User-Centered Methods Applied to 4D/BIM Collaborative Scheduling

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- *User-Centered Design methods*
- *Collaboration analysis through speech, gesture and interactions with artifacts*
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- User centered approachs and Collaborative innovation with interdisciplinary groups on Product/Service/Organization

- Innovation actions in research, education and companies.

-Ergonomist and Industrial Engineering

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Construction project scheduling

Each discipline brings its own knowledge in order to design a building

Discipline’s knowledge is represented with drawings or « representational artifacts »

Which are physical or digital representation of the building caracteristics

Representational artifacts have various form and include

- 3D models
- 2D floor plans
- Gantt charts (time)
- Graphs
- Etc

Scheduling mainly occurs during the pre-construction phase when artifacts are well defined

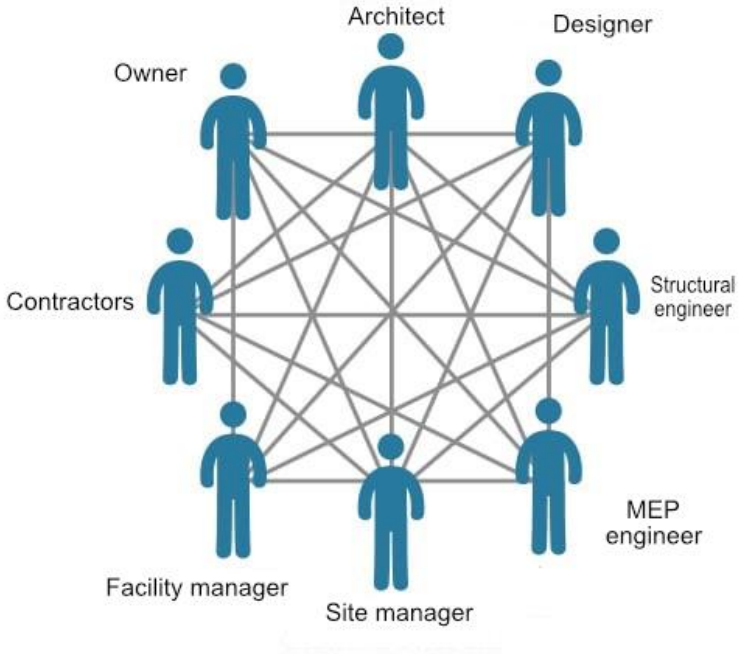
Coordination meetings

The project information is not easily accessible by all members at the same time

Thus communication between stakeholders require a lot of coordination and information is lost in the process

Multidisciplinarity issues are solved during coordination meetings

Where artifacts are used to identify issues and find a common solution



Information exchange without BIM

What is BIM ?

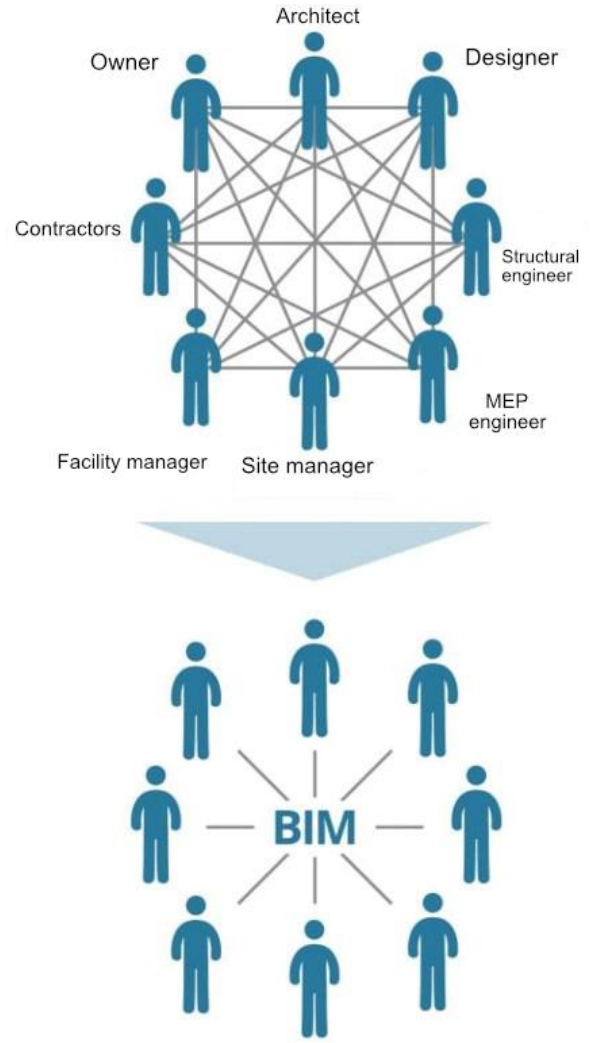
Building Information Modeling (**BIM**) is a technology but also a process

