POST-DIGITAL SUSTAINABLE DESIGN

ПРОЕКТ, ПОДДЕРЖИВАЕМЫЙ «ПОСТ-ЦИФРОВЫМ»

Dominik Holzer (Д. Хольцер)
Spatial Information Architecture Lab (Sial), RMIT University, Melbourne Australia

Abstract

In the wake of global warming and increased sensitivity towards the impact of human civilization on our planet, architects face new challenges and responsibilities in how they deal with the resources required to construct and operate buildings. Digital tools and computational processes have revolutionized the way we plan, design and construct buildings over the past three to four decades. We are now at a cusp in architectural practice and education where digital do more than just help us draw and document our buildings. We now can actually simulate and analyze building performance in virtual design-spaces to complement sensory information-feedback from the physical design-space. A studio-based design project is used to illustrate how students have approached this issue to address aspects of building performance in a post-digital way. Moving between digital and physical models without difficulty, the students were able to study the effects geometrical changes on sustainability-performance in real time.

Keywords: digital tools, computational process, virtual design-space, post-digital

Introduction

What has changed in the use of digital design tools in architectural practice and education, and how can we take advantage of the "smartness" of digital tools in our design practice? Decades after its initial use in the media and its adoption in everyday life, the description "digital" still maintains a notion of newness, correctness or even "betterness". The idea that every little piece of information we use, the medium that carries it and even the tools that process it can be based on a binary logic of ones and zeros adds the notion of order and control. In addition to that we associate "digital" with speed, precision and unlimited possibilities of sharing standardized information with others.

As for architects, there has been a substantial transition in dealing with the "digital". Whilst embracing computational tools to digitally reproduce their traditional (manual) work-methodology in the early CAD days, architects have engaged in a more philosophical discourse about the digital. This has consequently leaded to a move away from materiality and a deeper engagement with the virtual to address the challenges of the information age[1]. As a by-product of this transition which started in the mid 1990s, and assisted by modeling software borrowed from "digital"-animation, architects began to experiment with shapes and structures that did not follow conventional rules of materiality and physics. This movement was soon proclaimed as "blob architecture" and it was later described as *"happy accident"* [2]. In retrospect, few projects from this era have been realized. The main reason for this may be the level of complexity of these projects, combined with a lack of knowledge by architects on how their non-standard designs would perform and how to actually build them. At the same time it illustrates the fixation of many architects on visual aspects of design and their appetite for the spectacular.

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[1] see Perella, S. "Hypersurface architecture and the question of interface" *Interfacing Realities*, V2 Publishers Rotterdam, pp Z23, 1995

[2] see Silver, M. "Towards a Programming Culture in Design Arts" *AD Programming Cultures, Architecture, Art and Science in the Age of Software Development*, John Wiley & Sons, London pp 5-11, 2006

In parallel to the above mentioned development, we have seen a drastic change in the way designers and design-consultants work. The hegemony of paper based design and physical model-making has gradually been taken over by the possibilities offered by digital tools for drafting, representation and simulation. These developments have certainly brought benefits to designers and their consultants to augment their capabilities. Over the past decades, engineers have become confident in the use of digital processes to analyze and test specific aspects of building performance[3]. Architects on the other hand have become more dependent on engineers as their own digital modeling tools do not allow them to derive basic feedback of building performance for their design. This and the lack of sensory information-feedback from haptic investigation with physical models have lead to the fact that architects have increasingly isolated themselves from the process of making.

Design heuristics

Back in the early 1970s when Negroponte first described the use of computational tools in the arts, he noted that the creative thinking of a designer can get affected by the "machine" and he explored how human-machine interaction can assist in a plethora of decision making processes in a design environment[4]. As consequence of his observations Negroponte urged designers to draw a distinction between heuristics of form and heuristics of method and to find ways of taking advantage of digital technology to pursue both of these. Whilst heuristics of form relates more to an investigation of space, geometry and structural systems, heuristics of method implies a far deeper investigation on how creative design processes unfold, how they can be made explicit, and how they can be shared with others.

In this "digital" age architects rather seem to investigate heuristics of form through digital means to assist their drawing. This is taken to the point where morphological explorations of some architects push the limit of geometrical experimentations for the purpose of testing "what is possible". Some investigations for the use of digital processes as form-generators have had positive side-effects to the development of the architectural profession. By introducing aspects of "time" to their design-methodologies, architects and design-researchers have increasingly become involved in "thinking in processes" and the exploration of dynamic systems. This has lead to a diverse design-culture which adopts techniques and methods of form finding from various backgrounds through the support of digital processing and simulation[5]. The inclusion of computational tools for morphogenesis has allowed designers to learn letting go of total control over their design process and to allow the computer to surprise them with unexpected results. In addition to this, the more playful use of design software has enabled us to generate a plethora of design variations for comparison and selection. The designer's perception about the end-result of his/her investigation has shifted. We are no longer pursuing the idea of producing "the perfect design" but we are now able with little or no extra effort to producing a series of possible solutions to choose from.
Why is this such an important step, and why do we need to progress beyond it?

