ShareLab, Support for Collective Intelligence

1 deadline, 11 designers, 1 project

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Abstract— **This paper presents the implementation of a collaborative action research approach aimed to assist in constructing collective intelligence. Named *ShareLab*, this project was implemented as part of a call to an international competition bringing together different skills originating from varying cultures so as to produce a common project in a very short time. What is the origin of *ShareLab*? How was it put into play? What are its advantages and limitations? This article aims to answer these questions thanks to the feedback obtained from this competition experience.**

Keywords-collaborative action-research; case study of collaborative activity; managing collaborative design project; adaptive collaboration; collective intelligence.

I. INTRODUCTION

Architectural design is a complex activity that operates in an increasingly coercive regulatory environment and that has to deal with the competition and urgency resulting from ever-shorter deadlines. Under competitive circumstances, the challenge of the designers is not only to comply with all these constraints, but also to propose creative and innovative ideas that can win over a jury. To address these constraints fully, architectural firms (whether small, medium or large) innovate through interdisciplinary approaches to combine various skills needed to carry out the project. Nevertheless, faced with this variety of contributors to the project, certain information related to the constraints and design arguments is lost; the risk of generating misunderstandings and disagreements grows, and managing group cohesion becomes more and more difficult [1].

With regard to this problem, we propose the employment of a novel approach, entitled *ShareLab*. It targets the cohesion of a group in order to gradually bring about a collective intelligence [2]. In this vein, this article first sketches the main scientific contributions that have identified those components promoting collective intelligence. We then propose to connect those findings to create and define our unique approach, while demonstrating its significance thanks to the concrete case of a multidisciplinary, collaborative work carried out as part of an international architectural competition.

Our article is divided into four parts. Section II will introduce the theoretical framework of our study by highlighting the concepts that characterize collaborative activity and the approach that best cultivates it. Section III will describe the context of our study and the design team. Section IV will present the methodology implemented. Finally, the conclusion will address the contributions and limitations of this experience, with possible avenues for improvment.

II. THEORETICAL FRAMEWORK

A. Specifying collective activity components before choosing tools

To define our research framework, let us start by distinguishing between what pertains to *cooperation* and what pertains to *collaboration* in collective design activities. We hold that collaboration entails instances in the design process where multiple contributors interact together around the same objective and the same tasks, thus difficult to separate [3]. Conversely, in times when they cooperate, each player carries out his or her own task in parallel with the others. These two distinct stages of the collective design process involve different tools and procedures.

For roughly the past twenty years, the field of Computer Supported Cooperative Work (CSCW) - has been developing many supports for collective activity. However, most of these scientific contributions remain rather technically centered and too often neglect the organizational aspect in addition to personnel management. Most tools proposed therein are intended to assist the cooperation of contributors by facilitating asynchronous, remote exchanges. These cannot, however, be used when the project is sufficiently advanced. The sketch phase, during which the most important design choices are decided upon, enjoys little instrumental aid from the collaborative perspective.

However, meeting up despite long distances, exchanging ideas in real time, maintaining trust between members, managing both *cognitive* and *operational synchronizations*,

collectively sharing artifacts, and developing *awareness* and *common ground* are primordial in ensuring a collective design project. On their own, current tools are not enough to manage all these elements of collaborative activity. Our research question lies herein: how can we combine these into an inclusive model that is applicable under real conditions?

B. Orientation towards a collaborative action research approach

To answer this question, we propose here to define, contextualize and integrate all of these elements composing collaborative activity, within the framework of an approach that invites the contributors to reflect upon their situation. To this aim, ShareLab - defined by the LUCID laboratory at the University of Liège and developed as part of this contest with TARTAR, a design team - employs an interventionist approach. This method aims to support work situations that involve multiple collaborators, working together for the first time to design, in this case, an architectural project in a competition with a very short deadline. That is why our approach integrates all of these collaborators and attempts to engage them in "a critical and dynamic reflection about a situation that concerns them" [4]. Inspired by the methods of "collaborative action research" [5], the aim of this approach is to focus the attention of all players both on the results of the competition and on their processes and methods of working with multiple people. This type of method is not opposed to conventional scientific approaches, but rather supplements them by managing the concerns of participants in a situation created by the intervention of researchers wanting to develop a shared understanding of that situation [6]. All contributors (researchers and practitioners, observers and designers) work together to build whole new meanings related to their activity, thanks to the synergy of their views, self- and mutual appraisal of their actions, self- and co-training, and co-evolution of the methods implemented in order to work together [7]. Although the principles of the approach applied here are part of a specific, predefined, theoretical framework, it remains necessary to implement a protocol that integrates the specifics of each work group and their project, as well as the context and the constraints that they will have to manage.