BIM is about creating, interralating and managing all of the digital information of a project

BIM process is highly collaborative and is based on the exchange of data between project stakeholders in order to produce the most accurate and complete model of a building

With BIM, project information is available in the all lifecycle of a project for all stakeholders

In coordination meetings, BIM facilitates the access and visualization of the building's information



Information exchange with BIM

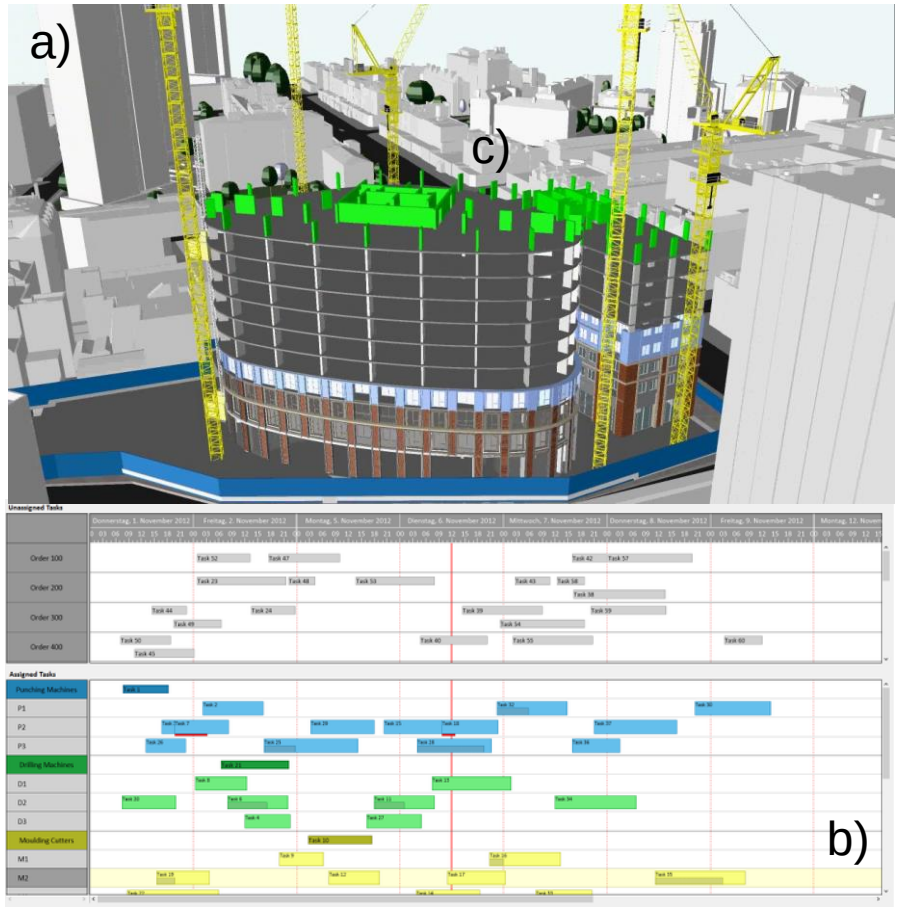
4D/BIM

4D is created by linking a 3D model with project schedule (time information)

