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► **To cite this version:**

Flore Barcellini. A developmental framework to analyze productive and constructive dimensions of collaborative activity in simulation workshops. 20th triennial congress of the International ergonomics association (IEA 2018), International Ergonomics Association, Aug 2018, Florence, Italy. pp. 452-456, 10.1007/978-3-319-96080-7_54 . hal-02433618

HAL Id: hal-02433618

<https://hal.science/hal-02433618>

Submitted on 9 Jan 2020

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A developmental framework to analyze productive and constructive dimensions of collaborative activity in simulation workshops

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Abstract. This communication proposes a methodological framework to produce knowledge about collaborative activity performed during simulation workshop, on their productive and constructive dimensions. Producing knowledge about these situations may have two type of outcomes : an epistemic one dealing with a better understanding of (1) the productive and constructive potentiality of simulation, in line with the Constructive Ergonomics Approach (Falzon, 2014; Barcellini et al., 2014; Béguin, 2014; Béguin, 2003) and (2) the role of ergonomist in designing and managing simulation workshops. The proposed methodological framework is anchored in more than thirty years of research about collaborative design situations (e.g. Darses, Détienne, Visser & Falzon, 2001). Grounded in this initial framework we propose additional methods to address the constructive dimensions of collaborative design activity (Barcellini, 2015): (1) the analysis of roles of participants – in relation to the functions of their verbal interactions - and their various forms all along design interactions, as a revelator of the constructive potentiality of interactions ; (2) the analysis of the development of the project in which participants are engaged, thanks to the analysis of intermediary objects produces.

Keywords: Simulation, collaboration, constructive activity, methodology

1 Why revealing productive and constructive dimensions of activities performed during simulation workshop?

Research in ergonomics about design articulates two complementary approaches: understanding of collective design work in various technological or organizational situations (e.g. Détienne, 2006; Visser, 2009; Barcellini et al., 2013); and proposal of ergonomics's model of action, such as project management regarding design of work situation (e.g. Barcellini, Van Belleghem and Daniellou, 2014) or methods (e.g. simulation, Béguin, 2003; Daniellou, 2007).

This communication is grounded in these two approaches as it proposes to mobilize methodology used to analyze collective design work at stake in simulations workshops set up during ergonomics action.

Producing knowledge about these situations deals with a better understanding of the productive and constructive potentiality of simulation, in line with the Constructive Ergonomics Approach (Falzon, 2014; Barcellini et al., 2014; Béguin, 2014; Béguin, 2003). This approach advocates for a renewal of ergonomics scientific discipline goals, which may target explicitly design of work resources supporting development of individuals, collective and organization. In this sense, Ergonomics' goals is not anymore "to fit job to the workers" but also the to support a sustainable development of work activity through actions of the design of organizations and resources proposed to workers to act. This proposal is directly in line with Activity-Centered Ergonomics (e.g. Daniellou & Rabardel, 2005) which outline that any work activities incorporate a productive – in relation with goals pursued by workers – and a constructive dimensions – acting at work generates individual and collective learning and development for workers (e.g. Samurcay & Rabardel, 2004). Thus, in Constructive Ergonomics approach, one finality of ergonomists' action is to foster this developmental process, in particular through specific design actions (e.g. Barcellini, Van Belleghem and Daniellou, 2014). Here, development is taken with a large scope as it concerns individuals, collective and organizations (Falzon, 2014).

In this frame, our goal is to propose a methodology to produce knowledge about development potentialities of actions set up by ergonomists, in particular simulation workshops. To do so, we propose to better understand actual collaboration at stake in design situations and its role in learning process. In the following, we briefly review previous research of collaborative design work in order to ground and then present the approach we propose.

2 How to analyze developmental potentialities of simulation workshops?

2.1 A socio-cognitive perspective of collaborative design work : analyzing the productive dimension of collaborative design work

Here, we assume that simulation workshops are seen as a collaborative design situations (e.g. Detienne, 2006), that are designed and managed by ergonomists. By *collaborative design situations*, we mean situations in which participants are joint to fulfill a common goal, in this case design of a future work situations. They collaborated as they interact to build a common representation of the task they have to perform and knowledge regarding their work. These interactions mainly take place during meetings considered as the driving force of design in which participants negotiate among different viewpoints at stake in design process (e.g. Bucciarelli, 1988). Lots of research in Ergonomics and Design studies (e.g. Cahour, 2002 ; Détienne, 2006 Olson, Olson, Carter & Storosten, 1992 ; Luck, 2012) focused on these meeting in various contexts (software design, aeronautic, engineering, robotics; architecture).

