A Problem-Solving Game for Collective Creativity

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ABSTRACT
There are many studies on how individuals solve problems in a creative way but few on how the collective that the individual make part turn solutions into changes. We propose that creativity starts from the individual but is not fully realized until it gets into the collective. The collective must be conscious about the contradictions in order to embrace change. The lack of studies on collective creativity makes researchers and practitioners underequipped to deal with complex design process where multiple actors interacts. This paper presents and discusses a design game that takes problems and solutions as placements to find activity contradictions and raise consciousness about the possibilities for change.

KEYWORDS
Creativity, Problem-solving, Activity Theory, Design Games

INTRODUCTION
First studies on creativity have taken it as an isolated act from an individual, as a result of a personality trait or intelligent quotient [1]. More recent studies have included other factors for creativity, like motivation, acquired cognitive skills and social environment [2]. The cognitive factor opened up opportunities for teaching creativity skills and observe how that impacts learning, moving the focus from causes to effects of creativity. Problem-solving was used as the favorite process for observing creativity, as it provided the rational and measurable phenomena that cognitive studies targeted on. With the exception of the situated cognition studies pioneered by Lave [3], the social factor was taken only as a cause and not as an effect of creativity, making it difficult to apply knowledge about creativity for pragmatic social change.

This paper introduce a notion of creativity as a collective process, shaped by material conditions and social contradictions. This notion is developed under the Activity Theory framework presented by Engeström[4]. Further, we present and discuss the development of a game that takes problem-solving as a social distributed process, following the network theory of Koppenjan and Klijn [5] and the doctrine of placements of Richard Buchanan (Buchanan, 1992). We argue that rethinking why — not how — problems and solutions are formulated in design process will enable Design Theory to support the collective coordination that is required to deal with wickedness in societal change process.

COLLECTIVE CREATIVITY
Activity Theory, developed from the Cultural-Historical Psychology of Lev Vygotsky, is based on the premise that human consciousness is produced by social activity [6]. Even when an individual is engaged in a solitary endeavor, he is using instruments socially learnt. Instruments are used to mediate the relationship between the individual and the world in a certain way, which was learnt by interacting with other individuals and using other instruments. The process of taking consciousness of the instrument and gradually converting it into a sign is named internalization by Vygostky. Internalization is not about abstracting representations, but precisely about perceiving things in context, making concrete representations.

Because each individual experience different contexts through life, each develop his own way of taking consciousness about things. Activities are bound to material conditions, but this subjectivity makes it possible to behave insofar changing the activity. Vygostky named this process externalization. More often than not, externalization efficacy depends on collective capabilities, on how the group deal with an individual deviant behavior. Change, then, is realized when the collective becomes conscious about it. If an individual proposes changes that are not accepted by others, activity remains the same. Creativity, thus, could be defined as “a feature socially ascribed to those whom generate a type of behavior and solutions that trigger a social change” [7]. This notion of creativity is taken by Sosa and Gero for assessing intelligent computer agent behavior, but we consider it useful for taking human agents creativity as less romantic and more realistic.

Often, the individual doesn’t give up and try to push change even if the collective is not willing to do it. Following the Marxist grammar, Vygostky called this phenomena contradiction, an opposition of different forces that coexist together. Engeström [4] describes other types of contradictions in organizations, not only between individual and community but also between instruments, rules, division of labor, and the object that is being transformed by the activity. One activity can have many contradictions in itself and also with other interconnected activities. However, contradiction must not be understood as a conflict; “Contradictions are historically accumulating structural tensions within and between activity systems” [4] An activity can remain stable, yet with many tensions, for a long period, but at a certain point something triggers a conflict that leads to a radical change. An outsider can be surprised how that change could happen, but a careful

analysis of previous contradiction reveals where it came from. The change was already there, but in a potential state. However, when a contradiction is resolved, new potential contradictions emerges, so the activity can always evolve.

CREATIVITY AND PROBLEM-SOLVING

A contradiction is not a problem inside an activity until someone perceives it as so. A problem states that there is something wrong within the activity. In social process, when something is stated as a problem, it implies that there are possible solutions to eliminate the problem. But, if every change comes from and creates contradictions, there is no possible definitive solution or definitive problem. And, most important, the activity will proceed to change irrespective of formulation of problems and solutions.