It is a simulation of the construction process through time

It allows stakeholders to visualize all the activities to be done, But also to identifie schedule erros more easily

a) 3Dmodel view
b) Gantt chart view
c) In green : objects under construction



4D/BIM advantages and issues

4D/BIM can reduce errors,enhance project visualization and communication between stakeholders or reduce rework

Its potential for strenghtening stakeholders' collaboration during coordination meetings is high

Yet 4D/BIM softwares are not adapted for collaborative work during coordination meetings

Each stakeholder brings their own device to the meeting and managing interactions with a multitude of artifacts across various personnal devices slows down collaboration

Also, there is a lack of visualization standards for representing information

This does not facilitate mutual understanding

4D/BIM adoption and use is therefore low

User-centered design process and methods

In order to resolve 4D's flaws and issues and produce a solution adapted to users' needs

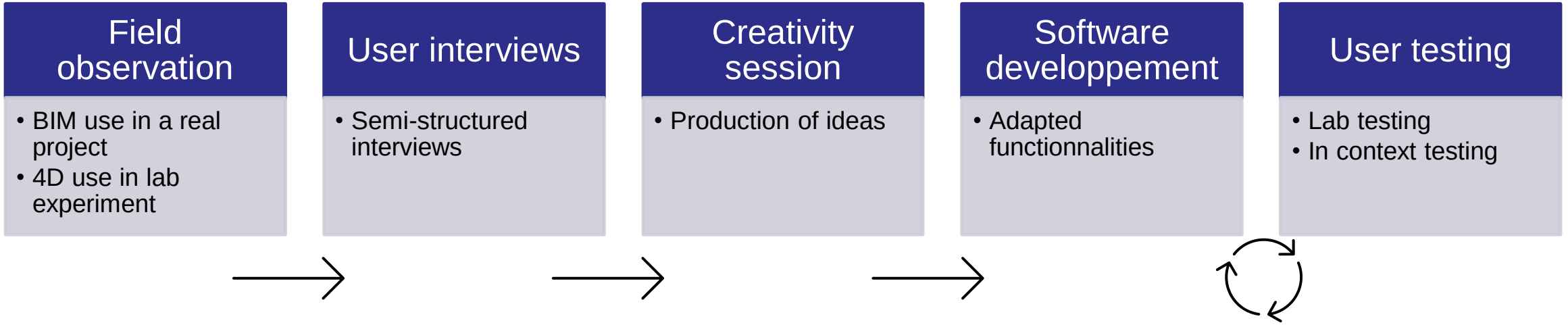
We have adopted a User-Centered Design (**UCD**) process, where users were involved in all the steps

