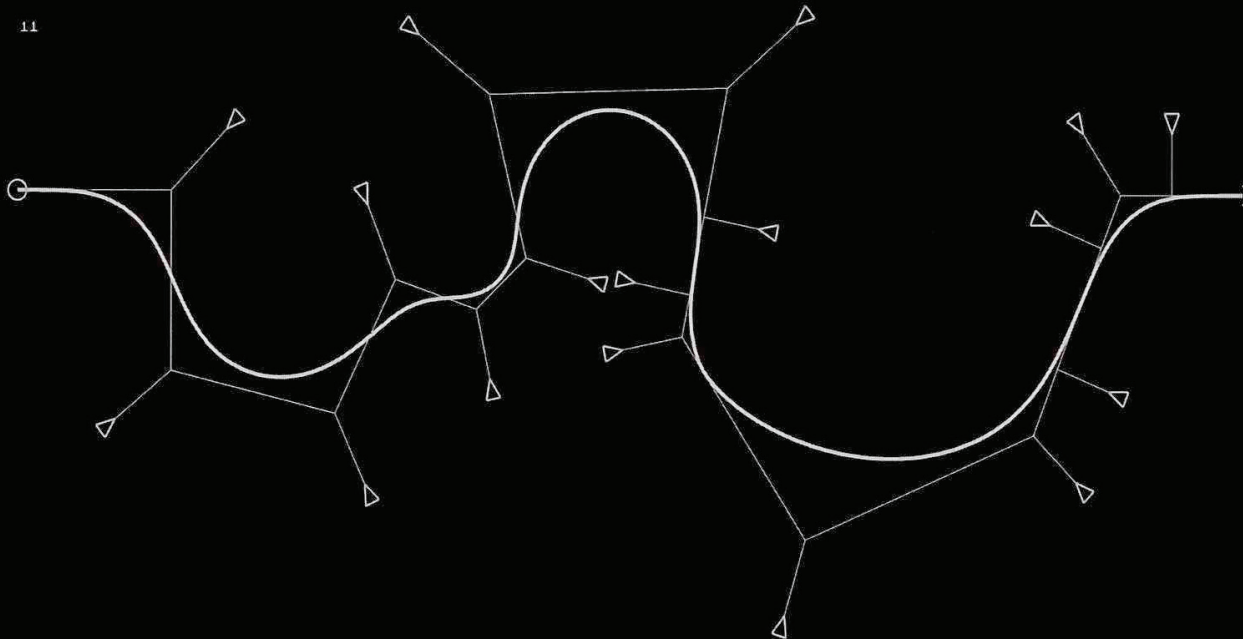
11

Figure 11:
A similar curve described using spline geometry, in which the radii are replaced by control vertices with weights and handles through which the curved spline flows.

ABSTRACT

CAD tools have changed the discipline of architecture. It is now possible to not only make forms of any kind we can imagine but also make these forms quickly, painlessly and at almost no extra cost. But while this has its benefits, it also has severe architectural implications. The lack of constraints in this environment tends to make choices of form less deliberate - CAD infact, is potentially too easy.

Thus, a re-thinking of how design tools impact designers, and constructive speculation and creation is needed to not only rethink CAD, but rethink the effects of tools in the design process.

PREAMBLE

The discipline of architecture suffers from many myths, but one that I find particularly problematic is of the architect as god holding a compass - as the figure who alone is the determinant of all form. Very often, it is assumed that the architect designs unburdened, unbiased, and intentionally. That is also often the dominant pedagogy pushed in most institutions of architecture.

This however, is not just incorrect, but also problematic, as it masks not only the underlying infrastructures affecting the decision making of the architect - which today are primarily digital design tools, like CAD, but also prevents us from leveraging these in intentional ways, from using and more importantly, mis-using these design infrastructures. While architecture's medium is indeed space, architects still need ways to communicate space, both to themselves as well as others, and this communication almost always happens through a specific medium, be it the pencil and the paper or the CAD software and the printer.

The argument to be made here is that these media are predefined infrastructures, created over several years by teams of people working under one unified project, themselves projecting new ideas about the ways we design and think, and if we, as architects are oblivious to that, the discipline and profession loses a certain power and intentionality to its tool-makers. In order for the profession to regain this subliminal power, it must become significantly more conscientious about these media.