Nevertheless, problem-solving is a recurrent strategy for activity change or, as we use here, creativity. Creativity is considered in common-sense as an unexpected, unusual or clever conceiving of a solution to a given problem. Because problems arise from contradictions, a common solution is a trade-off between one opposing side to another like, for instance, increasing an engine cost for better performance. Al'tshuller [8] studied many invention patents and observed that the problems they addressed required overcoming the contradiction by arriving at a solution that had no trade-offs, e.g. an engine that had better performance without increased costs. Afterword's, he created TRIZ, a method for problem-solving that consists of extracting the contradiction from the context and comparing it to typical solutions that he catalogued until a specific solution is conceived.

Although Al'tschuller developed his method for a very specific design context – technical invention, problem abstraction and typical solutions are very common in other design contexts. Cross [9] reports that experienced designers usually apply the same problem frames for different situations, thus leading to a variation of previous "proven" solution. They know from experience that the solution is not definitive, but satisfactory for that situation. Contradiction doesn't disappear, but it's moved out of sight, where most of the people involved into the activity won't complain about it for some time. Treating a specific problem as a typical one can hidden contradictions that will become even more tense in the future.

Creativity, then, is not only about solving the problem, but about framing the problem. Dorst and Cross show empirical data that suggests that conceiving problems require as much as creativity as for finding solutions.

> *"It seems that creative design is not a matter of first fixing the problem and then searching for a satisfactory solution concept. Creative design seems more to be a matter of developing and refining together both the formulation of a problem and ideas for a solution."*[10]

From that, we arrive at a basic design contradiction that prevents to linearize the design process: to have a creative solution, one must have a creative problem and to have a creative problem, one must have a creative solution. That's not a requirement for creativity, but the way the process evolves. Activity problems are ill-defined and constantly revaluated whenever a new solution is created. Horst Rittel and Webber call them wicked problems because one can never catch them entirely.

> *"The process of formulating the problem and of conceiving a solution (or re-solution) are identical, since every specification of the problem is a specification of the direction in which a treatment is considered."* [11]

Reflecting on Rittel and Webber work, Richard Buchanan [12] explain how designers deal with wicked problems: they rely in a set of placements from which they constantly create and criticize concepts. Placements are developed by experience because wicked problems force them to change. They are not fixed categories with common definitions or solutions, but create some boundaries to think about. Buchanan recognizes four common types of placements in design: signs, things, actions and thoughts. We think that problems and solutions could also be treated as placements in design thinking. Although designers are aware that wicked problems have no clear definition or definitive solutions, they jump from one to another constantly when planning what to do.

THE GAME OF PROBLEM-SOLVING

Buchanan doctrine of placements was formulated to explain how designers think, but that's not enough for explaining how that happens in a collective level. Koppenjan and Klijn [5] observe that complex problem-solving doesn't happen on the individual's mind, but on a social context where the individual is just one of the multiple actors that are interacting to evolve problems and solutions. Drawing from the "garbage can" model of decision-making[1], they propose that different streams of problem formulation and solution finding evolve independently across organizations, but intersect at arenas where decisions are made. In these arenas, people perform strategies for realizing their objectives, making compromises or coming back when there are conflicts. Koppenjan and Klijn take problem-solving as an organizational game and develop a theory for managing uncertainties that comes from them.

[1] Cohen *et al* [16] studied how large public organizations like hospitals and universities make decisions and proposed a metaphor to explain it: different people from the organization formulate many problems and solutions until there is a choice opportunity to put them in the "garbage can", process it and come out with a decision. Choice opportunities can be, for example, meetings, informal encounters, or public consultations.

