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CREATIVE TOOLS TO ADDRESS COMPLEXITY IN DESIGN: FEEDBACK FROM AN INDUSTRIAL CONTEXT

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ABSTRACT

This article provides a presentation of the creativity method that is deployed in our industrial context and a synthesis of observations from around thirty creative workshops. Our work has led to the development of a systemic approach of creativity that, we argue, can guide the development of creativity tools suited to complexity in design. We begin by presenting a creativity method that has been deployed in an industrial context, and then a summary of observations drawn from the workshop analysis of ten industrial projects. Next, we present a short state of the art on the systemic approach of creativity that we promote for a better understanding of creative mechanisms. We conclude by highlighting ways to develop new tools suited to the stimulation of creativity in a complex industrial environment.

Keywords: Creativity cognition, creative design process, creative tools and methods, systemic complexity, industrial context

1 INTRODUCTION

The problems we currently face are increasingly complex, and there is therefore a need for a change in design mentality and different ways of thinking (Charnley et al., 2011). It is often difficult to visualise solutions to these complex problems. They consist of a large number of interconnected and scalable systems and sub-systems, which makes it difficult both to have an overview of the whole and carry out an analysis (Manzano, 1998). It is this awareness of the complexity and uncertainty of the modern world that has led to the spread of the systemic paradigm, which takes full account not only complexity and uncertainty, but also ambiguity, vagueness and randomness (Durand 1979). In general, solutions to such complex problems are very difficult to understand and represent as they consist of multiple sets of objects, services and relationships. In design, the systemic approach can be used to examine a problem as a whole, identify and use the relationships between its various parts, and to develop trans-disciplinary skills (Charnley et al., 2011).

Our research is motivated by the needs that we have identified both as researchers and as practitioners working in an industrial context – in particular, a car manufacturer. Responsible for managing creativity and running creativity workshops in a division dedicated to the user experience, we use existing creativity tools and methods that are widely used in the industrial environment, such as brainstorming, Synectics, TRIZ, etc. However, the issues we face have become so complex (both in technical and organizational terms) that these tools can no longer meet day-to-day needs. They have been pushed to their limits, and it is very difficult to use them to stimulate creativity at the levels of

performance required in complex design environments that are often difficult to understand.

We hypothesize that the perceived complexity in design projects in the industrial context and the difficulty in finding creative tools to address it, comes from a lack of understanding of complexity and the systemic character of creativity mechanisms themselves. We argue that a systemic approach of creativity will make it possible to develop appropriate tools to stimulate creativity in complex industrial settings. The first part of this article is a presentation of the creativity method that is deployed in our industrial context. Next we present a synthesis of observations from around thirty creative workshops (ten industrial projects). In a third part we propose a short state-of-the-art review of creativity, and we conclude with a discussion that highlights ways to develop new tools.

2 THE CREATIVE METHOD DEPLOYED IN OUR DIVISION

The context for our work is the User Experience design division of a French car manufacturer, which is responsible for the design of the overall user experience of a client. Our mission is twofold, first to design Human Machine Interfaces (HMI) that provide new services and features both inside and outside a vehicle, and secondly to script experiences for prospective customers that show a systemic view of mobile use. The design methodology adopted is essentially the result of User Experience (UX) design practices, composed of short, iterative cycles of design and prototyping, and test user cycles carried out very early in the process.

Beginning with the initial brief, there are four levels of intermediate representation before we arrive at the final deliverables. The first type of intermediate object (R1) is a summary of field data on a given topic. We use tools taken from sociology and qualitative observation and interview methods. This field study provides the raw material that forms the basis for creativity workshops aimed at producing innovative ideas and concepts. The second intermediate object (R2) is a creativity summary. This consists of a collection of ideas and concepts produced by the "creative group workshop", which is discussed in detail below. This creative summary provides the raw material for the development of an initial prototype. The third intermediate object (R3) is a design summary. This takes two forms: an HMI design dossier containing development guidelines, or a prospective use scenario. We use HMI design tools or storyboarding to develop these. Both forms may be explored in more detail and used to develop a second prototype, which is our fourth intermediate object (R4). This either takes the form of a more-or-less functional HMI demonstrator, or a more-or-less detailed animated film script. These represent the final deliverables for our division.

