Fab the Knowledge

Sofia Scataglini and Daniele Busciantella-Ricci

Abstract This paper draws a link between what happens in maker spaces and how these processes can be simulated in the mathematical collaborative model (co-model) of the research through collaborative design (co-design) process (RTC). The result is the ability to identify the main variables for simulating the "making" dynamics of the RTC model. This outcome is discussed with an emphasis on the "intangible" role of "making," alongside the proposed concept of "fab the knowledge." Speculative thinking is used here to link the innovative and theoretical aspects of design research to their application in and for innovative learning contexts. The RTC co-model can be used to compute, simulate and train a co-design process in intangible spaces, such as fab labs. In these spaces, multiple actors with different skills and backgrounds, who may or may not be experts in design, collaborate on setting a design question and identifying a shared design answer, in a process of RTC. A "network" of neural mechanisms operating and communicating between design experts and non-experts, like a computing system of a biological mechanism, can be used to train and simulate a research answer, thereby "fabricating" knowledge.

Keywords Research through co-design · Design research · Co-design · Neural network

1 Introduction

This paper focuses on the research activities of the FabLearn network for "project-based, inquiry-driven education" (https://fablearn.org/research/). These concepts have in common their relationship with the field of design research [1, 2] and the

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research through design (RTD) approach [3, 4]. Adopting a speculative approach, this paper draws a link between what happens in maker spaces and how these processes can be simulated in the linear mathematical co-model of the research through co-design process [5]. The result is a model designed to simulate the "making" dynamics of the RTC model. This is discussed with an emphasis on the "intangible" role of "making," alongside the proposed concept of "fab the knowledge."

1.1 Making and Prototyping in Contemporary Design Domains

Making and prototyping are widely explored in maker spaces. They are traditionally recognized as supportive actions with tangible content (Fig. 1, right). They are also activities within design domains (Fig. 1, left), where design is seen as "making" (traditional design practice), or as "integrating," and for value creation (see [6, 7]). At the same time, there is a growing interest among practitioners and researchers in understanding the relationships between design culture and complex social systems. As this awareness increases, "making" and "prototyping" take on a decisive role in complex societal and policy-making contexts, where design processes demand a good understanding of the concept of intangibility. Given this premise, this work is driven by the question of how we can model the "fabrication" of intangible things like knowledge.

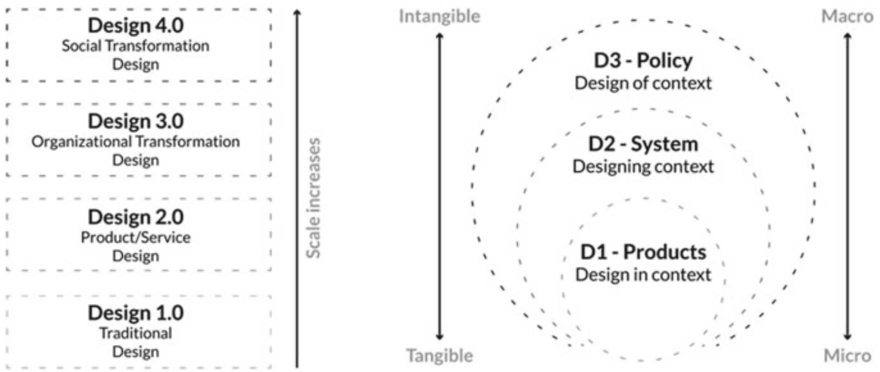

Fig. 1 Mapping design domains (left) (revised from [7]) and levels of design content (revised from [8])

1.2 The Research Through Co-design Co-model

The RTC theory describes how the RTD process works within collaborative design. Previous work by the authors of this paper [5, 9] explain this theory, which is based on the control system theory [10]. The result was the design of a collaborative model (co-model) in the form of a "mathematical model of cognitive control that describes the process in doing research by an RTC process" [5]. This model can be used to understand how to gain knowledge from co-design within a wider process of research. As a form of collective creativity in a design process (see [11]) in learning contexts such as those found in maker spaces, co-design can also be "understood as a creative process developed collaboratively by teachers, students and researchers to design inquiry-based and technology-enhanced and networked learning scenarios" [12]. Participatory design is a process in which people learn from each other [13]. In this sense, the action of co-designing, as a specific instance of co-creation [11], can be related "to actions of collective creativity and co-creation of knowledge" [12].