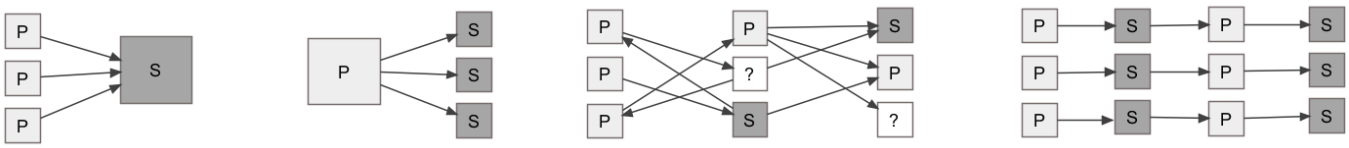

Figure 1 - Four game modes of collective problem-solving (left to right): Requirements Gathering, Brainstorming, Unstructured Discussion and Multi-threaded Discussions

From our experience on playing those organizational games we can argue that not every player act rationally as if he had a clear strategy. Players are aware of the uncertainties and the impossibility of realizing a plan without adjusting it on execution. As Lave [3] reveals, people rely much more on tactics than on strategies for solving problems. Influenced by Lawson [13] systematization of design tactics, we identify four common modes in the game of collective problem-solving (see Figure 1):

1. **Requirements Gathering**: identify all the problems and try to solve them as much as possible with one integrative solution;
2. **Brainstorming**: define one problem and generate as many solutions as possible.
3. **Unstructured discussion**: problems and solutions are discussed in a non-linear fashion. Participants can find problems on other's solutions. Often, some arguments are neither a problem nor a solution.
4. **Multi-threaded discussion**: each problem stream is discussed at a time; solutions are created and revised for possible problems until participants reach consensus on an acceptable solution.

As designer practitioners, we observed those game modes being applied in different situations, with different degree of success (activity change), but one common feature was that the time consumed were much greater than participants would like to be. Rittel and Webber [11] also found that solutions to wicked problems are usually chosen when planners run out of time or patience, as the best they could do within projects limitations.

A PROBLEM-SOLVING GAME

Based on a very naïve assumption that design creates more problems than solutions, the authors developed a group game that mixes the aforementioned game modes in a structured way. It's important to note that the argumentation we developed until here were not fully articulated at the time we conceived the game, but evolved meanwhile experimenting the game on different situations.

The design game was applied by the authors in projects that they worked on, acting mainly as game moderators. We describe the experience we had from the following contexts: product conception in an educational tools provider, workflow redesign in an appliance factory, workflow redesign in a mobile software factory, and product evaluation of a financial web application. Unfortunately the sessions were not recorded, so we make our report based on our participative observation and photo registering. We adapted the game variables to each context, but kept mechanics the same.

The game mechanics was inspired by an old Brazilian television show called *Passa ou Repassa*, where one competing team received a quiz question and if they didn't know the answer, they could pass the question to the opponent team, doubling its points. The opponent team could answer or return back the question, tripling its point. If the team really didn't know the answer, they could "pay" for the points by doing a weird task like making a human hotdog. Every round had very short time and the show presenter put as much pressure as he could.

We changed the mechanics a little bit in our game, but we strived to keep this emotional effect that made the television show so appealing. We considered the time pressure very important for keeping players excited and, considering our context of wicked problems, we thought that feature could keep players more engaged with the task.

Before the game starts, the moderator propose an open discussion for participants to agree on which activity or part of an activity (e.g. an instrument) they will target the game. This decision is usually easy because participants can feel where the tensest contradictions are. Then, participants are split into two teams. Participants negotiate team formation by themselves, but we suggest them to keep a mix of different backgrounds and expertise. We worked with teams of two to four participants in each team, sat down on different tables.