In parallel with our design and scripting responsibilities, we organize creative group workshops where the raw material derived from field studies is transformed into usable outputs. An analysis of the results of more than thirty workshops held each year means that we are able to propose a generic formalization of our current creativity method.

This method consists of three phases:

1. Structuring the study synthesis into visual and textual content that is easily understandable by stakeholders. This phase leads to the formalization of a workshop facilitation guide.

2. The organization of a series of workshops. How many are organized depends on the level of detail and the complexity of the deliverable required by project stakeholders.
3. Structuring the creative synthesis of the workshops and distributing it to all stakeholders for use by their design teams.

Inputs to the creativity workshops mainly consist of visual content, customer scenarios, benchmarks, and test results that are illustrated graphically (diagrams, photos and videos). This content is supplemented with textual information and oral presentations by domain experts.

The workshop itself is divided into three parts:

1. An initial phase (stimulation) preliminary to the generation of ideas and concepts. Various input data are presented to participants in order to stimulate their knowledge with these new pieces of information.
2. A second phase (representation) where participants combine this new information with their existing knowledge, and formalize the ideas and concepts that come to mind. We encourage them to express themselves through drawings, and if necessary with words. Each participant or group of participants then gives an oral presentation of their ideas to the others.
3. A third phase (selection) concludes the workshop. Stakeholders evaluate proposals by ranking them on several criteria that vary depending on the project, such as compatibility with the company's business sector, technical feasibility, or value for the customer.

The output of the creativity workshop is also mainly composed of visual content: illustrated scenarios in the form of storyboards, drawings and graphs, and concept sketches. This content is supplemented by textual guidelines and design specifications.

Various creativity tools are deployed during these three phases (stimulation, representation and selection). These fall into three categories and can be used interchangeably in each of the three phases described above:

Sentential tools:
— Brainstorming: rapid generation of ideas, written or oral
— Challenging questions: essentially oral reminders
— Role playing: experiments in social situations

Visual tools:
— Free sketching: unconstrained drawing
— Sketching with canvas: constrained drawing and visual stimulus
— Writing with canvas: constrained writing and visual stimulus

Objectual tools:
— Bodystorming: experiments with objects
— Quick-and-dirty prototyping: formalization of a "draft" prototype
— Scale modelling: spatial ideas on a one-to-one scale (vehicles, architecture, etc.)

Subsequent workshops can be organized in the same way, the output of the first serving as input for the next, and so on until the final deliverable is sufficiently clearly defined.

Figure 1 shows the overall design process, with a particular focus on our creativity method based on the cycle of creative workshops. This method makes it possible to move from intermediate object R1 to R2: the creative synthesis.