2 Methodological Approach

This research uses a speculative approach [14]. Specifically, the authors used the RTC theory co-model as a speculative design proposal [15], linking the co-model variables to the learning activities of maker spaces (Fig. 2).

For this reason, this kind of space is shown as the variable G(s), which represents the design process within an RTC co-model (collaborative model). When we input a research question R(s) through a co-design process G(s) and test it H(s), the co-model uses a closed-loop system [16–18] to calculate the error between the research answer obtained and the research answer set C(s) in Fig. 3 [5].

In the co-designing process, the co-designers' team is a cross-disciplinary team made up of the product coi and coj:

$$Co = \sum_{i,j=1}^{n} co_i * co_j \tag{1}$$

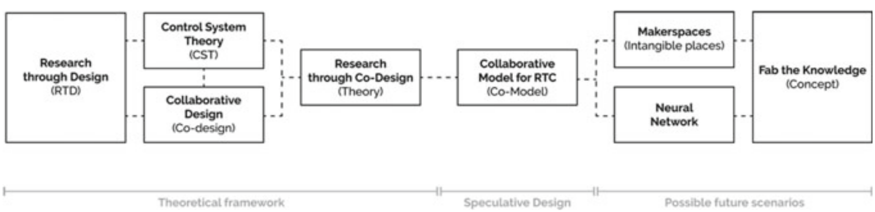

Fig. 2 Diagram summarizing the speculative approach adopted by the authors

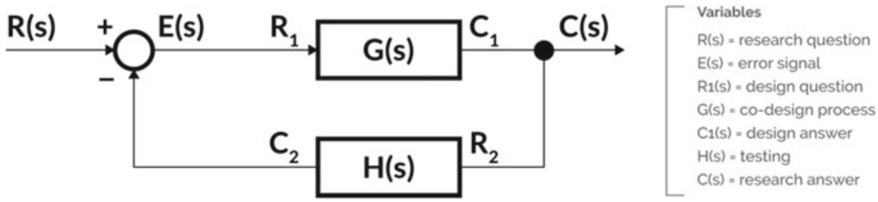

Fig. 3 A co-model based on a closed-loop system in research through co-design [5]

where coi and $co_j \geq 2$. Consequently, with a design question R1(s), the co-designer should use the design tools T in the co-design process G(s) to solve the design answer C1(s): G(s) = Co * T/R1(s). A design tool is a context-related set of actions, thoughts, or objects that makes actions, thoughts, or objects possible for design-related tasks (cf. [19]).

3 Results and Discussion

If a maker space and/or a fab lab is linked to the G(s) variables, then they can be used to simulate, calculate and model research through co-design processes. Accordingly, the maker space can be considered an intangible (non-physical) "space." This means that it is a simulated space that is mathematically linked to the cognition process that leads to a new kind of knowledge.

Physical or tangible spaces can be perceived by the senses, whereas non-physical or intangible spaces are not available to the senses [20], only to conscious perception [21]. Fab labs and maker spaces are intangible spaces where co-designers can convert the intangible values, factors and constraints of "conscious making" into tangible and measurable actions within RTC ensuring sustainability. Indeed, when we define G(s) as a design process in this intangible space called the fab lab, we can represent collaboration in an RTC as a "network" of neural mechanisms that acts and communicates like a computing system of a biological mechanism [22]. The neural network mechanism [23] works by computing, training and simulating the best criteria possible for maximizing the accuracy of the research answer through an RTC process. This is achieved by associating a node in the co-designing neural network with each co-designer in G(s). Each node communicates with the other node in this co-designing neural network to produce a final output. This output is represented as a gain in terms of knowledge of a skill fabricated through study, experience, or teaching in a co-design process.

4 Conclusions

The RTC co-model can be used to compute, simulate and train a co-design process in an intangible space like a maker space. In these spaces, multiple actors with different skills and backgrounds, who may or may not be experts in design, collaborate on setting a design question and identifying a shared design answer, in a process of RTC. A "network" of neural mechanisms operating and communicating between design experts and non-experts, like a computing system of a biological mechanism, can be used to train and simulate a research answer, thereby "fabricating" knowledge. The RTC co-model is therefore a support model for collaborative learning processes and for understanding how to fabricate intangibility through participatory design processes. Accordingly, the authors argue that the RTC co-model can be used in educational research for experimentation in project-based and inquiry-driven education programs. Finally, the authors argue the co-model can play a crucial role in the FabLearn network to increase the knowledge of its various stakeholders in innovation and educational research processes.

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