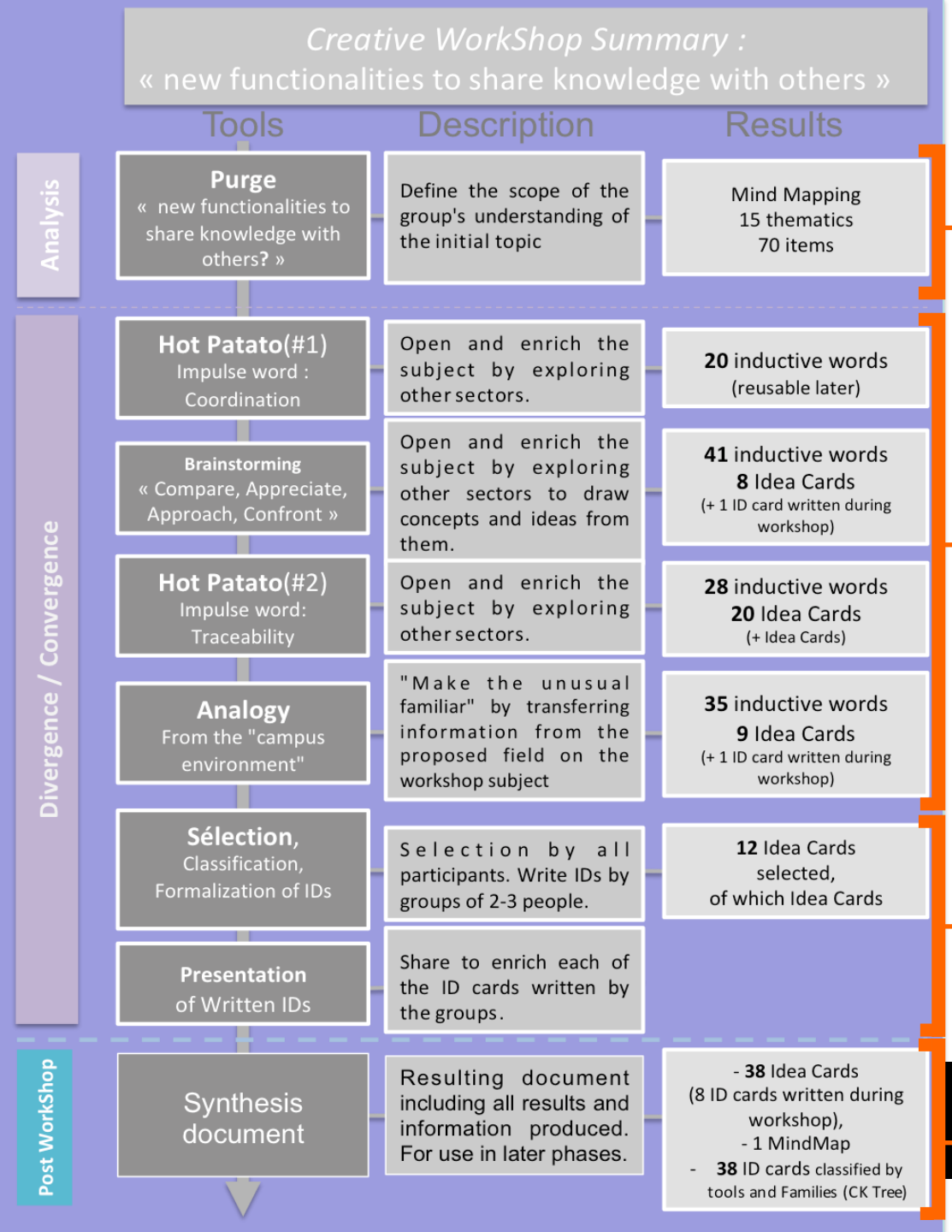
Our UCD is divided into 5 steps : Field observation, User interviews, Creativity session, Software developement and User Testing (see slide 8)

The first two steps aimed at identifying users' needs through field and lab observation of coordination meetings and semi-structured interviews

Users' needs were then used to frame the third step : creativity session

UCD process


Field observation
• BIM use in a real project
• 4D use in lab experiment
User interviews
• Semi-structured interviews
Creativity session
• Production of ideas
Software developpement
• Adapted functionnalities
User testing
• Lab testing
• In context testing



4D Collab

Interdisciplinary Creativity session

Working group of 13 people (3 women and 10 men) from different professions:

2 architects, 2 computer scientists, 1 building construction professional, 1 researcher in architecture, 1 researcher in psychology, 2 mecanical engineers, 2 programmers in BIM, 2 computer editors.

Theme of the session focused on user needs :

«New functionalities to share knowledge with others»