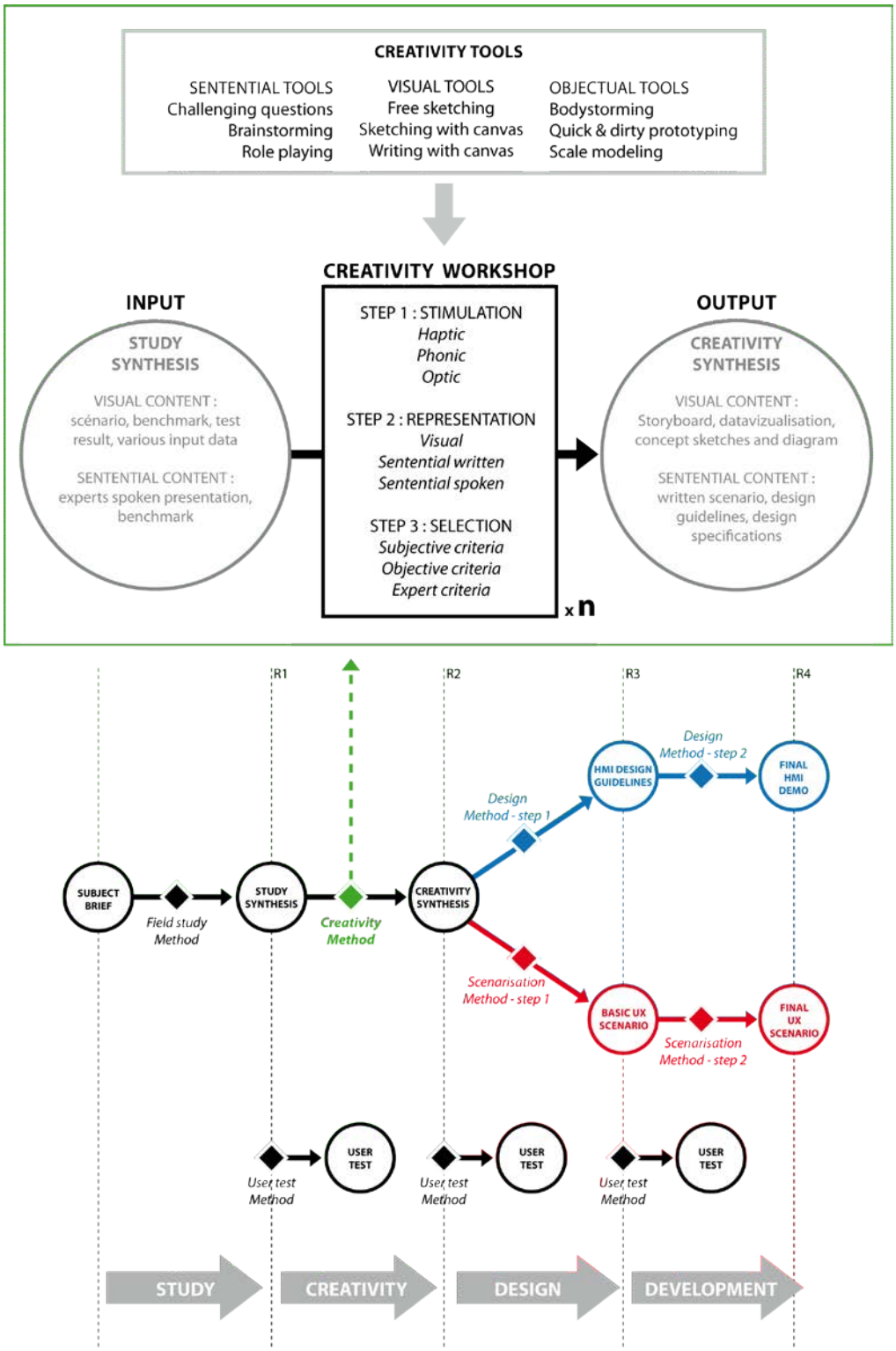

Figure 1 – Creativity method deployed in our UX design division

3 OBSERVATIONS FROM CREATIVITY WORKSHOP ANALYSIS

As around thirty creative workshops are held each year, we are able to highlight recurring observations and draw some conclusions about our current practice. Table 1 and Table 2 sum up feedback from ten projects in our industrial context.

PROJECT NAME	TEAM SIZE	TEAM PROFILE	SYSTEMIC	INPUTS	OUTPUTS	TOOLS
V	Big	Multi-disciplinary	Yes	Visual scenario	Enriched storyboard	Sketching; challenging questions; subjective dot voting
VO	Medium	R&d	Yes	Visual scenario	Enriched storyboard	Mapping; sketching; objective dot voting
K	Medium	Multi-disciplinary	Yes	Visual scenario	Enriched storyboard	Brainstorming ; sketching; objective dot voting
C	Big	Multi-disciplinary	No	Uses mind mapping	Spatialized concepts	Scale modelling ; sketching; dot voting
D	Small	Researchers	Yes	Concept book	Ux scenarios	Scenario planning;
R	Small	R&d	No	Technical data	Hmi design guidelines	Role playing; user flow
K2	Medium	R&d	Yes	Storyboards	3d mockup	Quick n dirty prototyping
P	Small	R&d	Yes	Technical data	Concepts	Concept map; mindmap
V4	Big	Multi-disciplinary	Yes	Multi-disciplinary data	Uses & systemic vision	Scenario planning; brainstorming ; expert voting
P2	Big	Multi-disciplinary	Yes	Multi-disciplinary data	Uses & systemic vision	Brainstorming ; sketching; expert voting

Table 1 – Creative workshops settings from ten industrial projects

We can see that our analysis mainly focuses on systemic design projects involving teams whose number and multi-disciplinarity are important. We note also the type of inputs and outputs, which are predominantly visual and illustrated. Finally the tools used are mostly graphical and representational techniques, more or less concrete, as well as collective evaluation techniques.