INTELLECTUAL FRAMEWORK

1. HOCKNEY FALCO THESIS

The Hockney–Falco thesis is a theory of art history, advanced by artist David Hockney and physicist Charles M. Falco. Both claimed that advances in realism and accuracy in the history of Western art since the Renaissance were primarily the result of optical instruments such as the camera obscura, camera lucida, and curved mirrors, rather than solely due to the development of artistic technique and skill. In a 2001 book, Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters, Hockney analyzed the work of the Old Masters and argued that the level of accuracy represented in their work is impossible to create by "eyeballing it". Since then, Hockney and Falco have produced a number of publications on positive evidence of the use of optical aids, and the historical plausibility of such methods. The hypothesis led to a variety of conferences and heated discussions.

2. THE STUFF OF BITS - PAUL DOURISH

An argument that the material arrangements of information—how it is represented and interpreted—matter significantly for our experience of information and information systems. Representations of data in many ways set up the user to operate upon them in specific ways.

3. BUILDERS OF THE VISION - DANIEL CARDOSO LLACH

This dissertation identifies and documents a "technological imagination of design" emerging around the reconfigured discourses of design and design representation by the culture of technology production in the Computer-Aided Design Project, a Cold War era research operation funded by the US Air Force at MIT, tracing it into its contemporary deployment in the technology project known as Building Information Modeling. Exploring the discursive and technological linkages between these two sites, the dissertation outlines the ongoing project of construing technological centrality and universality as the dominant trope in discourses about design production. An expanded critical perspective on design is thus developed that looks at technological systems -such as software- and the cultures that produce them, with their histories and regimes of power, as crucial participants in, rather than as neutral vessels for, the design and production of our built environment. The dissertation ranges from examining the politics of representation, participation and authorship in the systems imagined by members of the Computer-Aided Design Project -in particular that of Steven Coons and Nicholas Negroponte's "man-machine" design systems. Artifacts act as brokers for culturally dominant conceptions of design, representation, and work.

INTELLECTUAL FRAMEWORK

4. TOOLS OF THE IMAGINATION - SUSAN PALLADINO

Before the tools of construction ever arrive on the site, the architect wields a different set of tools to design, develop, and document the building-to-be. The history of these drawing tools is one of invention and innovation. Here, Susan Palladino argues that there is a certain fidelity to older pre-digital tools that has been lost in modern CAD, and that CAD would greatly benefit by re-thinking itself in the language of these tools.

The above precedents have in common a certain method of looking at design tools that sets up the foundation for this project. Design tools in the past have affected the trajectories of art, can the same be said for architecture? Computational tools are to be thought of as infrastructure, as constructed sets of data and procedures, that directly impact the way we operate upon them - is this also true for CAD tools? Digital tools, in many ways have been crafted with speculations about the built environment in mind, they are intentionally created projects that push their own biases and projections - how can architects leverage this?

PROJECT PROPOSAL

Given the above context - of design tools and how they can potentially impact designers and also the already present projective nature and intentionality in the design of these tools, I propose a thesis to do two key things:

1. Study and analyze the history and impact of design tools on architectural form - not necessarily to produce potential linkages, but more so to understand how design tools are a part of the network of actors that play a role in the design process. This study then forms the basis of a framework that gives the foundation for creation of new design tools. This foundation is intended to foster a new intentionality in both the creation and use of such tools.

2. Create new, projective tools that are informed by the lessons brought forth by the above study. Using the above framework to create "prototypes" that form a part of the feedback loop for the modification of the framework and production of new tools that will inform this modification. In this way, the framework will not only be affected by historic precedent and research, but also day-to-day experimentation in making and testing new tools based on this framework - to see how it applies in practice.

A POSSIBLE TOOL - GEOMETRIC CONSTRUCTION

IMPLEMENTATION

This study proposes the development of a tool that biases a descriptive/geometric augmentation of CAD, in order to add more constraints and deliberate construction into the digital design process. This intends to be done through the use of the pre-digital toolset as reference for a new implementation of the digital in architecture.

The tool will take input from the user in terms of a drawing in the CAD environment, and return "construction lines" from the perspective of a pre-digital tool (hand drafting tool).

