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DIGITAL STUPEFACTION

Seduction and Complacency of Digital Techniques

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Abstract. Digital design techniques have saturated architectural discourse in the past forty-plus years from modelling to simulation and fabrication. Digital or Computational Design now forms part of the standard architectural curriculum, promising efficiency in modelling, design, advancing site analysis and ease of fabrication. Alongside these promises, we as educators begin to witness a new level of complacency governed by the use of the digital tools; we call this Digital Stupefaction. With the increasing 'smartness' of digital tools, what is the risk of shifting away from the focus of what students should/could know, and what information they embody? Is it still relevant to be able to draw on intrinsic background knowledge, or tacit knowledge in action, when everything can be analysed and verified on the fly (or even pre-selected via AI)? How can educators respond to these challenges by adjusting the way they deliver subjects associated with digital design?

Keywords. Digital; Education; Critical; Pedagogy; Knowledge.

1. Introduction

We are on the cusp of a new era of digitally-enabled design: Artificial Intelligence (AI) and Machine Learning (ML) will further our ability to automate design processes as they provide 'decision support' based on precedence and using supervised/non-supervised algorithms. With that development in mind, Digital Stupefaction presents itself as an ever more tangible threat to design education. Questions arise about the readiness of students (and the educators) to critically reflect on the 'digital' opportunities at hand, and the impact they have on their desired design process.

25 years ago, Tom Maver (1995) wrote his brief essay on the 7 deadly sins of CAAD. There, he warns about a number of cultural aspects to be considered in what we'd call Digital Architecture today, ending with his most striking critique: the lack of critique itself. 25 years on, we do not seem to have received his message. When scanning available literature on digital design, one will rather find critique on what hasn't been achieved yet, and little-to-no critique on the effects of what has been achieved. Some observers, who previously commented on the effects of 'the digital' on architectural education (Lawson 2002, Kvan

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et al. 2004), warn about potential pitfalls when digital tools and techniques get introduced to architectural education. Theodore (2010) laments the lack of embodiment of concepts and ideas, experienced by those who exclusively dwell in the digital realm. Today, the discourse has moved on from this rather binary way of comparing digital with non-digital approaches. Questions still remain about the appropriate positioning of digital (next to non-digital) tools in architectural design and fabrication processes in tertiary education. Based on the experience of the authors who have been teaching both technical, as well as design subjects in academia for the past 15 years, the increasing adoption of digital tools does not automatically lead to an increase in design quality. In some instances, the application of digital tools can be seen as detrimental to the quality of design output overall.

This paper reviews the symptoms of digital stupefaction across various domains of digital design. As a provocation, it examines why and how such symptoms emerge in digital architectural design education through specific case studies. As Willis and Woodward (2010) question the promises of digital fabrication, claiming 'there is nothing "automatic" about it'. We question digital tools and asked if the black-boxing of software and plug-ins aid or simulate design thinking? If not, what is the alternative? The paper concludes with a set of recommendations towards de-stupefaction of digital design in architecture education.

2. Background

Over the past four decades, Digital Design has become a pervasive addition to the tool palette of architects (Mark, Gross, and Goldschmidt 2008). Academia is playing an essential role in promoting design computation and digital approaches in order to expand the boundaries of architectural education. If enabling CAAD and design graphics were the predominant focus on digital tools in their early days, their application has expanded with the advent of computational analysis and simulation, object-oriented modelling (BIM), parametric design, virtual reality, and geospatial data (GIS). The more recent focus on design to fabrication, mixed reality and the potential to apply Machine Learning in design add to the range of design processes that can be supported by digital means.

2.1. WHAT IS DIGITAL STUPEFACTION?

Reasons for the use of digital tools and techniques vary greatly. They are applied to automate repetitive tasks, allow students to deal with complexity (inherent to calculus-intensive tasks), form-finding, visualises their designs, manipulate it via parametric information exchange, and test their ideas for constructability and fabrication, just to name a few.

The question emerges: Does the increased application of design computation processes and techniques potentially lead to a decrease in the quality inherent to architectural design education? Should the use of digital tools be blamed for de-skilling and de-sensitising architecture students to the point of stupefaction? The aim of the paper is to examine the potential adverse effects digital design can have on architectural education via a differentiated analysis of issues that have arisen over the past decades. We will focus on both the tools and knowledge related to computational design and how it has affected design education. The authors do not seek the blame in the use of digital tools as such but point out how misguided pedagogy and andragogy do not necessarily correspond well with the opportunities presented via design computation.

