ZERO+

Architecture Design Studio
Yearbook 2016/17

Edited by Simone Giostra
with Alberto Lunardi and Giovanni Nardi

Energy / Form Unit
Graduate School of Architecture
Politecnico Milano

First published 2017 by Energy/Form Unit
Graduate School of Architecture - Politecnico Milano

Contact information:
Simone Giostra
Department of Architecture and Urban Studies
Via Bonardi 3, 20133 – Milano, IT
E-mail: sgiostra@polimi.it

Designed by:
Simone Giostra, Alberto Lunardi, Giovanni Nardi

ISBN 979-12-20-02213-2

Printed in Italy

Cover: Image by Scott Sorenson

Contents

Tools

Digital Tinkering: Experiments in Energy Form-finding

Simone Giostra

After nearly 3 decades since their first appearance in architectural practice, digital design tools are increasingly pervasive in nearly every aspect of the profession and throughout the building life cycle, from project development to construction administration to demolition and recycling. While an integrated approach to building information management is becoming the key to winning projects, the creative attitude of an earlier generation of computational designers is fast replaced by new tools and protocols geared toward achieving efficiency targets and boosting profitability.

The studio takes on a different path toward our shared digital future—one that tries to address the environmental challenge while fostering creative freedom.

Gateway to another world

A claim frequently heard from older colleagues, both at school and in the profession, is that new forms of digital practice—that is, using a machine in the artistic process—stifles creativity and generates anonymous architecture.
In fact, the problem of design is not, and it never was, one of creativity—of enabling the mind to formulate new formal constructs, that is, of 'coming up' with ideas—but quite the opposite:

The creative process desperately needs parameters, limitations, some kind of intellectual friction in order to operate.

Unchecked, the mind is capable of conceiving the wildest shapes, none of which would actually turn into architecture. The first set of limitations comes in the form of a tool enabling thoughts to take shape in some intelligible way. Ideally, a useful design tool would limit the range of expression to only that which can be eventually built. If the tool is too restrictive, you will end up with conservative or conventional design; conversely, if the tool is too loose or unresponsive, you will end up with wild propositions that cannot be built. If architectural drawings are the anticipation of the act of building, then tools are the guardians of the act of anticipating, deciding which line/form/structure has a right to exist in a drawing.

Many older modelling and visualization tools, such as 3ds Max and Cinema 4D, knew no boundaries, since they were created by the film animation industry precisely to 'unbound' the imagination of the designers and to create an imaginary world that needed to exist only on screen: "your gateway to another world" is the promise by a leading developer of 3D software. The evolution of graphic interfaces only meant an increasingly smother transfer mind-mouse-screen that effectively eliminated many, if not all, limits to creating free forms—making the results largely irrelevant to the purpose of building.

The fact that an early generation of architects were being introduced en masse to these tools in the mid-1990s by elite architecture programs at Columbia University in New York, SCI-Arc in Los Angeles or the AA in London, speaks to the opportunistic, disingenuous relationship between architecture and the graphic software industry. By and large, this first generation of 'digital' designers were responsible for stretching, once again, the boundaries of what was considered architecture—and for raising much of the opposition to the so-called 'blob architecture' that is still felt in academic circles today, along with a lingering suspicion toward any new digital tool since.

From the command line

Digital design, however, has many strands. At the opposite end of the spectrum, early CAD tools offered a great deal of resistance in the form of a reduced number of operations, none of which included unforeseen or unimaginable results. A 'command line' implies a master able and willing to spell out orders: here every shape is the result of explicit instructions given in a specific sequence, using a mediating protocol that requires training and some ability. Similar to the visualisation tools discussed earlier, CAD software was developed for the engineering industry, not architecture, and presented its own kind of limitations. For one, it forced the designer to a level of precision that finds no application in architecture, particularly in the early stages of the project. Also, it did not allow for any tolerance, since it demanded that each line should be placed in Euclidean space without ambiguity or hesitation, with the snap function marshalling any wandering line to its designated place. Incidentally, Building Information Modelling (BIM) software belongs to this second lineage of digital design tools.