By implementing the concept of ShareLab, our objective is not to impose a sole method, but rather to adopt an integrated approach that encourages group cohesion and that aims to bring about collective intelligence. To adopt an integrated approach while maintaining each designer's individuality: our assumption considers the collective activity in design as complex, difficult to generalize and which result is first thought, negotiated, valued, challenged and co-built by the group before it even exists.

III. A SHARED RESPONSE TO A DESIGN COMPETITION

Cohesion in a work group is not something to be taken for granted, even less so when the group members do not know each other and assemble for the first time, as is often the case. Players might exit the framework of their habitual activity, but their past experiences still shape how they work with others [8]. Their mutual interactions are thus subjected to several emerging and recurring factors, such as trust, culture, language, individual specificities, tools and mediation procedures between them, etc. [9]. Other factors also come into play, like the notion of leadership or motivation to participate in a joint project [10]. As part of the competition involved in this study, the group of designers and researchers had aspired to create an innovative process motivated by the novelty of the situation bringing them together, even before starting the design itself. For the group, this involves going beyond their own experiences and areas of expertise so as to incorporate the interests and fields of others in achieving an unprecedented joint result.

A. Presentation of the competition and project produced

The work team in our study concerns one of three winners of an international architectural design competition that attracted 1.749 applications from 90 different nationalities [11]. This team focused on the problem of "the rise of sea levels around the world." Dubbed TARTAR, it consists of 11 people working together for the first time, whose academic backgrounds are different (graduates of France, Romania, Tunisia or Italy), and whose skills (as practitioners, professors, researchers, and students) also come from diverse backgrounds (architecture, urban planning, engineering and humanities). Such diversity, at the heart of their participation in this contest, and their motivation comprise the specific character of this team. Their premise was that an original idea could only take shape within the diversity of all the points of view made up of each of the project participants. To help them reach their goal, the definition of the organizational protocol itself was put together beforehand along with the collaborators and evolved over time from their feedback. The result of this competition was therefore based on this organization and on this co-constructed process. The project was born from the diversity of skills, on the one hand, and, on the other, from the awareness of problems caused by the rising waters (from inventory of various specialties), and the latest scientific discoveries in the fields of artificial intelligence and synthetic biology.

The project submitted by the group consisted in creating new territories through a cooperative system connecting a digital data system and an evolving material inspired by coral.

B. Organizational setup

The organizational structure created here strives to support collective decision-making and to develop an environment that promotes understanding between group members. The ShareLab complements this structure and is based on principles which are defined enough to be understood by all, but also open enough to be re-appropriated and easily adaptable to changes in the project and how the actors interact.

This organizational protocol, called Collective Intelligence Support Protocol (CISP), aims to manage the team in the collective design of their project, all the while integrating space-time constraints on the one hand, and levels and production capacity of each individual within the

group on the other [12]. This protocol ensures the coordination of the team and its *operational synchronization* (relative to the sharing of tasks, according to the definition given by Falzon and Darses [13]. It provides a structure for production level management, deadlines to be met, exchange tools, work produced and the role of each player in the process. Based on a multi-layer system, the work group was initially divided into four interconnected teams: "Organization", "Research" of concept, "Exploration" and "Production" of project. Based on this division, the design stage was then divided into three phases: research phase, exploration phase and production phase. Each team was responsible for its own phase, but all teams were involved in all phases (cf. Figure 1). Wishing to complete the organizational structure, ShareLab was set up to manage the transition from one phase to another and thus ensure the construction of a collective intelligence in the group.
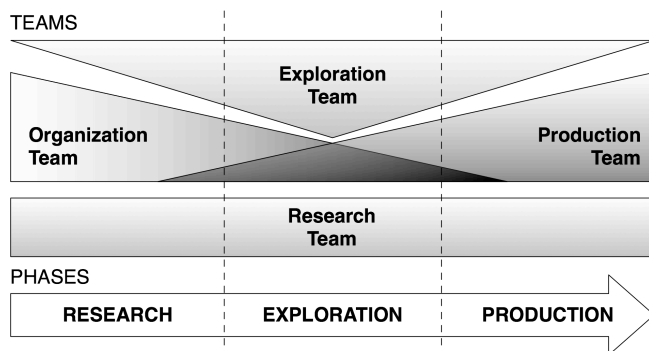