2.2. PEDAGOGY APPROACH

Digital design, by the nature of the media, requires an added layer of skill set before designing. Many authors have suggested that the need to acquire technical expertise with design is a constraint of the media (Salama 2008, Loh 2015, Loh 2018) and digital design requires a different pedagogical approach (Kvan et al. 2004, Oxman 2008). In our opinion, there is no single digital design educational approach, but instead, we consider that there are multiple approaches which are still evolving with emerging technology. In this paper, we are less concerned with modelling in the form of CAD but modelling with some technical skill in visual scripting, or using other programming languages or digital techniques. In other words, there is some form of specialised tool (software and hardware) that stands between the designer and the outcome.

3. Methodology

The argument formulated here is based on the authors' observation in teaching digital architecture design through studios, seminars and workshops in the UK, Europe and Australia. The combined teaching experience of both authors exceeds 30 years. Where literature is available, we use them as a counterpoint and reflect on the current model of teaching practice and its outcome.

Some observations emerge from a qualitative questionnaire conducted by the second author on the use of digital technology and media in teaching and learning. The anonymous and voluntary questionnaire administered as an online exercise using SurveyMonkey(TM) were answered by students from a master-level design studio and a 2nd-year subject titled Digital Design and Fabrication at the University of Melbourne. Both subjects take place over a semester or 12 weeks period. The questionnaire aimed to capture the students‘ perspective of learning using technology and understand their views on how digital technology has affected the students' design outcome and learning experience. The invitation to participate was sent between 2015 and 2018 to 116 students, of which 38 responded (approximately 33% response rate).

4. Observations

The observations presented in this section highlight the key challenges educators encounter in the engagement of their students with digital design processes. Some of these are not caused by the fact that the tools used are digital, but the bespoke opportunities they offer to students as part of their design workflow. First, we discuss cognitive barriers relating to a mismatch between a digital design approach taken by a user and his/her ability to comprehend its affordances. Second, we examine how tools can misguide learning through overcompensation and putting tools before techniques and ideas.

4.1. KNOWLEDGE AND ASSUMPTIONS

4.1.1. Comprehending the meaning behind the data

Educators face a challenge when introducing (for example) structural or environmental analyses as part of architecture students' design process. An ever-broadening range of tools allows students to interrogate their projects in endless ways, but students do not automatically understand the process of analysis and simulation itself. The selection of criteria to be analysed, or the fitness function associated with the results often remain elusive to students who feel they should use analysis because they were told to. This problem gets reinforced by the student's inability to interpret the meaning behind the numbers - the results they derive from the analysis. Everything can be analysed, but to what effect? It is easy to let the analysis drive the form-finding process but never actually achieve any definitive result. It is a problem associated with the early-use of generative algorithms, and the symptoms continue. In generative design, the emphasis of design decision is critical in selecting the desirable outcome to enable the generative nature of the process. As Frazer (2002) writes, 'Design must be creative - or it is mere imitation'. If there is no sense of hierarchy in the performance criteria, the danger is an undifferentiated design that seemingly satisfies every criterion without privileging a particular design idea or concept.

4.1.2. Limitations of digital embodiment

Tacit knowledge is the conversion of information through practice (Senett 2009, p50); Downton (2003, p62) calls it the *knowledge-how*. Its counterpoint is explicit knowledge which refers to knowledge that can be formally learned. A number of authors believe that the creation of new knowledge and learning comes in the interaction of the two systems of knowing (Papert 1988, Nonaka and Konno 1998, Ratto 2011, Sanders and Stappers 2014, Loh 2019). To exclude one from the other might lead to a dangerous territory in architectural design. It leads students astray to make an assumption that the proposed solution is feasible without testing. Qualities such as mass, friction, scale, textuality and acoustic are intrinsic in the tacit, yet they are often absent in the realm of the digital media.