Colin Rowe famously took Peter Eisenman to the Villa Rotunda and asked him to draw something he could not see; this algorithm, at its core, intends to show the architect something he/she cannot see in their design. It posits that computation as a paradigm can be used not only to free, but also to constrain, allowing for a richer design process. This independent study is an exploration of a methodology of bridging the gap between the modern CAD environment, and the older, pre-digital environment. The primary goal is to construct a tool /algorithm that brings back the values of the pre-digital, and descriptive geometrical approach back into the CAD environment, such that the architect is then able to see the construction of the geometry they create through the lens of a particular pre-digital tool (such as Tubular Compass, Rolling Parallel Rule, Perspectograph, Centrolinead, Spring Bows, Parabolagraph, Antigraph etc).

The idea is to look at geometry (usually in the form of a 'sketch' made in the CAD environment) through the bias of the tool - which reveals aspects of the geometry to the architect unseen before. This has been tangentially posited by Greg Lynn in his book Animate Form, where the meaning of a curve changes when you look at it as a construction of circles, or as a construction of weighted points (a spline).

This also intrinsically changes the way one operates upon the geometry, and thus plays a very significant role in the design process. The power of the algorithm is in the ability to work as an operative device, showing the designer a geometrical bias toward the design, and allowing the designer to work on the design using that bias as a methodology.

The revealing of the construction through the pre-digital tool is an illusion, of course, CAD geometry is predominantly based upon the NURBS framework, which uses points and an interpolation algorithm based upon the point weights to generate the curve; however, this is not meant to reveal something about the underlying computational process, but in-fact to project a bias upon the geometry. A potential further goal for the algorithm is that it also begins to allow the user to

A POSSIBLE TOOL - GEOMETRIC CONSTRUCTION

operate upon the geometry through this lens. So, to go back to Greg Lynn's diagram of the spline, allow the designer to change the radius of the circles, which would change the curvature of the underlying geometry - and thus becomes an operative method.
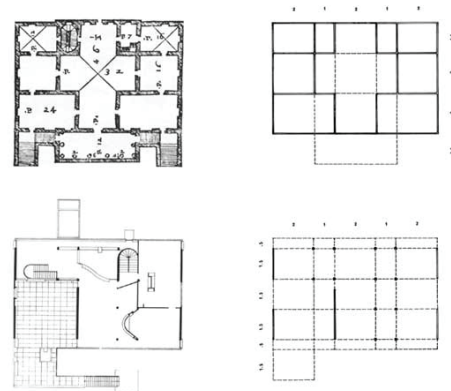
RATIONAL

At several points in the history of architecture, architects and theorists have tried to connect the notion of architectural beauty to the underlying geometric construction of the aesthetic. From the Ancient Greeks using the word "symmetria" to describe the notion of modules, ratios, dimensioning disciplines and progression (different from the English "symmetry" – which holds a fraction of the meaning, primarily relating to bilateral symmetry) and Alberti famously remarking in his treatise that "if a dog had one ear like that of an ass or if a man had one foot larger than another, we should immediately pronounce them deformed", to Le Corbusier's belief in primitive geometries having inherent value - to many contemporary architects, especially those concerned with the Baroque and the Parametric, such as Greg Lynn and Patrick Schumacher, architects have generally gone by the unwritten rule of geometric construction.

It seems to be that there is some inherent value in geometrical construction when it comes to design, and that this method of design usually leads to a resolved aesthetic
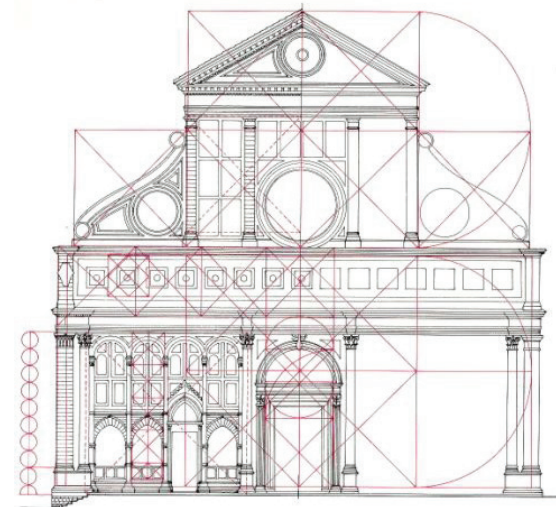
Leon Battista Alberti - Facade of Santa Maria Novella

Colin Rowe - Mathematics of the Ideal Villa

DESIGN AND RESEARCH METHODS

GENERAL METHODOLOGY

The project aims to be both research and design focused, with research serving as the foundational, past and present focused element, which will then be used as basis for the design of a framework which guides the design of future tools. The research occurs in two parts: First, through the investigation of potential parallels between the invention of design tools and architectural movements from the Renaissance onward, and second, through an analysis of the effects of current CAD tools on the design process. This then enables the design of a framework, which will create a methodology of thinking about design tools and for the design of future tools. [This model closely follows that outlined in Fig 2.1 from Groat and Wang - Architectural Research Methods] While being posited as a binary, between research and design, it is quite possible for the two activities to occur in smaller simultaneous sections, or even in parallel, the main distinction to be made is that research will enable better design.