Figure 1.   Relationship between each work phase and the involvement level of each team in that phase.

IV.   DEFINITION OF SHARELAB

ShareLab arose from reflections built on observing collective activities in action in an architectural, design, and engineering firm setting [14]. Aimed at a more interventionist approach and drawing on methods from "collaborative action research," the LUCID laboratory at the University of Liège has sought to define a process of co-reflection in which the problem definition, analysis and the recommendations come from both researchers and practitioners themselves.

Based on "activity theory model" and following the work of the CRADLE Finnish research team from the University of Helsinki [15], ShareLab attempts to foster common ground, helping synchronization within a group whose work habits, procedures and tools are not yet clearly defined.

Indeed, the "activity theory model" (cf. Figure 2) provides the means to understand collective activity by taking into account the actions and contributions of each individual (*subject*) in the group (*community*) focused on an activity (*object*), to meet a common goal (*outcome*). This model also connects these elements with (1) the explicit or implied rules defined between the subjects and their community, (2) the tools used by the subject to act on the object, and (3) tasks to be performed on the object by each member of the community in order to achieve the final goal

collectively [16]. This type of model should be analyzed very carefully because (relative to the 5 principles of "activity theory" as defined by Engeström [17]) it is necessary to incorporate an activity model with other activity systems. While the overall goal of the group is the same, the sub-goals of the individuals can differ. It is therefore essential to see the model as a continuously shifting network of nodes of activities faced with a set of contradictions [18]. These may occur within the same node, between the nodes of a same system, between the existing system and the objective, or between one activity system and another, involved in the production of a common outcome.

In a system where neither instruments nor rules nor even a division of tasks has been defined, this consists in making the three nodes interact throughout the design process. As part of this competition, the definition and implementation of our ShareLab are aimed at better anticipating conflicts and helping the group build its own collective intelligence (see the linking circle in Figure 2).
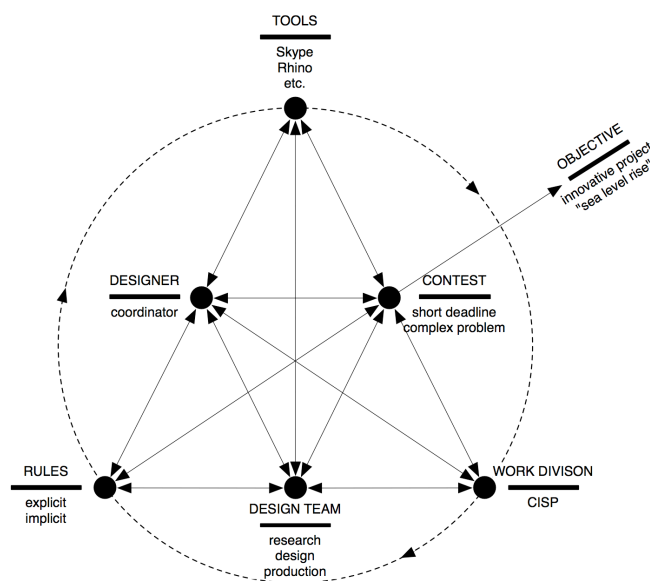

Figure 2.   Activity theory model applied to the TARTAR project, according to Engeström, 1987 [19].