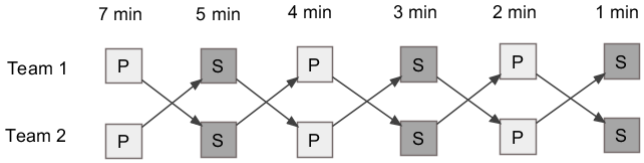

Figure 2 - PS^3 game mechanics featuring the exchange of problems and solutions between groups and round duration

At the first round, both teams have to write down a set of problems, each in a separate post-it. The number of problems is pre-defined, but varies according to the number of participants and context. We usually propose four to seven problems. Meanwhile participants are discussing and writing down problems, the moderator draw attention to the time which is being registered by a chronometer. When time runs out, the chronometer plays an annoying alarm. For the second round, the problems are exchanged between the teams and they now had to propose a solution to every problem, attaching a different colored post-it. On the third round, they exchange both problems and solutions and they have to find possible problems for each solution. This exchange goes on until the sixth round, where they arrive at

three pairs of problems and solutions in each stream, that's why we call this game PS^3. The streams could grow more, but we tried to keep the maximum playing time to 20 minutes in total. We experimented different round times, but the most productive was this sequence (in minutes): 7 – 5 – 4 – 3 – 2 – 1 (see Figure 2). It's important to note that the moderator allowed for extra time for players to finish what they started writing down and, sometimes, when the moderator felt both teams needed more time, he extended the time counter without acknowledging players of that.

The time pressure had the exciting effect we intended, but participants complained that they didn't have enough time, specially, of course, on the last rounds. When they didn't find an answer, the stream was abandoned and, on the next round, the other team got an advantage because they had to work with fewer streams. If they could keep up with it, the further round would turn advantage back to them. This mechanism made an artificial sense of competition that, of course, didn't make sense to the context where everybody was concerned with the same contradictions. Also, when time was about to run out, participants proposed irrelevant problems or solutions just to keep up with the game, making the next round for that stream fall into a recursive argumentation like: "if the problem is money shortage, just put more money on it."

DISCUSSION

As practitioners, we didn't employ that game with the goal of finding solutions or, at least, arriving at a well-defined problem. We knew that in such a tight time frame it would be impossible to elicit the most important problems and get consensus on solutions. Our main goal was just to warm up the group for working with contradictions without trying to eliminate them too soon, but to learn from them. The real task of dealing with contradictions happened after the game, when participants came back to work. But now, they have experienced working together in an exciting fashion, explored some issues and are aware of potential pitfalls. We don't consider the game as a creativity stimulant, but as an opportunity to learn what is creativity for that collective. That's why, after the game was over, the moderator read each problem stream for the group and proposed an open discussion about the experience they just had.

Participants reported that the main benefit of the game was to prioritize problems. Without being asked to, half of the teams we worked with started creating a list of priority problems soon after the game. Reflecting about the game, they mentioned that it demonstrates the importance of formulating clear problems, being aware that no solution is definitive, that's easier to push problems to other's than finding solutions to them, and, what we think is most important, that each participant had different conceptualization of what is a problem and what is a solution.

Figure 3 - Final problem streams after a game session

CONCLUSION

Individual capabilities and group methods are not enough for providing creativity. Creativity requires attitude. Individuals must struggle with contradictions, negotiate with others, have courage to propose new ideas and be prepared to learn from failures. At the same time, the collective must be willing to change. There's no general formula that can anticipates all situated actions [14] that it requires. The situation is shaped by the collective, so the possibilities of change reside on its own condition for consciousness. Creativity starts from the individual but doesn't fully realize until it get into the collective.

We believe that games enable the collective to rehearse change. Players reveal their strategies by their actions, making others aware of the intentions for change. Conflicts are worked in an arena where there always the possibility of pullback. By means of the particular game we discussed here, players could be aware of change consequences, raising the collective consciousness about the possibilities of change. The experience with the design game suggests that Buchanan placements can also be employed by collectives. We believe that having challenging and dynamic placements can be a good way towards collective creativity.

After reflecting about our experience with the PS^3 game, we're planning to make systematic experiments comparing different variables like round duration, number of streams and participants. Also, we think the game goal must be clearer to participants. We're considering starting or finishing the game by going backwards from the first proposed set of problems: instead of finding a solution to a problem, trying to trace which previous solution created that problem. Doing that for more three pairs of rounds can provide a glimpse on the history of the issue. Then, perhaps it would be clear that the game goal is not actually to solve problems, but to question why the collective needs to solve that set of problems. There is a long road to go from problem-solving design to problem-posing design, but we believe with Paulo Freire [15] that helping people make questions are the way to really support collective creativity.

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