We also note a recurrence in projects involving a large group of multi-disciplinary profiles. The expected outputs and used tools are oriented to a collective definition of (strategic) visions or (prospective) scenarios, and supplemented by objective and rigorous assessments.

PROJECT NAME	METHOD STRUCTURE	METHOD PROCESS	CONTENT FORMAT	CONTENT ORIGIN	TOOLS USE	PERSONAL MOTIVATION	SOCIAL COHESION
V	Negative		Positive		Negative		
VO			Positive			Negative	
K				Positive		Negative	Negative
C		Negative	Positive		Negative /Positive		
D	Negative		Positive				Negative
R					Negative /Positive	Positive	
K2		Negative	Positive			Negative	Negative
P	Negative						Negative
V4		Negative	Positive		Positive	Positive	Positive
P2				Positive		Negative /Positive	Negative

Table 2 – Creative workshops analysis from ten industrial projects

Before addressing a more qualitative analysis of these brainstorming sessions, we can already observe some recurrences from the previous table 1 and 2:

— The lacks in the structure and process of the method, can be correlated with declines of personal motivation and group cohesion.
— The origin of the content (personal experience for example) may play a more important role in the motivation and cohesion of the group, than the use of creativity tools.
— However, the visual formats used to represent the content of the workshops and the graphical techniques are well understood and appear to improve motivation and cohesion in some cases.

3.1 LACK OF SYSTEMIC VISION

We note that there is a lack of exposure to a systemic vision, which is often the result of focusing on "targeted marketing snapshots" and the examination of only one use case, which obscures the overall vision.

We also note that interconnections between ideas receive little attention; they are considered independently and the potential links that can be identified between them when they are generated are not highlighted. Ignoring these links immediately limits opportunities to identify potential combinations.

Similarly, the separation of participants into thematic groups that focus on different aspects of the problem leads to a loss of systemic vision.

3.2 IMPACT OF GRAPHICAL TOOLS

We noted that asking participants to draw encourages a playful mood, without creating an overly permissive climate detrimental to the quality of the ideas generated. However, when illustrated scenarios are used as input, participants regularly find it difficult to focus, and struggle to develop and transform them. When working with a future time horizon, care must be taken to ensure that the illustration remains relatively abstract.

The illustrated presentation of the results of earlier workshops is beneficial and is put to good use, particularly if it is visible throughout the workshop. However, it must be prepared with care, in order to be easily understandable.

It seems important to provide participants with their own "free zone" to record interesting ideas that are not necessarily directly related to the topic. It is also important to keep early drafts so that they can be included in the summary and maintain the paper trail that led to the genesis of ideas.

We found that the quality (novelty and usefulness) of an idea is independent of its representation, while the quality of visual representations has an impact on understanding, acceptance and diffusion.

Finally, the summary of a creative workshop is less widely distributed in cases where there is no clear stakeholder who can take responsibility for disseminating the document to design teams.

3.3 INFLUENTIAL FACTORS AND PROCESS

Group workshops are based on the creative profile of participants, together with their involvement as a stakeholder in the project.

Regarding the context, there is a balance to be struck between a stimulating and uninhibited atmosphere, and a fun environment that is overly permissive and unstructured. An excessively long workshop has a negative impact on the attention of participants and data integration. It is often necessary to reorganize the space to meet the needs of the project, even if the place itself has little impact on creative performance.

Time must be taken at the beginning of the workshop to present the methodology to participants. In the industrial context, we noted that participants feel secure when there is a rigorous method, and a process is followed that is clearly divided into specific phases.