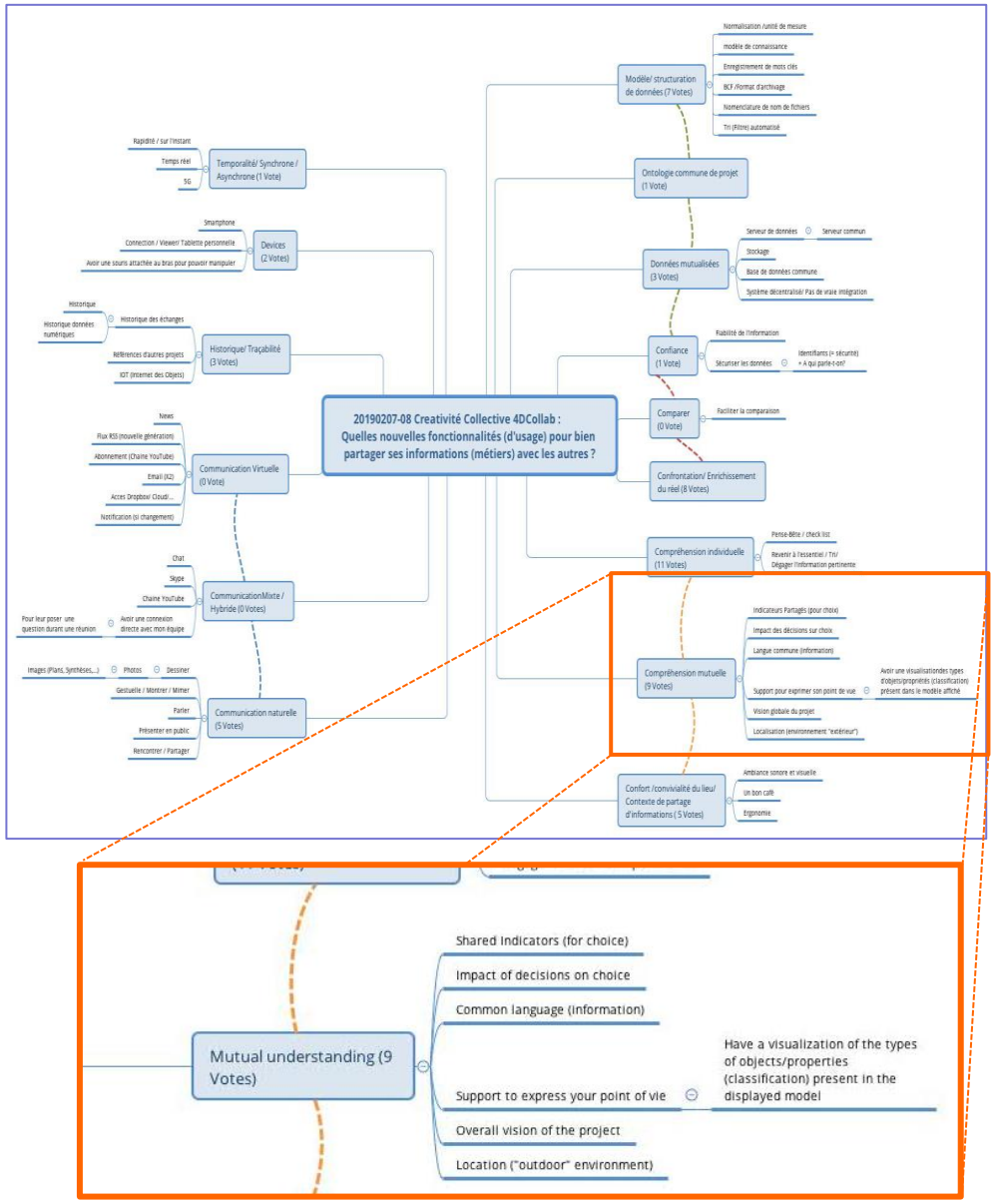
4 main phases process :