The proposed methodological framework is anchored in these more than thirty years of research about collaborative design situations and the development of specific methods to analyze it (e.g. the COMET Method Darses, Détienne, Visser & Falzon,

2001). These methods consider mainly verbal interactions as the mean of co-elaboration of knowledge in design and functions of these interactions regarding the design task (e.g. generation and evaluation of design solution, clarification, synchronization...). This framework was mainly used to understand the performance of the design, i.e. its productive dimension, with regards to the design of an artefact. It helps in revealing three main subsets of collaborative activities:

- *Generation-evaluation activities* related to the process of solving and evaluating various aspects of design problems. These activities are based on argumentative process by which participants negotiate among various constraints and viewpoints inherent to collaborative design situation (Wolff, Burkhardt & de la Garza, 2005 ; Détienne, Martin & Lavigne, 2005).
- *Clarification activities*, concerning the construction of common references, or common ground, within a group of participants. Here too, argumentative process is of prime importance, as it supports the elaboration of a common ground between participants (Clark & Brennan, 1991; Baker, 1996).
- *Group management activities* related project management activities that concern the coordination of people and resources - e.g., the allocation and planning of tasks – are of this kind, or meeting management activities – e.g., the ordering and postponing of topics of discussion – are another example of this kind of activity.

2.2 Contradictions and argumentation as a driving force for learning and development in collaborative design situations

Some research specifically targeting understanding of learning process in design situations (e.g. Beguin, 2003) reveals that learning among designers may originate from contradictions experienced by participants, due in particular to the various viewpoints present in design process. An issue to analyse the learning process at stake is thus to better understand how participants cope with these contradictions, in particular thanks to argumentative process. Actual collaboration – co-elaboration and thus learning – is intimately linked to this argumentative process. The field of cooperative learning (e.g. Dillenbourg *et al.*, 1995) reveals in particular that quality of interactions – in particular argumentation and management of disagreements - among participants is the driven force of actual collaboration and learning, as it helps in supporting understanding of participants. Moreover, these research stress the importance of distribution of activities among participants : actual collaboration is viewed as an interactive situations in which alternance of activities is symmetric and smooth, i.e. roles are distributed among participants.

2.3 The Actual Role Analysis in Design as a proposal to understand actual collaboration and learning among participants

Following proposals of the cooperative learning field, analyzing learning in collaborative design situations implies to characterize quality of interactions among participants through the distribution of roles among them. To do so, we develop a

method called “Actual Role Analysis in Design” (ARAD) approach proposed by Baker et al. (2009), Détienné et al. (2012b) and Barcellini et al. (2013) to study collaborative design. The ARAD approach has been designed to capture actual collaborative design activities, i.e. that are no predefined but effectively performed by participants, and that emerge from actual interactions between participants. It identifies roles that correspond to distinctive and regular individual behaviors emerging in the interaction. Four types of role are considered to embrace different facets of participation. They are characterized on the basis of the structure of the interactions during design meetings (interactive role), and according to the orientation of the interactions among the participants engaged in discussions in relation to collaborative design activities (Barcellini, Détienné & Burkhardt, 2008, 2013; Détienné, Baker, Fréard, Barcellini, Denis, & Quignard, 2016).

3 Conclusion

The approach has been used in various design contexts: distributed and asynchronous design situations such as in Open Source Software Design (Barcellini, 2008) or participatory design in agro-ecological context (Barcellini, Prots and Cerf, 2016).

In this communication, we will propose an instantiation of this framework to analyse collaborative interactions between ergonomists and others participants in simulation workshops, in relation with the developmental potentiality of simulation we discussed in Barcellini, Van Belleghem and Daniellou (2014) or Béguin (2003). We will mainly propose to understand this potentiality not only with regards to the development with one or another artifacts under design (space, organization, process) but with regards to the development of a future activity performed thanks to these artifacts. We will be mainly interested in the type of knowledge that co-elaborated, and the role of ergonomist and the setting she/he propose to support this co-elaboration. This epistemic outcome may have a pragmatic one dealing with teaching of ergonomics (e.g. Barcellini and Van Belleghem, 2014), in particular the role of ergonomist in designing and managing simulation workshops.

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