An intelligent 3D model-based software that involves functional and relational characteristics, BIM represents a more pragmatic and conservative response by the industry to the same disruptive forces transforming all levels of design. In fact, BIM tools are designed to enhance productivity and ultimately profitability—one major player in the market incites architects to "use BIM architectural design software to win more work and retain clients"—at the expense of innovative and risk-taking approaches to design. Contrary to a generalised perception that BIM software should empower the architect and foster design innovation, I am convinced that it will regiment the creative process in favour of delivering normalised, predictable (and profitable) results.

Interestingly, BIM software represents the antithesis to the experimental processes pioneered by early digital artists and the hacker culture that infiltrated many artistic fields over the past 40 years—first electronic music, then video art, interactive design and gaming—and slowly percolated into more traditional design fields such as architecture, with the introduction of graphical algorithm editors like Grasshopper and Processing.

The projects presented here bring back the spirit of this early experimental phase, when algorithms were used to propel as much as disrupt the traditional design practice.

Generative tools

Because of its disruptive potential, a conservative majority still perceives the digital practice in opposition to analogue modes of design, such as hand drawing or model making—a futile distinction at best, serving the entrenched

Tools

interests of an older generation. And it's not merely a fight for self-preservation. Some of the most exciting digital tools making their way in the profession are generative in nature, that is, they open up design opportunities that become apparent only to those who practice. As with any other craft, there is no verbal substitute for a digital practice. Most decision makers, in our schools as well as in most traditional industries, simply lack the digital skills to appreciate first-hand the generative potential of these tools.

For centuries, architects have been using scale models to predict the performance of buildings by applying materials and techniques that replicated actual constraints. Physical models, however, cannot test a design solution for structural integrity, as commonly accepted before the discovery of the so-called square/cube law by Galileo in 1638. Interestingly, for over 300 years from the first publication of the 'Two New Sciences', we did not have a reliable analogue method to test structural integrity of buildings in the early phases of design. This is particularly striking if we consider, as Reyner Banham noted, that the history of architecture up until the end of the 20th century is largely an history of space-enclosing structures.[1]

Remarkably, intuitive computer simulation tools provide designers with the unprecedented ability to test early design concepts for structural integrity and energy performance, effectively overcoming a centuries-old limitation.

And there is more: the introduction of accessible parametric tools, such as Grasshopper a decade ago, allows to use rules and algorithms to generate forms, resuming the tradition of form-finding that consumed the best minds of an earlier generation of architects—including Frei Otto's experiments with lightweight structures and Gaudi's analogue force models.

Rather than a fictitious opposition between digital and analogue models, then, what's really a stake is a dramatic shift in recent years from form-making to form-finding.

Today, energy considerations are supplanting structural integrity as the main parameter in designing a building. Thanks to advances in computer technology, we are the first generation of architects with the tools to simulate relevant energy indicators from the very early design concept, using inexpensive applications run on our laptops. Of particular interest are tools that produce graphic output in the form of 2D- and 3D-color-coded diagrams, in some case projected directly onto the space being evaluated. I am convinced that the defining challenge for our generation is to do for energy what Frei Otto and Gaudi did for structure: shaping buildings using energy-related constraints—in other words, energy form-finding.

Invisible forces

The problem with parametric design tools is that they require explicit instructions to operate; in other words: they only execute orders. As any architect working on a design problem knows well, much of the creative process in architecture is based on what Malcom McCullough calls 'intrinsic information', that is, information that is embedded in the ambient and come to fruition less through focused attention than by situational awareness.

Creative work does not always involve deliberate thought; a skilful practice, tools as props, habituation—all play a cognitive role in 'coming up' with ideas. As he puts it, "A great deal of knowledge is inarticulable, especially when in use. In music, sports, or many other expertise, you can do things you cannot explain".[2]

While digital tools should not replace the architect's mind in formulating a design concept, they can be very helpful when dealing with information that does not fall within the visible spectrum. In one of his seminal writings, Buckminster Fuller famously declared: "[…] Forms are inherently visible and no longer can 'form follow functions', because the significant functions are invisible".[3] He was referring to natural forces, as well as to material properties that are not detectable by senses or experience, since they result from manipulation at the molecular level that are invisible to the naked eye—yet have a great impact on the built form. Environmental analysis tools can provide critical insights into these invisible functions by widening the architect's gaze in areas of knowledge outside the spectrum of visible light.