Again in the industrial context, a shortage of time often means that tools are chosen in a hurry. In this case, the tools that are selected tend to be those that are most familiar, but which are not necessarily best-suited to the task.

A final recommendation is to pay attention to subjectivity when ideas are selected. This assessment should be only be carried out by experts and not by the group of participants, even if it seems beneficial to group cohesion and motivation.

4 SYSTEMIC APPROACH OF CREATIVITY : THE STATE OF THE ART

Creativity is a complex system composed of processes between an individual and an interacting technical and social environment (Chanal, 2004; Fisher et al., 2005; Iba, 2010). This system is open and produces knowledge links between the experience of individuals and new information from the environment (Gordon, 1961; Koestler, 1964).

Thus the individual and the elements that make up the environment (objects, other individuals) co-evolve over time (Maher, 1994; Maher and Poon, 1996; Wiltschnig et al., 2013), through an interactive cycle of description and changes (Hybs and Gero, 1992; Weisberg, 1988, 1993, 1999; Ward, 2007; Lubart et al., 2003) to representations or intermediate objects (Mer, 1998; Blanco, 1998; Jeantet, 1998; Prudhomme, 1999; Lattuf, 2006).

Consequently, the individual carries out two operations that are characteristic of the act of creation: description, the extension of the perceptual field to improve the quality of informational elements available to them (Poincaré, 1908); and modification, the externalisation of knowledge in memory by materializing it into a representation or intermediate object (Oxman, 1997).
Knowledge that has been externalised is evaluated through the subjective judgment of domain experts and integrated into the culture as a validated creation (Csikszentmihalyi, 1999; Karni and Shalev, 2004).

Thus, we also put out three important elements that complete our previous workshop analysis:

— Brainstorming, lateral thinking or Synectics can improve productivity but the results are often poorly structured (Jones, 2001). The choice of creativity techniques does not matter much. Their effectiveness relies heavily on the experience of the facilitator, and the lack of formal methods has led to criticism of techniques that do not have a rigorous theoretical framework (Degrange 2000; Thiebaud, 2003; Tyl, 2011).
— The forms are used, individually or together, as a symbolic language that can describe, store and process (Oxman, 1997, 2002). They structure relations in the consciousness of the individual, and interact with their mental images (Bruner, 1996; Van der Lugt, 2000, 2005; Visser, 2006, 2009; Iba, 2009).
— It is important to note that collaborative processes are convergent and limit divergent creative performance (Hoegl and Parboteeah, 2007). For greater

efficiency, it is therefore necessary to switch between individual creativity for production, and group creativity for evaluation (Gordon, 1961; Drazin et al., 1999).

5 DISCUSSION

This paper presents a creativity method that is currently used in our company, and feedback from our practice. This work allows us to think about the further developments of our method, and the major improvements we will bring. Thus, from both our literature analysis and experience in the industrial context, we propose three axes for research into the design of suitable tools to go further in the stimulation of creativity in a complex industrial context:

— Promote the use of simple tools easily accessible (like analogy-based tools) to maintain the structural links between perceived new information and existing knowledge in memory, in order to improve perceptive interactions, individual autonomy, and motivation.
— Visually represent this knowledge using a structured graphical language to facilitate its description, memorization, and transformation, in order to improve cognitive interactions, communication and collaborative work.
— Alternate (in the context of an ongoing cyclical process) individual creativity, collective design and expert evaluation, in order to improve social interactions, avoid potential frustration, and maximize group cohesion.

Deployed together, we argue these three research axes improve creative performance in complex contexts, by acting together on tools, knowledge, and process.

6 CONCLUSION

This article has presented the results of our experience gathered from the organization of around thirty creative workshops (in ten industrial projects) and the creativity method currently deployed in a division of a car manufacturer. By comparing our observations with selected authors from the state-of-the-art, we have highlighted ways to continue our work on the formalization of creative tools to address complexity in design.

Although the issues we address here are particularly relevant to the business in which we operate as they provide methodological support for its innovation strategy, we believe that they are transferable to other sectors. We will continue our work in the areas presented here, in order to design and test new creative tools for design. These experiments will be the subject of future publications.

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