1- Analysis phase

2- Creative phase

3- Selection and writing of Bestest Ideas by the group

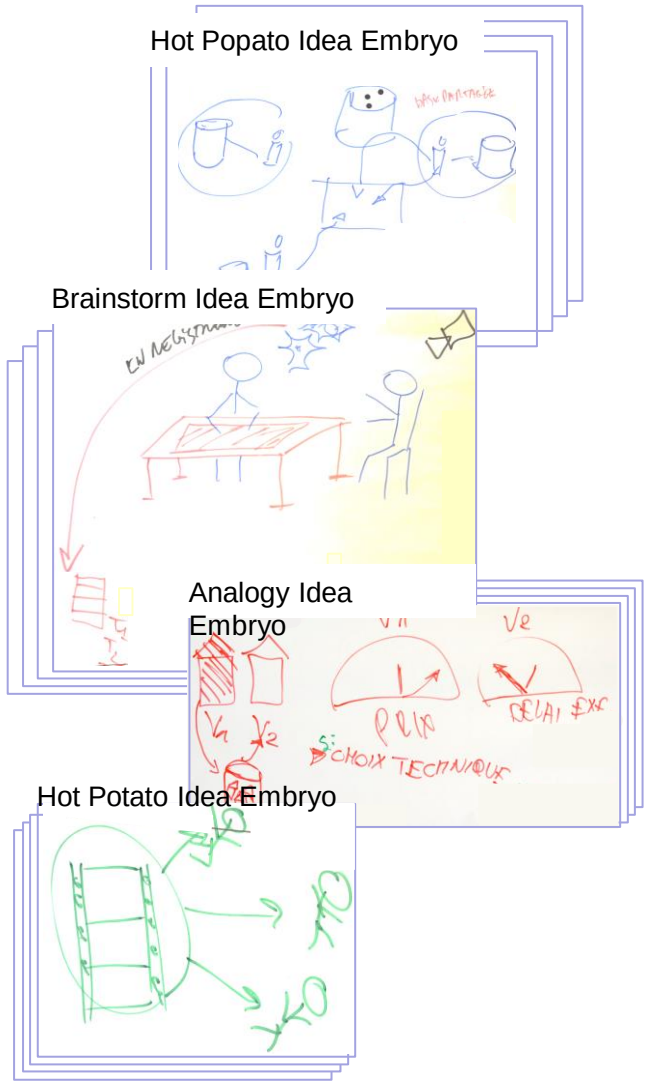
4- Synthesis document including description of the process, all results and syntheses



1- Analysis Phase with Mind Mapping

- Allows to define the scope of the group's understanding of the central theme.
- The only tool in the creative process that can be handled individually.
- These individual productions are then presented in turn to the whole group and grouped by family of similarities.
- Produces a collective representation, in the form of a mind map of ideas and notions expressed by the participants.
- They then vote together for the themes they want to explore further... with the creative tools.

Results : 15 sub themes with 70 Items



2- Phases of Divergence/Convergence

The divergent phase :

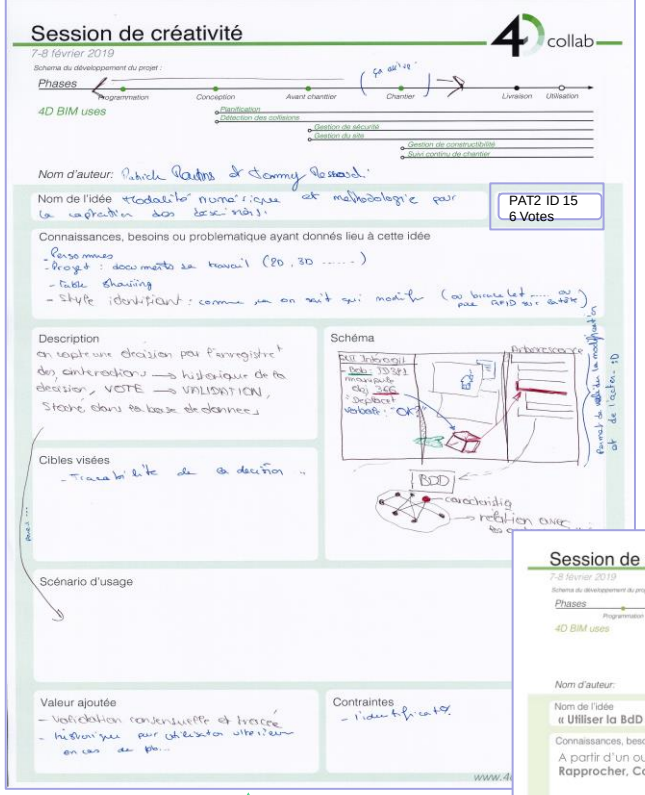
- the aim is to open up the initial subject and to draw from other sectors (e.g. industry, leisure, the city, everyday life, etc.) notions, concepts and ideas that can then be used to feed the initial subject,
- "bombard the chosen subject" from different points of view with complementary creative tools in order to widen the scope of the ideas,

