THIS IS DISTRIBUTED DESIGN

Making a new local & global design paradigm

Edited by Distributed Design Platform

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Forecasting New Forms of Distributed Design Supported by Extended Reality.

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Extended Reality and Distributed Design: A (thus far) Missed Interaction

The current scenario of socio-technical transformation, modified by the pandemic, has highlighted the importance of increasing the use of technologies such as augmented reality (AR), virtual reality (VR) and mixed reality (MR) - all grouped under the term "extended reality" (XR) - that offer the possibility of bridging the gap between the digital and real worlds.

Within the field of industrial design and product design, there has been a long phase of experimentation and reflection on the relationship between the design and extended reality, which concerns the implementation of more interactive, collaborative, and efficient design processes. The diffusion and adoption of practices and tools for augmented and virtual prototyping have been debated for almost twenty years. It is now widely accepted in the scientific community and the industrial world that AR and VR can contribute to increasing efficiency in the user experience, design, production, or maintenance of products. The first boost for the diffusion of extended reality in the industry came when AR and VR were included in the technology landscape of Industry 4.0. Gaming, on the other hand, has been the driving force behind the initial dissemination of these technologies to end-users. The most relevant case being Facebook, and what they did with Oculus , a device released during the pandemic and ready for large-scale adoption by both the general public and developers.

The pandemic, which required the sudden introduction of drastic social and organizational changes, has increased the average level of digitization of people and organizations. More people now own appropriate devices to interact with AR and VR. Meanwhile, more and more organizations are designing or configuring digital social platforms to support and democratize — from gaming to education and healthcare — the use of these technologies. Also during the pandemic, especially in the initial emergency phase, a population of makers and designers with the support of Fab Labs and makerspaces was the protagonist of mobilization on a global scale, aimed at designing and manufacturing personal protective equipment and parts or components of respirators. It was based on the use of traditional technologies for digital manufacturing. Any experimental approach to the use of such technologies as extended reality (the most accessible in the technological landscape of Industry 4.0) would have allowed interactive design operations in virtual environments within a context of physical and social distancing.

A search of scientific databases reveals a lack of literature on the relationship between Distributed Design and extended reality, while Industry 4.0 paradigm is increasingly interested in considering the Fab Lab operational model in two ways: i) to create digital twins of the Factories of the Future and increase their resilience (Bécue et al., 2020), ii) to experiment with the use of immersive technologies to increase the potential of human-centered manufacturing systems (Ramalho et al., 2020).

It emerges that makers and Fab Labs have not yet explored the potential of extended reality. The reasons might be different: historically, the extended reality is not part of makers' repertoire in terms of Fab Labs practices and equipment. Moreover, open-source software and hardware for virtual reality, which is more compatible with the philosophy and principles of making and distributed design, has only recently been implemented. Finally, before the pandemic, AR and VR were technologies that played a secondary role in the design, prototyping and manufacturing processes that were mainly carried out in the presence of people, especially in Fab Labs and makerspaces.

However, if we try to relate the practices of Distributed Design with the extended reality, we can identify three potential areas of experimentation:

- the first level concerns the virtualisation of Fab Labs and makerspaces as places where immersive processes of conception, materialisation, sharing and learning of distributed design take place. The focus here is on the creation of the digital twin of these labs, which until now has been little or not at all investigated or experimented.
- the second area is about the theme of virtualization of distributed design processes, ranging from the initial design phase to the use of machines, through the collaborative experimentation processes dedicated to immersive prototyping practices.
- the third area is about the virtualization of distributed design outputs and therefore everything that concerns the virtual or augmented user experience of the artifacts deriving from digital fabrication processes, especially for documentation of their use, and customization.

Extended Reality for Digital Creative Processes: What's Happening?

In the stage between design and fabrication, designers and makers typically spend a considerable amount of time during the prototyping activities, in order to understand the complex geometry necessary for fabrication operations. Extended reality practices could help designers and makers to limit time-consuming tasks, in favour of a more streamlined production process of

an artifact. We have selected some best practices regarding the use of extended reality connected to the different possibilities of the XR through the various stages of the design process: concept developing, prototyping, fabrication, and output validation.

´An interesting direction of development concerns the evolution of the role of Distributed Design in relation to digital technologies´

The first stage might be a problem when the users cannot simultaneously share the same physical space. The difficulties to show and explain a simple concept could be avoided through a series of steps that goes from drawing sketches on paper, showing a 3D representation, or a rough mock-up. Transferring these operations in a virtual collaborative environment could mitigate those drawbacks. Still, a lack of defined standards and tools, combined with rapidly changing hardware and software platforms do not facilitate this phase (Krauß et al., 2021). Nowadays, numerous solutions are coming up: already established VR software such Gravity Sketch and Tvori are demonstrating features such as the involvement of multi-users at the same time, while Facebook Reality Labs is working on its own VR collaboration experience.