The seemingly limitless opportunities inherent to computational tools allow users to generate topological experimentation with great freedom in geometric expressions. A broad range of software plugins and custom scripts are now available to students to expand on their morphological explorations and introduce highly formally driven building skins, structural systems or other geometric articulations. The tools for achieving such geometric differentiation are often extremely seductive as they promise to deliver unique results. What students struggle to realise is that they risk engaging with form, for the sake of it. The danger here results from selecting parameters that appear captivating, yet remain superficial as they are without material or structural consequences. Geometric expressions may well appear glorious on screen, but would not correspond well to fabrication logic or material performance if translated into an actual built proposal.

Tacit is not exclusively in the realm of physical making, but also apply to the use of a software as McCullough (1997) suggests. With increasing availability of open-source software and online forums, students often resort to *'borrowing'* script uploaded by others on the forum. While the open-source nature of these forums need to be respected, it is increasing more difficult to understand if a students actually understand the Grasshopper 3D definition used to generate the resulting form, let alone how it could be built physically.

A side-aspect of this problem is the availability of low-cost 3D printing options for generating physical models. Model-making and workshop spaces within academic institutions increasingly give way to '3D breeding farms'. There, the process if model-making becomes a black box where students submit their virtual models online to pick up the final result on the day of presentation. The convenience of the 3D printing solution, combined with the reliance on third parties to resolve any process-related issues, result in two problems. Firstly, a lack of criticality if 3D printing is the appropriate medium, and secondly a de-skilling of the student who will less likely be able to gain deeper insights into the tectonic and material characteristics of their design. The particular affordances and distinctive attributes of analogue, digital, and post-digital modelling have been discussed in a great level of detail in Homo Faber, Modelling, Identity, and the Post-Digital (Burry, Ostwald, Downton and Mina (eds.), 2010)

4.1.3. Confirmation Bias

Confirmation bias relates to the misguided use of computational simulation to confirm a designer's preconceived opinion. Design students are vulnerable to taking this approach when, instead of interpreting simulation outcomes to understand the performance of their design, they use the data to simply confirm what they hope the outcomes to be. In those instances where students prioritise form-making over open-ended form-finding processes, they will search for analysis outcomes that 'fit well' with their initial design ideas. The issues here are twofold. First, the pre-conception of the initial design ideas. An idea is a fluid notion; design intent is more static, although scholars have argued on the fluid nature of design intention (Malafouris 2016, Pacherie 2006). As Oxman (2008 p106) suggests, digital design theory has transformed the concept of form into the concept of formation. Hence, the non-static nature of the idea as a process of ideation. We will expand on this in section 4.2. Second, the black-box nature of plug-ins for tools such as Rhinoceros and Grasshopper 3D led to the window-dressing application of digital tools. While plug-ins make certain computational process more efficient for experienced users, they also removes the layer of understanding behind the objective, and logic instil in the plug-ins.

4.2. TOOLS

4.2.1. Tools before Idea

Oxman (2008, p101-102) proclaims that design is intrinsically related to its media. Just as the paper-based culture of design encourages immediacy of ideation through sketches, design ideation using digital tools and techniques has in the past 20 years been topological, performance, generative and sometimes materially driven as a bottom-up procedural thinking. Parametric modelling with its own set of shortcomings (Davis 2013, p39) such as front-loading of design criteria demands a fundamentally different way of conceiving ideas, less as a concept of form but more as a process-driven methodology.

An emerging symptom of digital stupefaction has been the placement of the design tool before ideation. Here, we are not concerned about the mimicry of a paper-based culture of ideation with digital technology. After all, if one can sketch or draw with pen and paper, then most millennials can draw with a stylus and a tablet. What is disturbing is the submission of ideation wholly to the tool with a lack of design intention from the designer. One cause of this issue occurs when a student is unable to match a design problem to an appropriate tool for resolving it. Another reason for putting the tool before the idea occurs in scenarios where a student feels obliged to use a digital tool or technique simply because it was suggested to do so as part of the course outline (but without truly understanding the motivations behind that suggestion).

When laser cutter machines are acquired by the various Fab Labs within schools of architecture, these model-making tools can condition the way student design. The constraints of the tool to produce 2-dimensional planar geometry could be misinterpreted as the only conceivable way of manipulating or conceiving a form. Volumetric forms and landscape-like geometry are often sectioned and stacked to produce awkward models without the consideration that a change in making-strategy can offer a better design solution, or might open-up new ideation potential.