"Change Laboratory is a method for developing work practices by the practitioners. Basing on the theoretical conceptions of the dual (double) stimulation (L. Vygotsky) and expansive learning (Y. Engeström) it facilitates both intensive, deep transformations and continuous incremental improvment. The method is developed and registered by the Center of Activity Theory and Developmental Work Research, Universityof Helsinki " [20]. In line with the Change Laboratory, ShareLab rather intervenes upstream, when the participants have not yet built any **awareness**, **trust** between them has not been acquired, the **shared items** still not defined, the **common ground** unincorporated, and cognitive and operational **synchronization** not ensured.

To better know each other, especially to meet a common objective on a short deadline, the ShareLab tends to support, through an iterative process, design collaboration and

collective ideation by involving all stakeholders and by integrating the maturity of their thinking and the progress of their joint project.

ShareLab was then imagined to join together these five key concepts, through an iterative process, to foster collective ideation (cf. Figure 3).

Let us examine these notions individually, to elicit the theoretical concepts and to indicate how they are implemented, in conjunction with one another, in our model.
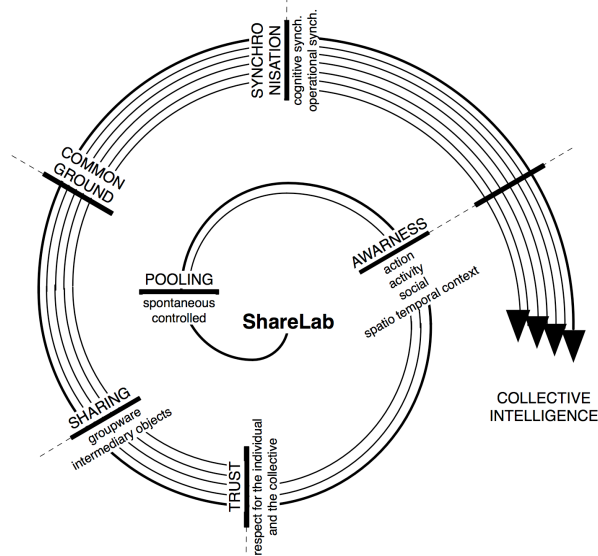

Figure 3. Evolving and growing strategy of building collective intelligence within ShareLab.

A. Synchronization

In a collective work, all contributors must know the objectives, processes, project context, topics and tasks to be done. This mutual knowledge improves the efficiency of the participants in their work together and facilitates dialogue between them. Two synchronization modes are distinguished and complement each other [13]: *cognitive synchronization* (on areas of shared skills and knowledge) and *operational synchronization* (relative to the distribution of tasks between collaborators). For its part, cognitive synchronization emerges from a process of discussion, negotiation and evaluation between collaborators. When tasks are new or not clearly divided, the *operational synchronization* plays an important role in the coordination of collective activity. It ensures, in fact, the definition of these tasks and their planning in connection with the common goal of the group. These synchronizations are not acquired but instead emerge from a process of discussion, negotiation and evaluation in which common ground co-evolves between collaborators.

B. Common ground.

The involvement of multiple skills requires taking into account the multiplicity of viewpoints [21] via an argumentative and negotiation processes. Everyone tries to ensure that their views are well understood by others [22]. These views are regulated little by little during the process to

converge gradually towards a shared understanding of project data. This shared understanding has been described by *common ground* [23]. This *common ground* is critical to collaboration: it helps to pool specific skills and contributes to the acquisition of new skills needed to work in a group. It also participates in the referential interpretation process by increasing the speed with which the referent is identified by collaborators. Common ground is thus not a prerequisite. It follows the same process of collaboration, involving a procedure of pooling and it stems from system rules, negotiations and sharing of artifacts, tools, and conventions [24].

C. Between the sharing of artifacts and tools

Mirroring the process of refining ideas, artifacts continue to evolve through the exchange of different views between collaborators. They promote "*reflective conversation*" [25], allowing individual participants to shape their thoughts and share them with others. These artifacts provide a common basis between the participants. They are called *intermediary objects* when not completely fixed but remain changeable throughout the process [26]. These intermediary objects can encourage mediation, translation and/or representation. These artifacts are also called *boundary objects* [27] when they comprise fixed materials for negotiation and collaboration. To manage the sharing of these artifacts, it is equally necessary that the designers agree on the tools to use to work together. This conscious sharing of artifacts and tools is possible, however, only once trust has been established between designers. Indeed, a lack of knowledge of the situation, context, tools and specificities of each member can cause conflicts, leading the group to unsatisfactory decision-making for the project [28].