The way we have previously applied digital processes for our design in CAD has rather alienated us from our intuitive design-methods. Most of the current standard design-tools are of a prescriptive

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[3] see Coenders, J. Coenders J.L. & Wagemans, L.A.G. "Structural Design Tools: The next step in modelling for structural design" Responding to Tomorrow's Challenges in Structural Engineering: Volume 92, 306-307. Budapest, 2006

[4] see Negroponte, N. *The Architecture Machine*, MIT Press, Boston Massachusetts and London England, 1970

[5] see Kolarevic, B. "Digital Architectures" Eternity, Infinity and Virtuality, Proceedings of the 22nd Annual Conference of the Association for Computer-Aided Design in Architecture, Washington D.C. 19-22, October 2000

nature as they ask users to perform tasks in a certain way. We are now in search for tools that will allow us to interact more intuitively with our digital and non-digital design-space. After interviewing a multitude of expert designers over three decades, Lawson asserts that computational tools can only become real design partners in our profession if they link into cognitive processes that support our creative design thinking[6]. Central to this is the ability of juggling different ideas simultaneously and to confidently deal with uncertainty. Polanyi argues that emotional affection is often crucial to the development of hunches and informed guesses in creative acts of discovery. In this context he describes in more detail how acts of discovery involving conceptual and sensory information lead to the build-up of what he calls "tacit"-knowledge that is highly personal[7]. Lawson has picked up this argument and he has researched its relevance in design practice.

Defining the "Post-digital"

Having to work with a computer tool that does not represent knowledge the way you do may cause considerable interference in your thinking[8].

We can follow from the above statement that the designer's interaction with computational software is a highly personal matter. If we individually learn to understand and develop the rules of engagement between our own design thinking and the support we derive from digital processes we can progress the status quo to develop our own distinctive design methodology and foster it by digital means. In this process we are neither stigmatizing the use of one nor the other, but we are exploring our personal boundaries for applying them in synergy as a matter of course. This is a post-digital approach.

Studio-based investigation

In order to test the above theory, the author has conducted a design-studio at RMIT University where students were asked to explore the "aesthetics of performance" and to investigate the various implications of using both analogue and digital design methods to achieve this goal. The participating students who were in their third and fourth years of study had a different knowledge-base in the beginning of the semester both in terms of physical model-making skills as well as their capability to generate 3D-computer models None of the students had previously undertaken any research in the use of building-performance evaluation software. They had previously been trained in isolation from structural, environmental or acoustic-related design issues and they were challenge by the task of communicating their design with practitioners from other backgrounds (in our case: engineers from Arup). Each class a practicing engineer from a different domain was invited to present their daily design approach to the students to give them an idea about the wider-ranging concerns we are faced in building practice. Each presentation of the engineers was followed by a question and answer session where students could get a better understanding of the various performance-requirements that would allow engineers to optimize the projects they were working on. Some thumb-rules were discussed to as basic design-guidelines for students when looking at specific performance-criteria.

During the first half of the semester, architecture students developed their personal design methodology on the basis of simple small-scale projects. The purpose of these tasks was for students to test and investigate "rule-of thumb feedback" about rudimental design questions related to structural, acoustic, and environmental performance. The students were asked to advance the aesthetic and formal aspects of their individual projects with each of the above performance criteria

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6 see Lawson, B. *How Designers Think* Elsevier, Architectural Press, Oxford, 2006

7 see Polanyi, M. *The Tacit Dimension*, Doubleday, Garden City, New York, 1967

8 see Lawson, B. *What Designers Know* , Elsevier Architectural Press, Oxford, 2004

in mind. By doing so, the focus did not simply lie in the formal definition of the end result, but on the process of negotiating and integrating performative aspects of building design in a concurrent way. Each student had to find his/her own balance in applying digital 3D design-tools, scripting, physical modeling, or a combination of the three to achieve this goal. Nearly all students chose to address this task mainly through physical model making. When asked for a reason they responded that they were unable to find adequate digital tools that would assist them to test the performance quickly and intuitively enough to act as design driver to generate their simple structures and shapes (Fig. 1).