4.2.2. Tool before techniques

An equally obvious symptom of digital stupefaction occurs where inappropriate techniques are applied to a tool to solve specific design problems. A typical example is the use of Panelling Tool (developed by Rajaa Issa for McNeel) to discretize a doubly curved surface. Most students understand the need to panelize a surface for buildability purposes. Recent build projects such as the doubly-curved metal cladding of Dongdaemun Plaza by Zaha Hadid Architects clearly demonstrated the principle in practice. However, when it comes to understanding the role between the tools and techniques, students are often confused. When panelling a free-form surface, students are quick to achieve the seductive results of the panelised surface. When asked to make a paper model using a laser cutter to produce the form, some students would continue to use the quad surface resulting from the grid of the panelling tool. The result is a paper model that does not join-together well as the standard paper can only produce developable surface.

The above identifies a lack of connection between the tool, technique, and the material. This complicated tripartite relationship requires a strategic understanding of design intentionality and how it relates to the tool, technique, and material (Pye 1968). While the lack of strategic thinking or design strategy often led to a manic adaptation of the tool to solve in-appropriate problems. Conversely, a lack of strategic thinking could also lead to complacency of the technique and rely on it to deliver a 'more or less' result without any material consequences or fabrication logic.

4.2.3. Overcompensation

As Mitchell (2009) reminds us: 'architect's tools aren't neutral ... availability invites use'. Tool affordances and biases go hand in hand with assumption and values affecting the way users interact with them. In the academic context, students may get seduced to extensive application of particular functions within a tool in order to compensate for a lack of design thinking. Observing student behaviour during design studio, one such occurrence relates to situations where students use Building Information Modelling to advance their projects and take advantage of limitless ways to represent their design on presentation panels. In most instances the choice of BIM tools for design results in a less than stellar outcome, and students mistake the fact that there is a lot on the panels as a qualitative characteristic. The root cause of this issue is not related to the tool being 'digital' or not, but to the selection of an appropriate tool in the first place. The problem gets exacerbated though by the lack of critical thought students apply when confusing quantity with quality.

5. Synthesis - Recommendations

All of the 'stupefaction symptoms' exemplified in this paper are surmountable. Educators play a pivotal role in anticipating where these negative symptoms are likely to occur, to then guide students and instil a sense of criticality towards the engagement with digital tools and associated processes. Based on their experience, educators will thereby aim to counteract potential pitfalls and establish a sense of responsibility among students to become invested in their design process and the selection of an associated tool ecology that balances both digital as well as non-digital approaches. Students need to learn to question their choices and the reasoning behind their design approach. At times this is easier said than done.

5.1. A COMPETING LEARNING ENVIRONMENT

Within the constraints of a semester-long design course, students' primary focus tends towards the production of a captivating design outcome, or the acquisition of a specific set of skills. In many instances, a strong reflection on process or tooling is not foregrounded when students conduct their research or when they advance their design thinking. Increasingly, the tendency is to teach software or skill within the subject with the aim to apply the skill set directly to the design task. Software skills should not focus on any specific tool only. It is the responsibility of the educator to help steer students in their selection of a tool ecology (both digital and analogue) that takes advantage of the best possible combination of applications to support their desired design process. Figure 1 depicts an example of a tool ecology.

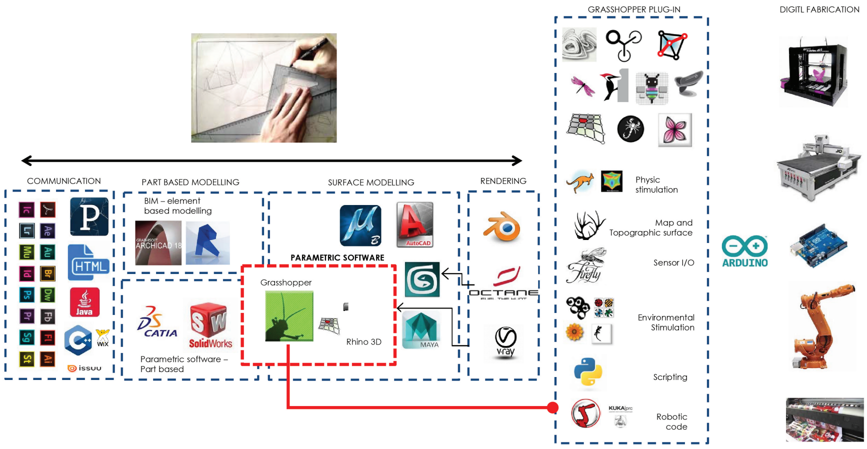

Figure 1. Example of a Tool Ecology for a Design Studio.