D. Management of trust by respect for the individual and the collective

Within a complex, multidisciplinary group activity, each participant must maintain the distinctiveness of their point of view and develop their own analysis of the problem to solve it. Yet this variety of perspectives may undermine the coherence of the project and may even induce a series of conflicts in the group. Avoiding groupthink while preserving group cohesion is the major challenge of any collective, multidisciplinary activity [3]. That is why it is worth developing methods that can promote integration of this diversity of perspectives, bringing about common knowledge that nurtures the project and participates in its development. Combining these views would, according to Belkadi [28], prevent conflicts and thus foster trust between project collaborators. Note however that trust-building strategies are not the same at the beginning or end of an activity [29]. Early on in an activity, social communications reflecting the enthusiasm of each participant and individual initiatives best promote trust, while, at the end of the process, individuals tend towards a concordance of views and more predictable communications with clear answers given in compliance with deadlines. All these parameters are facilitated by the construction of an awareness among the different members of the group evolving in a dynamic frame of trust,

encouraging each player to circulate their own knowledge, references and experiences with others [30].

E.   Awareness

Many cognitive and social science studies have focused on the concept of awareness as a central parameter of any collective activity [31]. Many definitions have been proposed, as well as typologies aimed at specifying these various aspects. One of the best-known typologies is that of Caroll et al. [32], where the authors distinguish three types of awareness: *social awareness* (relating to the consciousness of an activity's social context); *action awareness* (relating to the consciousness of all participants' tasks and contributions in the process); and *activity awareness* (relating to design activity within the group). We add the notion of *spatio-temporal context awareness* which considers the context and the interaction spaces. These various modes of awareness are facilitated by pooling, which may be spontaneous in an informal framework (*spontaneous pooling*) or controlled, in a more planned – but not imposed – one, and that participates in the sharing of knowledge, experience and references between contributors (*controlled pooling*).

V.   IMPLEMENTATION

ShareLab was set up as part of this four-month-long competition, with a threefold objective:

- to face the incongruity of managing creativity in a group in a very short timeframe;
- to organize the transition from cooperative circumstances to collaborative ones;
- to ensure a comprehensive group approach while respecting the specificity of each member.

Thus, ShareLab offers participants a collaboration-friendly environment and the emergence of new ideas in a process adapted to the reality of their activity. The principle behind this is that ShareLab is supervised and supported by the intervention of researchers working together with designers. Indeed, each ShareLab, marking the transition from one phase to another, was co-built with the previous phase's team leader. Before meeting with all contributors in the group, the researcher redefines the following with the leader:

- What are the objectives before the start of this phase?
- What are the objectives achieved at the end of this phase?
- What are the requirements, prerequisites and difficulties encountered during this phase?
- What are the goals to be achieved in the next phase?

Based on these concerns, the researcher and the co-leader build the protocol together to be applied in each ShareLab session, which is generally divided into three stages:

1) management awareness and building a climate of trust by:

- presenting each new member of the group: On what are they working now? Do they have other priorities outside of the competition? Do they have references or ideas to share? Do they have difficulty using a

given tool, sharing data or answering another member's request?

- co-defining the objectives of this new ShareLab, marking the transition from one phase to another;

2) management of sharing and building a common ground: by the co-design and co-development of ideas from pooling work done in the previous phase and using several methods from Design Thinking and Serious Game (Set, Search, Imagine, Model, Select, Implement);

3) management of operational synchronization: by co-distribution of tasks and co-definition of the objectives of each team in the next phase.

As shown in Figure 4, the ShareLab has been used several times along the design process: during its introduction (when designers meet for the first time), during its finalization (when designers finalize their rendering and synthesize the project together) and during each articulation between phases (for example, when the exploration team seeks to pass on the production team.

Let's take the example of the first ShareLab session: its aim was first to establish trust in the group, since all individuals meet for the first time.

Figure 4.   Different modalities established for each ShareLab.