Facets of Difference	Design	Research
Contribution	Proposal for Artifact (from small-scale to large-scale interventions)	Knowledge and/or Application that Is Generalizable (in diverse epistemological terms)
Dominant Processes	Generative	Analytical & Systematic
Temporal Focus	Future	Past and/or Present
Impetus	Problem	Question

Figure 2.1 Matrix of the primary differences between design and research.

METHODS FOR RESEARCH

The research part of the project will use both the Inductive and Deductive models for reasoning. The Inductive approach will be used primarily in relation to the past, as the "What"(the tool) and the "Result"(the architecture) will be known, but the "How"(its working) will need to be understood. The present however, will be understood through Deductive reasoning, as we will have an understanding of the "What" and the "How", but not the "Result". For researching the past, an epistemologically Positivist framework will be biased, but an ontologically Intersubjective one will be used. As happens with the past, understanding it within socio-economic contexts is always important, but it also tends to be understood as a distant object. For research of the present, the epistemological will bias towards Constructivism, while the ontologic will again be Intersubjective. The present tends to be hard to understand from a distance.The design part of this project will be carried in two main ways, Firstly through a series of conjectures about the effects of tools and the categorization of these effects (based on the research) which will then be evaluated and iterated upon. Secondly, through the contextual engagement of a multitude of contexts, such as the Architect's office, the University design studio and multiple contexts within these locations (schematic phase, design development, fabrication etc).

DESIGN AND RESEARCH METHODS

These two methods will allow for the creation of a framework that can be broad, and span between multiple parts of the discipline.

DELIVERABLES

HISTORIC RESEARCH

- Study and writings on design tools from the 15th Century onward (After Alberti)
- Analysis and categorization of CAD software in terms of their effects.
- Anthology connecting design tools and the designs they tend to create.
- Written framework for intentionality in use and design of such tools.

PROTOTYPES

- Series of implementations of CAD tools with above proposed framework
- User analysis of these implementations

POSSIBLE IMPLICATIONS

While not being intentionally biased toward the parametric, the tool could also serve as a bridge between the analog (the sketch) and the parametric model. Robert Woodbury, in his article in Theories of the Digital in Architecture by Rivika and Robert Oxman stated that the design process is based on the loose sketch, where the architect is intuitively, or implicitly draws the geometry based on certain parameters in their head. The parametric model on the other hand requires the designer to explicitly define the parameters he/she will be working with - which can be quite challenging, especially for the early stages in the design process. This algorithm can potentially be a method to bridge that gap, where the designer produces the initial sketch of the design, and the algorithm reveals to them a multitude of ways the geometry can be considered using parameters. A distinction also should be made however, between the general parametric model and what this tool intends to do. While the general parametric model operates upon geometry, the rationale it uses is not usually that of constructive/descriptive geometry. It tends to often be one of data/context-driven parameters, on the other hand, this tool is inherently biased toward geometry, and does not intend to impose the semantics of performance or context upon the design.

BIO

As someone currently negotiating between not wanting to become a practicing architect in the long term - but yet wishing to be within the discipline, Nicholas Negeroponte's articulation for why he chose to make design tools best argue for the reasons why I chose this topic - "I did not want to become an architect because to have an actual impact on the field as an individual is impossible, there's a one in a million chance that anyone will actually take reference from you - but I still wanted to make an impact, and so, I chose to make the tools that architects use" (Given at a lecture at Harvard G.S.D).

PRECEDENTS

The precedents below are not necessarily representative of the final image that I intend - but rather more so of the kinds of thinking that goes

1. NeoLucida by Pablo Garcia and Golan Levin (http://neolucida.com/)
This project deals with the Hockey-Falco hypothesis of art, which is essentially the crux of my thesis, except that mine relates to architecture. It is a modern version of the
Camera-Lucida, a 15th century drawing aid that arguably began the realistic drawing
revolution in art.

