Synthetic Computational Design

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"The designer finds himself in a specific historical situation, facing some particular problem. He responds to the logic of that situation with some design solution, and this in itself produces a change in the problem: it creates a new problem."

Philip Steadman [i]

In the twenty-first century, new terms increasingly arise, with which to describe new ways of thinking and operating based on developments of new technologies, which can be understood as the sum of technical theories. [ii] The application of digital design and manufacturing tools has profoundly changed conventional design methods and building processes. Parametric and computational approaches have emerged as alongside sustainable design, and interestingly, these two trends have only recently begun to become correlated. The first generation of digital architects, such as Greg Lynn, Frank Gehry, Zaha Hadid, and several others, opened up a new territory by embracing new digital design methods. A second generation continued to explore the possibilities of these new digital tools for architectural design, while the current generation of countless young designers is working towards the exhaustion of computation as new design problems are being created.

The first and second generations have demonstrated some of the possibilities of these new methods, in how we can technically build anything, as long as we can imagine it. If this is indeed a dream come true, then a question to ask the current generation is what shall we design if anything can be built? If past generations had committed themselves to the pursuit of the New, the current generation ought to aim for greater synthesis in their propositions.

What is synthetic computational design?

In order to articulate a definition of synthetic computational design, we should firstly delineate approaches to computational design which are not classed as synthetic. Non-synthetic design focuses on highly limited scopes of the entire design process, for example, aiming solely to invent new forms, to create new types, to explore new prototypes. It focuses on fragmented stages of the whole, as a single layer rather than multiple layers of a synthetic approach to computational design. Non-synthetic design severs the complex connective network of the mechanisms informing an architectural project into isolated tasks. Synthetic computational design covers a broader range of consideration throughout computationally driven project, including not only formal and spatial ideas, but also communication and procurement; not only generation and automation, but also optimization and evaluation; not only quantity and quality control, but also risks and costs management; not only aesthetics, but also efficiency; not only durability, but also flexibility; not only innovation, but also fitness. It is essential to map out these complex workflow networks, and to engage holistic processes with cutting edge computational tools rather than concentrating singularly on particular, isolated aspects of project workflow.

Consideration of a broader scope of processes is not enough. Distributed knowledge across different disciplines must be integrated coherently through computational means. The translation of project information into a quantified database shared by the design team, aims to distinguish, as well as integrate, the criteria and goals of a project. Design decisions are made, negotiated, and evaluated by all relevant parties, instead of being determined in a fragmented mode and then collided.

Thirdly, synthetic computational design must be meaningful for society and the environment. The measure of significance has many scales. Environmental significance can be measured through well established sustainable design evaluation systems, such LEED or BREEME accreditation. Here I am more concerned with social significance than with over-familiar environmental arguments. Synthetic design processes should not simply be driven by the strong desires of a singular designer, but rather being in correspondence to an intricate understanding of context, and in return, creating new contextual conditions with which to inform the design process. Architectural form can always be understood as the expression of culture and context, and at the extreme, architecture inevitably becomes symbolic. "Restoring symbolic meaning is a most fundamental task in a metropolitan world in crisis of communication. … Architecture, of all kinds, must be called to the rescue in order to recreate symbolic meaning in the metropolitan region, marking places in the space of flows. …" [iii] Symbolic, or rather, iconic architecture, I would argue, should not be criticized because of the deployment of symbolic form, but rather for the lack of integration to existing public space. Architectural form can increasingly be understood as cultural expression in the Information Age. Computation offers designers powerful tools with which to innovate and, to go beyond subjective inertia of individual styles. It also propels design away from the superficial mimicry of form into a new territory of understanding the logic of formation, so that architectural knowledge can be embedded into metaphoric forms. Emergent forms can be generated and negotiated with designers' intentions under specific constrains. Designers should learn from the process of engaging with feedback mechanisms which reshape initial intentions. In other words, synthetic computational design enables more meaningful iconic architecture.

Why synthetic design?

Reductive ideologies and methodologies dominated architecture in the twentieth century, perpetuating the belief that by understanding the parts of a system, the entire system can be comprehended. Avant-garde practices often engage in focused, isolated aspects of architectural design, to facilitate experimentation with new techniques. Experimental design is therefore not normally synthetic, as it focuses on particular aspects of a complex project in order to manage innovative thinking, with the hope of delivering the New. Nevertheless, experimental design is necessary to proceed to synthetic computational design, because, without understanding the parts, there is no way we can understand the whole.

Today's world is inter-connected, and multiplicities of relationships and interactions are more significant than singularities. By no means can we fully comprehend all the relevant issues of an architectural project by breaking them down into pieces, nor can we propose a meaningful scheme which exhausts the every problem within a context. We must, however, prepare ourselves to engage the whole with collective cooperation of distributed intelligence through computational platforms in order to maximize the effectiveness and efficiency of a design scheme. A parallel analogy can be made with Western and Eastern approaches to medicine, where the former directly targets the locus of pain, whereas the latter focuses on the micro-network causing the pain. The consequences of the Western approach are immediate effects but with more side effects and less durability, whereas the Eastern approach to medicine cures slowly but may have less side effects and longer relief. The Eastern approach aims for long term effects and is therefore more durable, as does synthetic design, which understands problems of an architectural project as a network of interactions.