It was then necessary to invite them to participate, as a sub-team, to a common activity on the theme of water, but outside their usual work area and using a new approach they did not applied before (here by taking photos at a water park of any reference concerning the topic of water).

A synthesis of this work had then to be co-built by the group creating a mind mapping with all the collected data. This approach allows to deconstruct their own representations by putting them in a non-standard situation. To force them to quickly collaborate with others in order to produce a common result in a small challenge far from the contest topic, invited them to go through a deconstruction phase prior to co-building a new common perception.

VI.   INITIAL FINDINGS

Before even attempting to equip participants to manage their processes and artifacts, one must take into account their interdependence and the context in which their collective activity will evolve. The application prescribed by a coordinator is never just the work carried out by the

collaborator. It is first interpreted and reconstructed by the subject through his or her own internalized psychological instruments [33]. That is why it is relevant to build the objectives of each task together, with its specific characteristics and interdependencies, rather than impose one without trying to share and synchronize tasks performed by one member or the entire group during the previous phase. Throughout the evolution of design and negotiation processes enabled by ShareLab, group maturity can come about. Taking a step back from one's own activities makes it possible to co-/self-assess and to improve the procedures and ways of working together. During ShareLabs, discussions and negotiations, based on their production and their ideas, resonate in each designer, causing various interpretations through the use of post-it, words play, or other types of games helping them to share and to compare their points of view.

Agreeing on the relevance of a particular action helps to clarify the options of each member and encourages iteration, creativity and the emergence of innovative proposals. This way, participants extend their skills and possible fields of inquiry, while taking into account each other's views.

The members of the group evolve together in this way and jointly develop some agility in learning to change. As a catalyst of collective intelligence, the foundations of ShareLab involve:

- participation of all contributors in the project early on and the involvement of a team of researchers, helping the group to build the objectives of each phase together, specifying their activity;
- an approach that aims to be interventionist and scalable via each other's interactions;
- joint definition of tasks, procedures and tools, as well as a co-evaluation of these resources;
- taking into account the space / time necessary for exchanges and for the work to be achieved.

VII. CONCLUSION AND PERSPECTIVES

A. Contributions

ShareLab makes it possible to offer a forum for all collaborators while helping them manage their specificities and differences in a very short design time. This approach is intended, firstly, to formalize a collaborative action approach capable of supporting collective intelligence within a work group. This feedback from players also allows the method to be improved, to reconsider it with respect to new application contexts and to help it grow by setting up a dialogue with other approaches simultaneously involving the object, the group and tools to support them in their activity. Although the absence of specific procedures associated with the establishment and definition of ShareLab could be regarded as a limitation, it can also be considered an advantage as it takes into account the specificity of each group, of each phase and of every possible iteration of the design process. We believe that this versatility allows collaborators to better meet their initial objective by taking into account the wide variety of parameters, contexts and approaches.

B. Limitations

While ShareLab reflects the emerging movement and dynamics of collective activity, it is also true that it alone cannot surmount the complexity of the project and of the context in which the players evolve. That is why it is imperative that this approach, even in a rationalized form, should not aim at too systemic a vision of production, at the risk of forgetting the contributors and their specificity in a group.

The motivation that characterizes all members of the group participating in the contest is the incorporation of all areas of expertise, cultures, experiences and views involved in the project. Yet isn't this motivation the cause of ShareLab's success? This parameter should undoubtedly be considered in the construction of intelligence within the group.

Furthermore, the feedback mentioned in this article has been explained on the basis of reports and video recordings of ShareLab conducted throughout the competition. This feedback could have been richer if it had been built on the basis of a reconstitution to participants after the final rendering; unfortunately, such was not feasible here.

C. Future work

A critical perspective, suggested in light of this feedback, is to support this method with the following stipulations:

- by confronting the protagonists with their own activities and by putting them face-to-face with their experiences and contradictions that had occurred in the process;
- by applying this method to other collective design contexts, such as design and engineering;
- by complementing it with other methods, such as analysis protocols or participatory approaches involving users in the study as well.

An epistemological framework is also needed to deal with the concepts that can define collective activity and manage its complexity. Faced with strong levels of inertia in work habits, the real challenge now is to implement strategies to better manage the group cohesion inside the design activity contradictions.

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