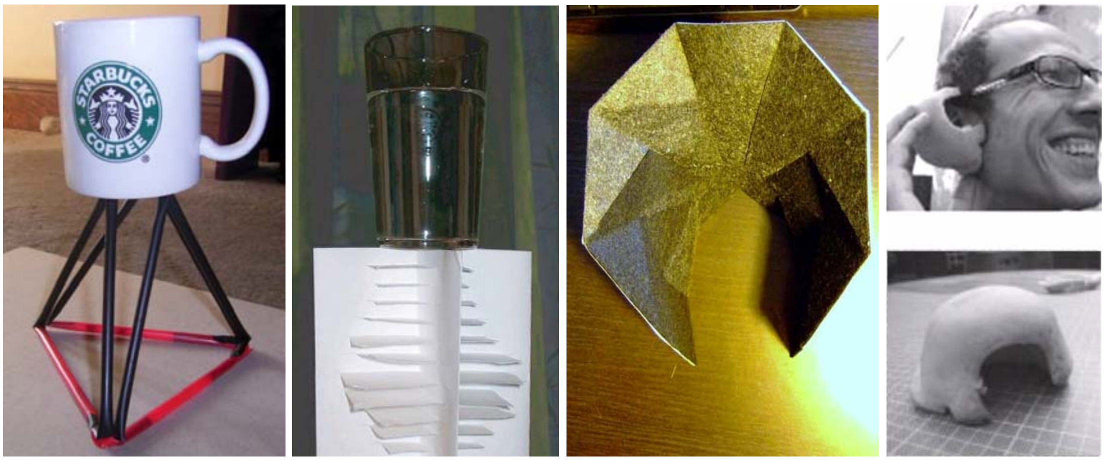

Fig. 1. Simple structural and acoustic models

In the second half of the semester, students were working on a building-related sustainability project which included the generation of sun shading options for achieving maximum daylight entry with minimum solar gain for a façade. Once the students were aware of the basic implications various shading options bring to bare, they were encouraged to start designing with shading performance in mind. This implies a step away from understanding shading as a technical add-on to a façade, to creating shading options which strongly influence the appearance of a building. In the beginning of the exercise most students were again relying on their physical model-making skills to gain tacit knowledge about the relation between shading options, sun angles and the shadows that were cast (Fig. 2).

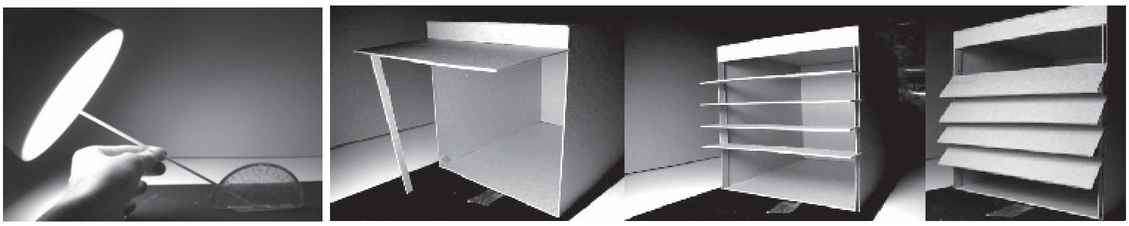

Fig. 2. Sustainability project physical model, testing various shading options using a lampshade to simulate solar angles

They built basic models from cardboard and placed a spot-light to simulate correct sun-angles. While progressing from basic to more elaborate models, they found their design method to be limited by the time-constraints of building new physical models and the lack of precise performance-feedback from them. The observation could be made that once students had reached a point where they wanted to explore more complex, non repetitive shading options, or shading devices for irregularly shaped buildings, they were willing to extend their investigation into the virtual world. In contrast to the earlier investigation with structural and acoustic models, they did find digital tools for testing environmental performance (in particular Ecotect™) that allowed them to intuitively connect their design thinking to knowledge representation (Fig. 3).

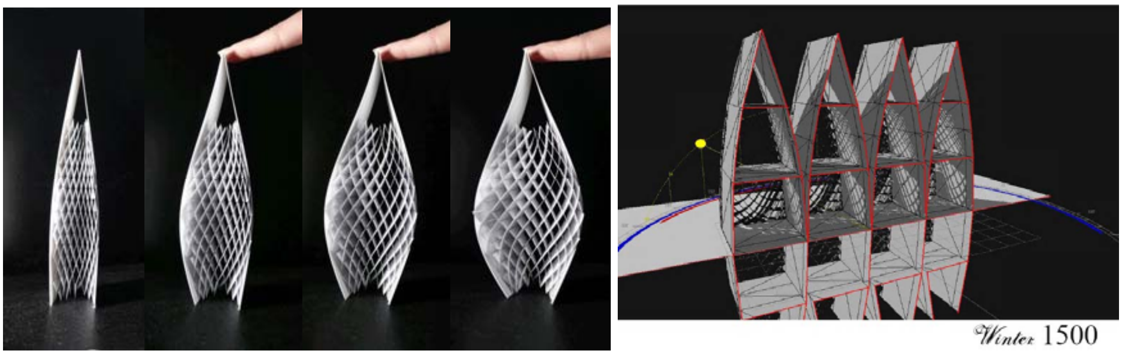

Fig. 3. Sustainability project physical model testing and transfer to digital model in Ecotect™

In many cases this occurred by first re-creating their latest physical model computationally to compare it to the virtual one. This was undertaken to gain confidence in the accuracy of the tool they were using and their capability to simulate a real-life scenario computationally.