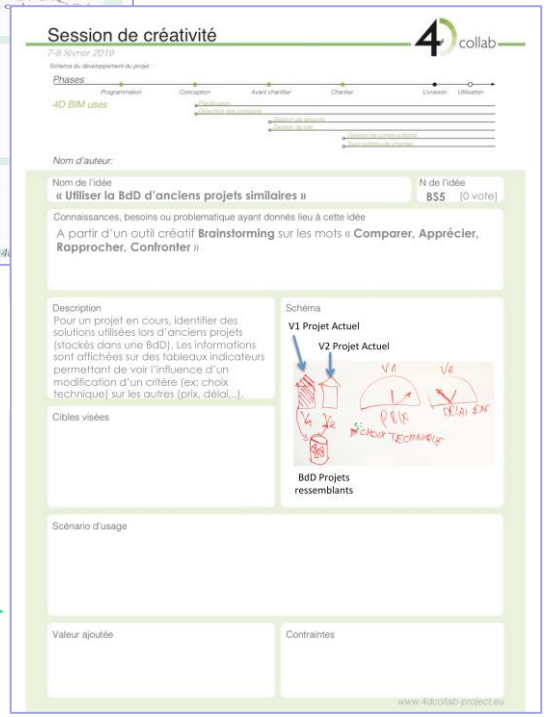
The convergent phase :

- focused on returning to the initial subject by integrating the elements found in the divergent phase.
- provoked at different moments of the creativity session, that the creativity group collectively makes the embryos of Ideas emerge.

Results : 38 embryos of ideas during the creativity session

3- Phase of Selection / writing of ID cards : deepening of the ideas





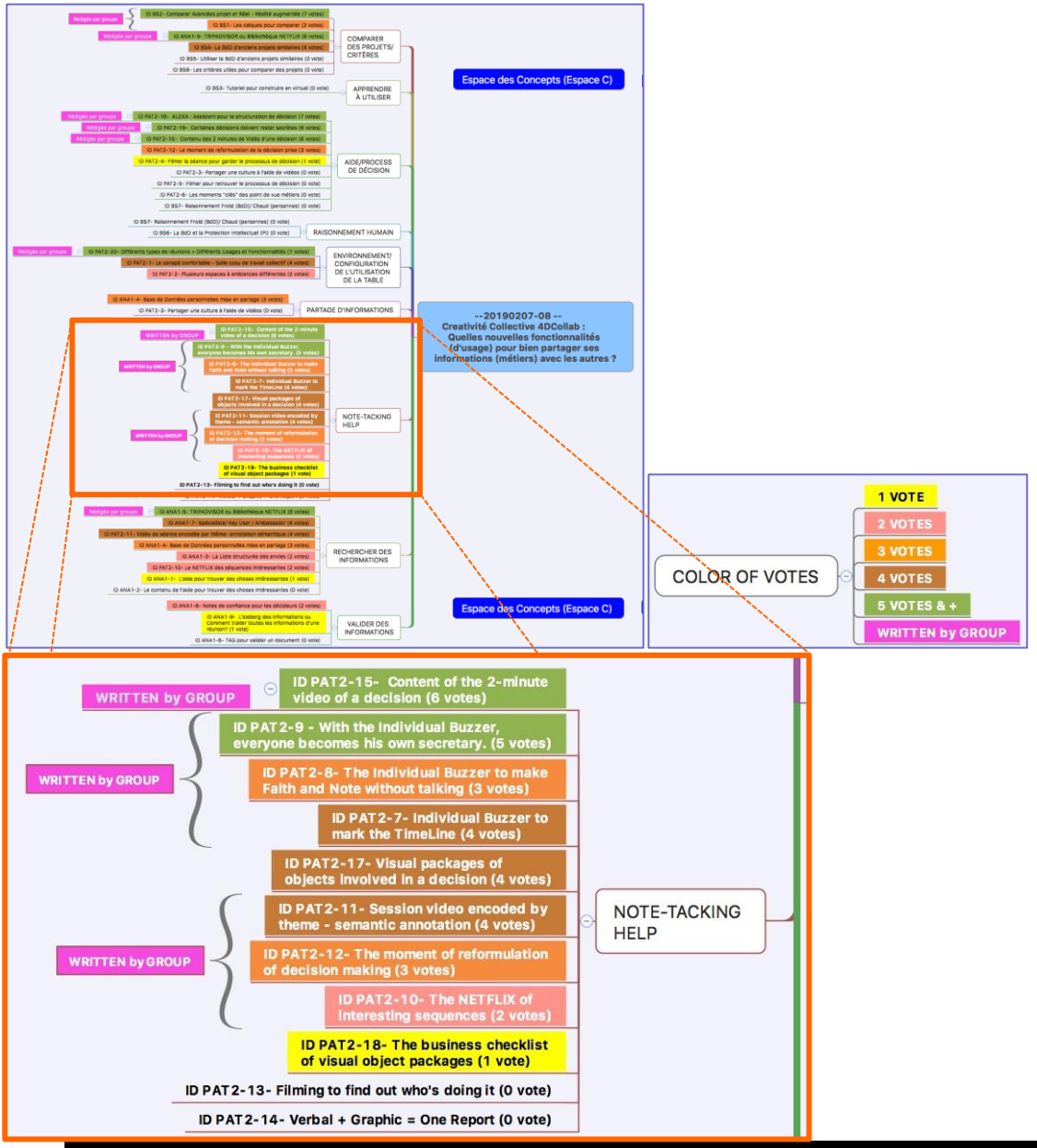
...2-3 participants at the end of the Creative workshop