There are obvious advantages in giving form to these invisible forces, as they play an increasingly larger role in the built environment. Architects typically resort to highly technical solutions for compliance with ever stricter energy codes—'green gadgets' that come in the form of sophisticated mechanical systems, super-insulation materials or expensive glass treatments—so that they don't have to question a consolidated formal language. Conversely, formal solutions that directly address these invisible forces at a structural level can dramatically improve the performance of buildings by reducing heating and cooling loads, fostering daylighting and natural ventilation, and generally lowering energy demand.

Additionally, a building form that is the result of a form-finding process can manifest information regarding the ambient—prevailing wind direction, solar radiation levels, air flow or pedestrian traffic—in ways that are intuitive and do not require mediation. A classic example of the architect's disconnected design approach to the new energy imperative are the many digital displays showing the amount of energy being produced by solar panels that are hidden away on the roof of buildings. This is particularly relevant in an age of mediated information: as we increasingly rely on screens, large and small, to retrieve useful information on our environment, embedding information in the persistent structure of buildings can have positive effect in learning to navigate our world without depending on a smartphone.

Beauty and survival

This bring us to a final question regarding the use of form-finding strategies and related computational systems predicting the behaviour of buildings. We understand that a form resulting from relevant forces might cope well with these same forces, so that if a building envelope is shaped based on solar radiation levels, for instance, it has a larger potential for energy generation than a building shaped after a crumpled paper bag. But how prominent should the energy radiation potential be among the many factors—such as program, context, budget, historic references or quality of interior space—contributing to the design of a building? The answer depends on the stage of human development in which you find yourself operating.

Cultural values govern the relationship between nature and human actions—a sort of protocol of engagement with our natural environment designed to improve the human specie's competitive advantage and, ultimately, chances of survival. Even abstract notions such as 'beauty', according to Denis Dutton, might be evolutionary determined, so that we consider beautiful that which enhance the survival of the human genes.[4]

By necessity, then, design criteria must be an evolving concept, as our collective success is continuously challenged by changing environmental conditions.

Tools

In his book *Collapse*, Jared Diamond argues that with changing environmental conditions, societies face the challenge of identifying which cultural value can be sustained and which one is no longer appropriate to the new set of conditions.[5] For instance, he writes about the choice of Greenland Norse to stick to Christian identity values—refusing to adopt habits and techniques from the indigenous Inuit that were much better adapted to the environment, because deemed culturally inferior—as the main cause of their extinction. Interestingly, he describes how societies on the verge of environmental collapse, such as the Rapa Nui civilisation, stubbornly clings to—and sometime even intensify—the very same practices that are the root cause of their demise. Erecting large ceremonial statues on Easter Island turned into an unsustainable practice toward the end of the 17th century, as it required a disproportionate amount of timber and human labour to sustain, in a context where sources of both trees and proteins were depleted. Interestingly, statues became increasingly larger and more complex, therefore demanding more resources, precisely when resources became more scarce.
Confronted with the progressive depletion of resources and declining quality of our natural environment, we continue erecting monuments to our minor gods.

In the eye of future generations, the irresponsible use of resources to serve the extravagant formalism of some of today's most prominent architecture will bring to mind the excesses of a collapsing civilisation.

And if history is any indication, cultural conservatism is not what will get us back on track. On the contrary, I believe that this is a time for vigorous experimentation and some serious debate on what we collectively can and cannot afford.

Notes:

1. Banham, R. (1984). *The architecture of the well-tempered environment*. Chicago, IL: University of Chicago Press.
2. McCullough, M. (2013). *Ambient Commons: Attention in the Age of Embodied Information*. Cambridge MA: MIT Press.
3. Fuller, B. R., & In Snyder, J. (2010). *Ideas and integrities: A spontaneous autobiographical disclosure*. Baden, Switzerland: Lars Müller Publishers.
4. Dutton, D. (2010). *The art instinct: Beauty, pleasure, & human evolution*. New York, NY: Bloomsbury Press.
5. Diamond, J. (2005). *Collapse: How societies choose to fail or succeed*. New York, NY: Penguin Books.