Digital Utopia: The Role of Materially and Digital Competency

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ABSTRACT

Digital technologies allow for an unprecedented level of design experimentation and construction possibilities. The article presents the argument that digital technologies and fabrication support a re-connection to materials and materiality, whilst facilitating the exploration of utopian ideals within a design context. Recent exemplars in the fields of architecture and academia that embrace a materials-first approach to innovative projects made possible by digital technologies and digital fabrication are discussed.

The design capabilities made possible with digital technologies, and in particular digital fabrication, is increasingly allowing for an unprecedented level of design and construction experimentation. Long established practitioners such as Frank Gehry and the late Zaha Hadid exemplify how digital technologies allow for an experimentation in construction and form with the digital model that results in built forms that require materiality be at the forefront of the design process and fabricated solution. Recent academic exemplars, such as Achim Menges and Neri Oxman conceive and experiment with new construction processes (such as digitally fabricated, robotically constructed and/or biologically integrated processes) and a "new materiality" (Oxman, 2010: 81) that demonstrates how the intersection of digital technologies and materiality allow for new imaginings, new forms and ultimately new realities in how we construct and interact with the built environment.

NEW FUTURES

Based on the urban concept that we shape our cities and our cities shape us, what is designed from the individualised object, to our dwellings and cities impacts on us as individuals, as communities and on a global scale. To discuss within the four pillars of sustainability – with social, economic, cultural and environmental drivers –, designers face a multitude of areas in need of reimagined solutions to create a liveable and sustainable future.

As the negative ecological and social impact of the Industrial Revolution creates a need for a redirection of design practice, where digital technologies such as additive manufacturing are the forerunners of an Industrial Revolution 2.0, designers must consider how to embed this future re-imagining into their process. There is an opportunity to engage with emerging technologies, to imagine, design and deliver new solutions, considering how we use the resources available in sustainable ways and as a consequence facilitate new ways of constructing our built environment, the structures we live in and the artefacts we interact with.

Sheeren discusses the impact the built environment has on our lives, noting that our spaces and buildings are prototypes and that there is potential to explore ideas of how the space of living or working could be different (2015). This is supported by Lefebvre's utopian notion of the possible-impossible, as extended on by Pinder, who argues that the design of space can "embody desire for better futures through the insistence that these futures are radically open, that different ways of organizing urban life and space are imaginable and potentially realizable" (2015: 30). This is further supported by Fuad-Luke, who suggests "designers are, after all, licensed to imagine, to realize what John Wood calls 'attainable micro-utopias', to make the unthinkable possible" (2009: xx). It is an engagement with these ideas such as Lefebvre's utopian 'possible-impossible' dichotomy that facilitate the imaging of new, yet unrealised futures.

DIGITAL MATERIALITY

Digital tools and fabrication technologies can facilitate the conceptualisation and fabrication of these new futures. Oxman (2015) exploits the possibilities of Computer-Aided Design tools (CAD) and Computer-Aided Manufacturing (CAM) and even extends beyond them, alongside Biomimicry research, questioning preconceived ways of constructing and creating spaces. Discussing the term "Material Ecology", *Oxman, Oritz, Gramazio and Kohler (2015) propose new possibilities to break away from the standardization of design that arose from the Industrial Revolution, which saw the design of objects and systems as assemblies comprised of single material parts and defined functions, a top-down approach further supported by industry supply chains. They suggest these paradigms are also supported in the designers workflow with Computer-Aided Design tools (CAD) and Computer-Aided Manufacturing (CAM), where "homogeneous materials are formed into pre-defined shapes at the service of pre-determined functions" (2015: 1). They propose Material Ecology as a new design approach "to establish a deeper relationship between the designed object and its environment" (2015: 1), to counter what they term a dimensional mismatch between the environment space and the conventional design space.*

This approach exemplifies the shift to materiality driving the design process that is then facilitated in the digital workflow (from design to fabrication). Key to this shift is knowledge of material properties that drives the research and form of the structures created. DeLanda explores the concept of materiality in suggesting:

> *We are beginning to recover a certain philosophical respect for the inherent morphogenetic potential of all materials. And we may now be in a position to think about the origin of form and structure, not as something imposed from the outside on an inert matter, not as a hierarchical command from above as in an assembly line, but as something that may come from within the materials, a form that we tease out of those materials as we allow them to have their say in the structures we create (as cited in Menges, 2012: 19).*

This is supported by Loschke, who looks at the historical context of materiality driving form, referencing Tarabukin, who suggests "the material dictates the forms, and not the opposite" (as cited in Loschke, 2014: 94). When looking at materiality in the digital era, a historical perspective is useful in charting that shift in process and thinking, from the Bauhaus emphasis on materiality to practitioners such as Frei Otto and Buckminster-Fuller's experimentation with material and form, to early adapters of materiality and technology, such as the previously mentioned Gehry and Hadid.