Idea Cards written by …

...the facilitator after the creative workshop

- The group collectively brings out 38 embryos of Ideas,
- Selection (by voting) and classification of ideas allowed the identification of 12 embryos of ideas evaluated by them as the most interesting,
- Idea card is like the identity card of an embryo of an idea that must be understood by and shared with people outside the creativity group,
- Drafting of 8 of them on idea cards was carried out in groups of 2 or 3 participants during the session,
- The others idea cards (of the 38 embryos of ID) were transcribed by the facilitator after the session.

Results : 38 embryos of ideas + 8 Idea Cards



4- Phase of Synthesis / writing of the document

- This document presents all the elements produced by the working group as well as syntheses,
- It takes up and explains all the elements used during the Creative Workshop :
  - the method, the approach and the tools used,
  - all the productions made by the group,
  - Syntheses to facilitate their subsequent exploitation.
- Example of « CK Tree » Synthesis :
  - vision of the links between the Ideas cards produced as well as an overview of the fields explored by the group's production,
  - derived from the C-K (Concept - Knowledge) theory, tree structure covers the entire production of idea cards, structured by concept proximity.

Results: Synthèse et transmission de l’ensemble des informations produites

Mind Mapping :

14 thematic areas comprising a total of 70 items.

38 Idea Cards generated by the group

Brainstorming Tool : 8 Idea cards (+ 1 written by the group)

"Hot Potato 2 » Tool : 20 Idea cards (+ 6 written by the group)

"Analogy » tool : 9 Idea cards (+ 1 written by the group)

8 ID Cards written during the workshop

Classification by "Families of Idea Cards"

with the Formalization of the CK tree

Conclusion

Following this collective creativity session, some of these new functionalities were also evaluated as relevant from a business point of view by 4DCollab project members

Implemented functionalities will allow stakeholders to keep track of their decisions made with help of the 4D/BIM artifacts

To ensure that functionality under development fits to users' expectations identified during the previous studies

Usability testing in laboratory and in real context will be carried out with AEC professionals

Once laboratory testing is done, our prototype will be tested on a real situation

We expect that the prototype will foster collaboration between stakeholders