Once this was achieved, students then continued their design process by creating several versions of their models and testing their shading-performance and material usage in real time. This way they could extract valuable information about the effects of geometrical alterations to optimize building performance in an iterative process (Fig. 4).

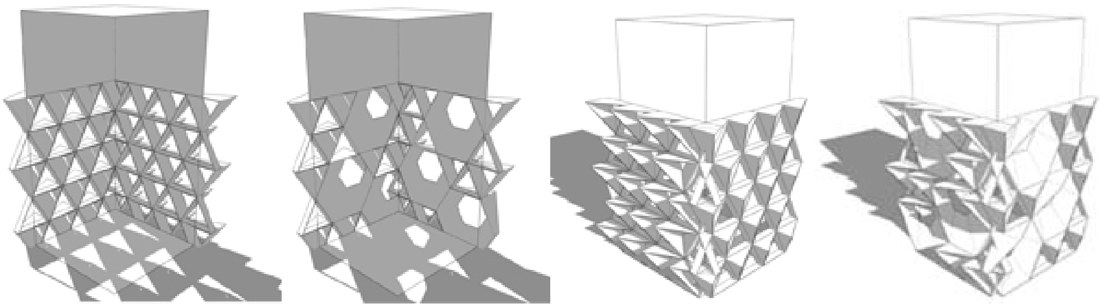

Fig. 4. Sustainability project, digital exploration

The uptake of digital technology as design-driver varied from student to student as did the goals that could be achieved by it. Whereas some students used their digitally augmented models to have more options to choose form, others used them to refine one specific design solution and others again used them to extract bill of quantities to compare material usage to shading efficiency. The immediacy of gaining feedback from daylight analysis under varying conditions was of greatest importance to advance the design in all cases. As a final step students used rapid prototyping to produce a physical model once the digital investigation had given them satisfying results. The step back from the digital to a physical model appeared to be necessary as it still seemed to reveal aspects that otherwise might have been overlooked in their virtual counterpart.

Conclusions

What mattered in developing a project in a post-digital way was that the following: Students could instantly comprehend the sustainability-task, produce hands-on physical models with simple materials, address performance issues by positioning physical spot-lights and then managed to reproduce the models virtually and to run basic daylight-analysis software. Through instant versioning and by flipping back and forth between the analogue and the digital models they advanced their design with constant performance checks and finally they were able to compare the effects of geometrical changes on the building-performance in real time. (Fig. 5).

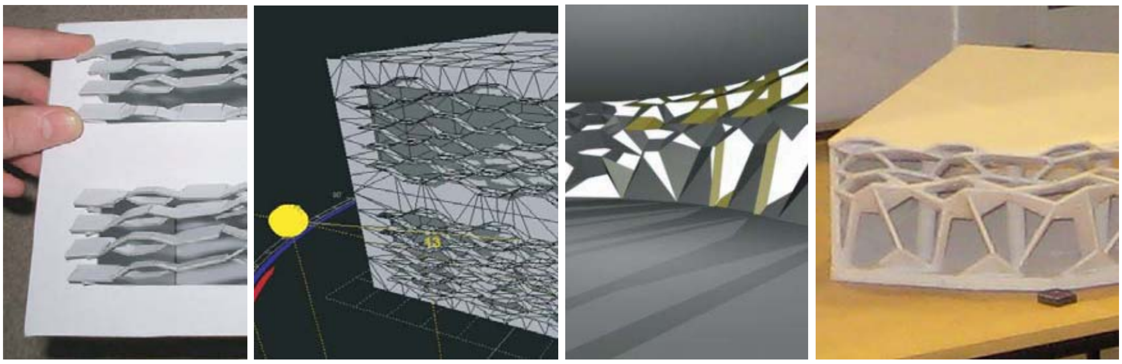

Fig. 5. Sustainability project: transition physical-digital-physical

It has shown during the semester that architecture students were easily capable of learning new tools and methods usually applied by engineers to inform their judgment on building performance. This was not done in the belief the engineer might become obsolete one day, but rather to give the architecture students additional guidance during the conceptual design phases. Digital tools were used in an intelligent manner, not simply as form-generators, but as valuable assistants in the search for more sustainable design options. During the semester it has shown that there is potential for software developers to include more basic building performance-analysis capabilities in their tools to enable architects to evaluate a wider range of performance aspects.

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References