Further stages of prototyping find a better way to implement XR application. VirtualComponent is a mixed-reality tool that allows users to digitally place electronic components such as resistors and capacitors on a custom breadboard, tune their values via software, and see these changes applied to the physical circuit in real-time. The research team behind this idea questioned the common difficulties behind circuit design and discovered that their pool of users spend a considerable portion of the circuit-debugging time working on topological aspects of the circuit and trying to select or tune the values of specific value components. We found that their solution is a good execution of MR integration with a prototyping technique (circuit design and physical computing) widely spread in Fab Labs. However, the result lacks universality and scalability because the team designed the system around a custom breadboard and a digital application that require specific skills to let everyone implement them correctly.

The application of the extended realities comes at the end of the fabrication process in the case of “Earthen Shells Digital and Manual Fabrication” (IAAC, Barcelona, May 2017), where it does not influence the design of the shelters, nor the prototyping stage. It is, indeed, an additional validation phase that brings a more valuable, intuitive, and quick look for the user. It was a seminar where thirteen students built three earthen vaults in their first master year. The students used clay deposition through a robotic arm and 3D-scanner to generate an AR analysis system of the structures by superimposing the virtual model passed to the robotic arm and the actual mesh generated from the scanning process. The AR application aimed to visualize the changes happening to the structure during the various fabrication stages, and thus enabling the user to understand the effect of their actions on the structure.

Extended Design? Experimenting Extended Reality for Distributed Design

The hypothesis emerging from the case studies outlines some themes concerning the potential interaction between extended reality and Distributed Design. More precisely, this hypothesis is that XR can support and foster the enhancement of Distributed Design practices in different ways. It can increase the potential of collaborative and participatory processes - from co-creation to co-production - that are already a heritage of Distributed Design. It can extend the possibilities of access and inclusion to the world of Distributed Design through the virtualization of spaces, equipment, and practices. It can technically expand the potential and scope of open and distributed systems. Finally, it can accelerate work on the circularity principles of Distributed Design, working on simulated innovation processes that can prevent or reduce errors in creative and manufacturing processes.

For these reasons, does it make sense to talk about Distributed Design also in terms of Extended Design? If we assume that Extended Design is a potential field of practice that expands the principles, practices and processes of Distributed Design into a virtual dimension, the challenge then becomes to understand how, pragmatically, extended reality can respond to the needs and potential of Distributed Design.

Starting from these reflections, Polifactory - the makerspace of the Politecnico di Milano - developed “CTRL+” in 2021, an experimental initiative that stimulates designers and makers to explore the potential of extended reality for Distributed Design in terms of co-creating and prototyping solutions that can enable innovative practices of Extended Design within the Fab Labs and for their communities of users and innovators. To support this purpose, CTRL+ experiments with the use of different software and tools for AR and VR involving companies like TVORI, scholars and technology experts in this field. In practice, CTRL+ supports designers and makers in the use of extended reality, to expand or augment the features of open-source artifacts created by Distributed Design processes and to explore the use of digital fabrication in the creation of tools to augment or expand the use of virtual reality. Finally, the scope of CTRL+ is to explore innovative ways to expand the potential of Distributed Design within the society.

Distributed Design is a magmatic area. Primarily, Distributed Design is characterized by a systemic dimension towards innovation and a human-centered approach in the relationship with technology. Moreover, Distributed Design conceives design and production processes as open and inclusive, and it is interested in the circular transition of the contexts in, or for which it operates. Finally, an interesting direction of development concerns the evolution of the role of Distributed Design in relation to digital technologies. In this sense, the body of technologies for extended reality can support Distributed Design to make a disciplinary scale shift, extending its scope and cultural sphere of influence from digital fabrication to digital transformation.

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CHAPTER 5
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Emerging at the intersection of the Maker Movement and design sensibility, Distributed Design provides a framework for designers, makers and creatives to innovate the field of design towards more sustainable, inclusive and collaborative practices. As global challenges intensify, shifting the global paradigm to support global connectivity and local productivity where “bits travel globally, while atoms stay local” becomes urgent. Distributed Design is a proactive response for makers and designs to prefigure viable design alternatives to the current paradigm which is designed for mass consumption.

As the final of four publications developed by the Distributed Design Platform, ‘This is Distributed Design’ presents a state-of-the-art, in an effort to inspire makers, designers and scholars alike. Within these pages you will hear from a non-exhaustive list of experts, hobbyists and educators whose work is advancing Distributed Design, clarifying through practice, its standing as the framework for collaborative, open, inclusive, sustainable design.

Distributed Design

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