It is important to highlight that design education is iterative, and there is only so much students can learn within 12-week long semester or term. From the questionnaire, when students were asked how they find learning new technology (both tools and software) during their design course, 65% responded saying it is time-consuming but manageable; 30% responded saying that it makes their workflow easy and 5% responded that time is a critical factor to learn the software in order to deliver the design outcome.

5.2. POST-DIGITAL PEDAGOGY

A number of written feedback examples from students cause us to reflect on how we teach in a post-digital scenarios.

"It's difficult to engage with the newest technology and at the same time have a design process, site analysis and all other aspects of an architectural studio".

"Technology in the end becomes a representation tool. However, should there be more time, there maybe an opportunity for technology to also take up the role of giving design feedback"

"I found that there was a disconnection in understanding how the 3D simulation form output really worked spatially. As the iterative form output was the result of a set of parametric inputs, we were not the direct makers of the output, and thus had to inspect the resulting forms on a 2D screen environment."

These comments highlight three critical issues associated with the pedagogy of digital design. First, the notion that design is somewhat separated from the technology or media. If we are in a post-digital era where there is no longer any binary schism between digital and non-digital approaches in design, then has our teaching been too technique-focused in the last decade? With increased emphasis on digital processes, does this mean that by nature, other skill-sets will be less taught? This leads to question such as, what other design skills have we left out? A pen can capture shadow and light, can a VR model not do the same job? In our opinion, this is simply a bias or preference of design tools and the debate around digital versus the non-digital is counterproductive to the discussion of a post-digital pedagogy. Rather, the effort of educators should be focused on how to deal with shifting pedagogical model of the post-digital, as technology will continue to remain in the discipline of design.

Second, the representation in digital media is both abstract (in the form of diagrams and data analysis) as well as corporeal. The notion of feedback has been critical to computation logic, but it has rarely been exercised in teaching. It is therefore pivotal to instill in students a sense of criticality towards the quality of responses mediated via digital means. Figures 2 provide examples of engineers and software developers joining class in order to assist students in understanding both the meaning behind the data, and to explain the simulation processes applied by tools to derive meaningful output.

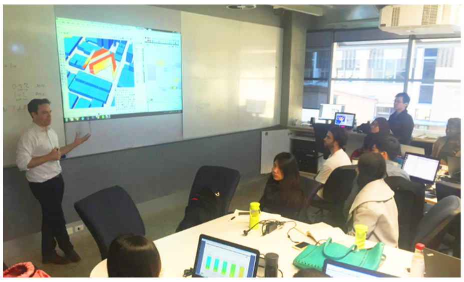

Figure 2. Expert input, explaining digital tools and techniques in the design studio.

Third, the disconnection between media, and design technique (and associated issues) could be the result of the way we teach technology as discrete units. Traditionally, design studios are run as iterative teaching environments, typically over 5 years of architecture education, supported by digital based communication subjects. If digital design teaching gets subsumed as part of the studio experience, it might assist in connecting the media with the design.

6. Conclusion

This paper attempts to summarise a series of observations we identified as Digital Stupefaction. It is broadly categorised into two areas. First, the cognitive barrier between the generated information and the students' ability to comprehend, make sense, or utilise the affordances of the techniques. Second, the technical barrier of the tool often results in students putting the constraints of the tool before the methods and at times, their conceptual thinking.

The increasing discretisation of technical learning with design techniques (and design sensibility) in the architectural curriculum has created an awkward disjunction between the understanding of digital affordances of tools and techniques with its application, interpretation and analysis. We called for educators to review how we teach digital design in an ever-evolving context of emerging technology. We may not be able to counteract stupefaction fully, but we can certainly minimise its impact on our student's learning by radically reconsider how we teach design.

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