2. John Hejduk 9 Square Grid
Constraining the design space by the tool used, this is a brilliant example of a pedagogical approach to design tools. It consciously designs a tool with intent, a way of thinking I hope my thesis will embody.

3. Scott Donaldson Voxcel (http://scottland.cc/projects/voxcel/)
Scott takes Hejduk's 9 Square Grid into the digital realm, where he sets up a very clear and intentional design language. This notion that a tool can set up a design language and bias its use intentionally is a primary focus in my thesis.

4. All of the examples here (https://drawingmachines.org/)
Historic Drawing machines were enormously constrained, allowing the drawer/designer to only work through a singular language. A lot can be gathered from studying these objects
and understanding their inherent biases first hand.

BIBLIOGRAPHY

1. Tools of the Imagination - Susan B Palladino
An anthology on different pre-digital design tools, with various essays arguing their purpose and biases, this will serve as a good starting point for thesis.

2. Animate Form - Greg Lynn
Moving from the line to the spline, Greg Lynn clearly articulates the notion that based on the tool the architect uses, they operate upon geometry, and thus building, differently. This serves as the basis for the rhetoric of my thesis.

3. Digital Turn in Architecture - Mario Carpo
Various arguments for what is inherently different in the digital medium, and how it affects architecture makes this a seminal text for my thesis, with various arguments detailing what is different about digital design, reflect the underlying rhetoric of "the medium is the message".

4. The Electronic Design Studio - Malcolm McCullough, William Mitchell, Patric Purcell
An exploration of possible methods in which the computational medium influences design, including design pedagogy, it will be a useful reference to looking into different methods of thinking about computation in the design process.

5. Second Digital Turn in Architecture - Mario Carpo
Projecting forward, and looking at the new way of computing and thus, the new way of designing provides a useful speculative ground for my thesis.

6. The Logic of Architecture - William J Mitchell
Mitchel's Mathematical Formalization of architecture creates a great example of how a medium influences a discipline. (Computers affecting architecture).

7. Descriptive Geometry & Computer Graphics - Ramesh Krishnamurti
Useful technical books for the implementation of any geometric tools I chose to create.

8. Mathematics of the Ideal Villa - Colin Rowe

9. Circles and Lines - Cameron Wu

10. Deviated Histories - Pablo Bronstien

11. Architectures of the Digital Realm - Experimentations by Peter Eisenman | Frank O. Gehry

12. Mapping the Unmappable - Stan Allen

13. The Projective Cast - Robin Evans

ADVISORS

CMU

1. Daniel Cardoso Llach (Architecture)
Professor Cardoso's wealth of expertise in tools for design and design systems as exemplified by both his PH.D Thesis, and his research from that point onward make him an obvious advisor for this thesis. He will be able to provide much of the background references and informed critique to structure my work and process.

2. Joshua Bard (Architecture)
Professor Bard's focus in tools for the purposes of digital fabrication, and the workflows related with such will serve as important provocation and rethinking of my project in pragmatic terms, where the tools I create will not just be for the purposes of speculation, but also real-world making.

3. Golan Levin (Art)
A strong advocate of the Hockney-Falco thesis, and a creator and explorer of digital worlds and thought processes, Professor Levin's background in the creation of digital worlds will guide me in thinking of my tools as "worlds" as well, which will be a very different notion as compared to tools as production machines.

NON-CMU

1. Kyle Steinfeld - University of Berkeley Architecture
Steinfeld's expertise in design tools, computer graphics, 3 dimensional geometry, and machine learning means that he will be an unending pool of resources, critique and discourse. His focus on drawing tools aligns very well with the same focus I intend to hold in my thesis. Hopefully his scope will be tangential/broader than mine to be able to shake my thought process up / make me rethink what I'm doing consistently.

2. Carl Lostritto - Rhode Island School of Design
Exploring drawing and code, Carl Lostritto is dealing with the primary medium of my thesis (Orthographic line drawings) and interpreting them in a contemporary medium (Code). His understanding of what a line drawing means in the digital age will expand my thesis beyond traditional notions of design and representation.

3. Pablo Garcia - School of Art Institute of Chicago
Pablo Garcia explores technology and culture, and how each one affects the other, beyond being one of the collaborators on the Neolucida project, he also has expertise in drawing machines as well as background in digital tools and their relationship to art.