DESIGNED FUTURES

With technology, fabrication and material innovation constantly changing, evolving and updating, the skills sets needed as a designer are diverse and transforming to meet the shifting and varied needs of how we live our lives, and the resulting adaptations and morphing of designed artefacts and structures.

To define a paradigm by which to approach a designed future involves considerations including the sustainable use of renewable materials, efficient material use, exploiting digital technologies in the fabrication and construction stages, and engaging with frameworks such as biomimicry and responsive architecture. The FAZ Pavilion Frankfurt (designed by Achim Menges and Scheffler + Partner in 2010) can be used as an exemplar of current research in this area, defined as an example of "ecologically embedded architecture, in constant feedback and interaction with its surrounding environment" (Menges & Reichert, 2012: 58).

It is important to note that the possibilities of biomimetic and responsive design are facilitated by developments in technologies – both modelling software and manufacturing technologies (such as CNC, Laser and 3D printing). The FAZ Pavilion can be used as a case study to support not only biometric design, but the interlinking of this with fabrication technologies available, while also utilizing wood, one of the "oldest and most common construction materials as a natural high-performance fibre composite" (Menges, 2012: 17). It exemplifies how a naturally occurring property, such as the hygroscopic behaviour of wood, "can be exploited in the development of no-tech responsive architecture" (Menges, 2012: 17) to create a biomimetic responsive material system.

Architect´s attitudes such as Kengo Kuma and Shigeru Ban's engagement with materiality are useful to consider also within a holistic approach, to include environmental concerns, the experience of space and time, and also place making. Kuma states, "currently local character is being destroyed by mass standardization. By using local materials, I will relate to the qualities of a particular locale" (as cited in Brownell, 2011: 42).

Kuma and Ban utilise digital technologies and materiality to create localised and contextual design responses. Ban's investigations into dynamic forms embracing technological innovations and in particular timber can be seen in projects such as the Haesley Nine Bridges Golf Club House (completed in 2009). Kuma's experiments with temporality can be seen in the nomadic structure of the Yure Pavilion. The translating of traditional construction elements and the scalability of connections into a contemporary context is explored by Kuma in the GC Prostho Museum Research Centre (opened in 2010). All these projects utilize timber in different ways and engage in the interplay between the hand-made, materiality and the digital-fabrication constructs of the built environment. The Haesley project for example utilizes manufacturing technology with the engineered glulam timbers, utilizing CAD and CAM technologies, along with timber being chosen for its environmental benefits. Whereas the GC Prostho Museum Research Centre engages with ideas around hand-made structures in the digital-machine age (ArchDaily, 2012).

These exemplars from Menges, Oxman, Kuma and Ban highlight the need for digital ability in creating these forms that use materiality as the starting point. As suggested by Oxman it is a material first approach, a reversal of the typical form driven process (2010). The ability to transform this material knowledge into the digital model and workflow is a crucial component.

DIGITAL ENGAGEMENT

The role of educational institutions comes into play in digital ability. Farmer and Stacey outline their pedagogical approach for MARS (Making Architecture Research Studio) integrating digital technologies and materiality, as can be seen widely incorporated in architectural and design schools. They argue for the importance of "direct, practical and tactile engagement with materials and making" (2012: 301), within an educational context, as a way to engage critical design thinking, skills development and material knowledge that the process of making supports. They argue that the knowledge gained by the designer promotes "reflective and considered dealings with the material reality of architecture" (2012: 311), as a counter to more modernist approaches to technology, fabrication and materiality.

The digital process allows for a high level of experimentation and also accessibility to prototyping technologies (for example, additive manufacturing and CNC) for students and designers to test new ideas of what design can be that isn't cost or time prohibitive. What is required to fully exploit these possibilities is a digital competency to embed the material knowledge and imaging of new futures into the digital modelling and fabrication process.

As the complexities possible within a digital workflow evolve, with modelling software, fabrication and robotic technologies, and material research and development, a digital competency is fundamental to fully exploit the possibilities. An understanding of these digital tools and methods is needed to fully engage with and model the material properties. Just as knowledge of drawing, hand tools and fabrication are needed, the increasingly digital workflow requires the embracing of digital knowledge and competency as a fundamental designer skill set.

In summary, digital technologies and fabrication allow a re-connection to materials and materiality (as seen with the exemplars discussed), that the rise of the modernist and industrialized system created a disconnect with. Where materials were typically a last consideration, and a mass-produced component parts model prevailed, the rise of technological advancements and digital fabrication technologies such as additive manufacturing allow for materials and their properties to drive the process. Key to the proliferation of material driven design in imaging new solutions and futures is embracing the digital workflow and exploiting the possibilities facilitated through the use of digital tools.

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