Many people still regard computational design as solely creating expressive and expensive forms, rendering judgments from a superficial level, disregarding irregular forms, but failing to understand the significance to design processes and discourses, modes of manufacturing, and the qualities of computationally driven products. Computational design has evolved from obsessions with the creation of forms, towards intelligence, efficiency and automation throughout the entire life of architecture. Synthetic approaches are gradually stitched together by increasing interests in various aspects of architectural industry rather than creativity being limited to formal and spatial issues.

Synthetic computational design targeting sustainable development

No doubt sustainability has become a central priority in the twenty-first century, aiming for patterns of resource use which aim to meet human needs while preserving the environment, so that these needs can be met not only in the present, but also for future generations. Sustainability will inevitably become ubiquitous, as will computational design. The underlying nature of computational design is optimism, corresponding to the core values of sustainable development, which aim to minimise resources and maximise performance. In this sense, the time has come to target sustainable design with computational design systems. Sustainability stands as intentions, while computation substantiates the technical means to confront these challenges.

Sustainable development comprises three dimensions: environmental sustainability, economic sustainability and socio-political sustainability. In short, environmental sustainability concerns the impact to the ecological environment by balancing the consumption of resources and deterioration to the eco-system caused by human activities; economic sustainability encompasses opportunities for economic growth which treats nature as economic externality; socio-political sustainability refers to the equal or greater access to social resources as the current generation. These three dimensions should be integrated into agendas of sustainable development to induce more holistic approaches to the building industry, which contributes to nearly 40% of global CO_2 emissions, and vast quantities of raw material consumption.

Sustainable architectural design has been addressed for many years, to the extent that its principles and constraints have been codified into building regulations in several Europe countries. Sustainable building products have been developed and are proliferating in the past decade. There are, however, three fundamental problems associated with most sustainable design practices.

Problem 1: Fragmented design approaches

Only when the social, economic and ecologic aspects of a project are integrated, can a coherent design solution be achieved. Otherwise, projects claiming to be sustainable remain as unrealistic show-pieces of so-called sustainable architecture. These claims may work in the climate this decade, but they may also become superseded by conflicting and changing interests of local communities and economic fluctuations. A holistic design approach capable of tackling sustainable development must be adopted to balance these three dimensions of sustainability. The greatest opportunity to achieve genuine sustainable design lies in the integration of all design factors into quantified data generated and managed through computational platforms.

Problem 2: Lack of inherent thinking of spatial and geometrical aspects of architecture

Due to the materiality of architecture, most efforts have been invested on building materials, energy preservation and supply, and construction methods for the sake of sustainable development. Contemporary design practice can be reduced to the selection of the standard products and placing them into a framework. An extreme symptom of this mode of practice is when architects design forms and spaces with neutral materials which are then filled by material suppliers. This leads to retrospective design modifications to cope with the material constrains, and therefore this workflow mode wastes time and material resources.

Architects are no longer masters of building materials, due to the overwhelming amount of resources, where new products flood onto the market every day, and nor are they the masters of building technologies, which are increasingly complex and distributed. What remains for architects is to be the master of form and space driven by all relevant parameters. Can architects address sustainable issues when they draw their first sketches as a mode of geometric expression? Instead of engaging in processes from design generation towards optimization, can optimization happen early in the design process as a form of optimized generation?

To achieve these goals, rule-based geometry is generated through the embedding of parameters which respond to optimization criteria later in the design process. A meaningful geometry, which is more efficient, effective and, corresponds with social, economic and environmental constraints, is more significant than undisciplined expressive forms. The value of contemporary design has been profoundly depreciated by the fact that nothing can be surprising any more due to the quick spread of news through media today. Meaningful geometry does not mean universal geometry based on the same principles. On the contrary, it should embrace novelty rooted to a specific site context to harmonise the battle between globalization and localization.

- *Problem 3: Experience-based design practice*

In conventional architectural practice, design decisions are made based on experiences due to the lack of constant analytic feedback data of the proposed forms and spaces, for example, thermal performance, daylight penetration, people flow, bills of quantity, structural efficiency, and other criteria. Instead of using analytic tools to optimise pre-defined geometries, can analysis-based technologies and techniques contribute to the generative geometric processes?

Conclusion

When new trends emerge, relentless resistance from the camps of well established discourses also tend to react, to safeguard their traditional values. Looking back to human history, technological developments have always brought changes. In many regions there are still many who are sceptical that computational design will soon pass as though it were a fashion. The current economic downturn has diminished the proliferation of complex forms generated by computational tools, and the currency of new computational forms faces its biggest challenge from these economic struggles, alongside concerns for greater sustainability.

Synthetic computational design extends the application of computation to architectural industry from focusing on creating innovative forms and spaces, to engaging with the entire process of an architectural project in order to make appropriate design decisions. Architectural industry is now driven by research within its own discipline. Synthetic computational design proposes comprehensive solutions to functions, fitness, innovation, efficiency and aesthetics through the embedding of digital design systems. We should shift our intentions from creating expressive forms, towards an immersion of computational apparatus into every aspect of architectural projects. Creativity does not need to be embodied only through visible forms, but can also be manifested in other less visible actions and procedures of architectural production.

Notes

[i] Philip Steadman, What Remains of the Analogy? The History and Science of the Artificial, *The Evolution of Designs: Biological analogy in architecture and the applied arts,* 1979
[ii] Peter McCleary, *A New Concept of Technology*, 1988
[ii] Manuel Castells, *Space of Flows, Space of Places: Materials for a Theory of Urbanism in the Information Age*, 2004