Mental Models and Creativity in Engineering and Architectural Design Teams

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Abstract Mental models play a decisive role when it comes to cooperate and coordinate team activities in complex environments and contexts. However, scientific knowledge about the coordination of mental models in heterogeneous groups, and even more across different disciplines, has not yield much progress in the last decades. Mental models affect design activities on content and process levels. These have consequences for the different phases in the design process, from the first moment of defining the problem till the final decision for detail design. The present paper focuses on the comparison of two different design disciplines, and analyzes how problems demanding creativity are approached. Two meetings of engineering and architectural teams solving a complex domain-specific design problem in the very early stage of idea generation were studied. Utterances of the transcripts from both team sessions have been explored based on the categorisation system developed explicitly for the analysis of group behaviour in complex environments. Qualitative and quantitative analyses are presented, from which conclusions about the differences in design problem solving processes of design teams with different disciplinary backgrounds are offered.

Introduction

Design problem solving can be defined as a complex activity involving a series of adaptive and generative steps such as problem definition, collection of different kinds of information, generation and analysis of solution ideas, selection and implementation of innovative solutions [1], to arrive at a certain specified outcome. For the sake of enhancing opportunities in the early design phase and to produce creative design solutions, design teams should strive for exploring different

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alternatives, and avoid discarding ideas prematurely [2]. Most of these activities have to be coordinated and communicated in different social settings such as face-to-face interaction with suppliers, negotiations with the selling department, different kinds of remote interaction with clients and other stakeholders, whereby designers often act as individual designer, but in responsibility for the whole project team and the company. The specific characteristics of the setting determine how information is collected, shared and used. Studying mental models can help gaining insight into basic processes of team coordination and team behavior [3]. Different research methodological approaches, such as comprehensive field studies [4] as well as laboratory settings [5] have explored phenomena of design teams acting in different contexts, e.g., how teams deal with different types of critical situations, and how they use information sources. Still, the detailed process of how mental models develop and influence creativity and decision making processes in design teams need to be addressed in order to support design teams.

Thus, the main goal of the study is to present an approach through which mental models are analyzed with an emphasis on creative design activities in different design disciplines. Here, the focus is set on cognitive and social behavior in engineering and architectural design teams.

General and/or Specific Knowledge Generates Creativity

What is the importance of studying activities within different design disciplines? In essence, we hope that the answer to this question provides knowledge on two different levels. First, we can gain basic knowledge about the phenomenon of creativity and second, we can build on this knowledge, and designers (students as well as practitioners) can be taught accordingly.

There are two concepts to be distinguished, which take up the origin of creativity as either caused by domain-general or by domain-specific abilities. There are empirical studies providing evidence that people with general creative thinking abilities are capable of generating creative ideas across diverse domains [6, 7]. However, other studies show that the generation of ideas requires the availability of domain specific knowledge and skills; see [8] for a comprehensive summary on the subject. Apart from these contradicting approaches, there is a third conceptualization that sees the combination of both, domain-general and domain-specific skills as contributing to the individual creative competence; see Fig. 1. Domain-general creativity encompasses knowledge of general problem solving strategies [9] and general heuristics [10] including reflecting activities. Domain-specific creativity, on the other hand, resort to factual knowledge about content and process (including design methods), as well as design specific skills such as sketching. Apart from knowledge and skills, the final creative product largely depends on the individual ability to generate, communicate, and coordinate own ideas within the social context; see Fig. 1.

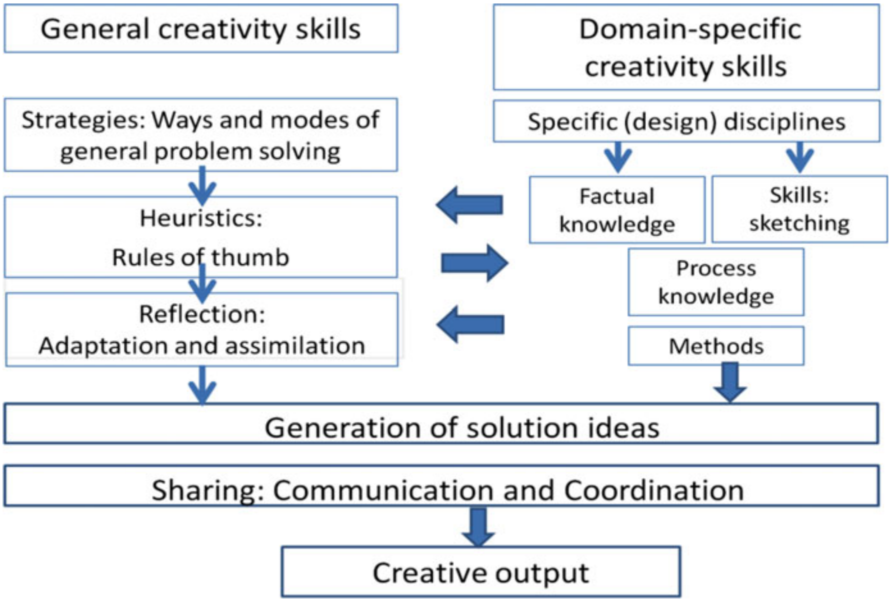

Fig. 1 A theoretical framework of the determinants of creativity

Idea Generation and Design Creativity

Designing is characterized by the generation of ideas and solution principles, mainly in the conceptual design phase [11]. The measurement of creativity is – as the definition of creativity – not unanimously defined. There are studies which use only the number of ideas produced. Some studies also rate the originality of ideas, their novelty and usefulness [12] or a combination of them [13, 14]. Shah and Vargas Hernandez [15] propose novelty, variety, quality and quantity as measures of ideation effectiveness.

In terms of creativity, idea generation is seen as the most influential activity since it largely affects the subsequent stages of the design process, including the design decisions being taken [16], and the final outcome [17]. In this process, a designer, or a team of designers work together with the purpose of developing not only functional, but also innovative and creative concepts. Typically, designers generate, give meaning, and interpret several ideas in parallel [18], whereas they explore further directions for clarifying uncertainties and developing potential problem solutions [19]. The generation of new ideas is on a physiological level an outcome of association processes [20]. Idea association is not necessarily promoting a high diversity of ideas [21]. Whereas the design process entails the evolution of a variety of ideas, idea association can help establishing relations [22, 23], and generating new design ideas in the conceptual stage [24]. While looking for alternative design ideas, creative designers enlarge the metaphorical search space of promising idea-solutions [25], enhancing by this the chances of creating better outcomes [26].

According to design methodology [18, 27], designing is the process of working through a defined series of steps that are defined as useful to arrive at the final outcome successfully. Thus, the idea generation process should be preceded by a problem definition stage, in which the design task/problem is structured and framed, and followed by idea-solution analysis, explanation, and evaluation stages, where solutions are developed, clarified, and assessed with regard to their suitability to the design goals. If the idea-solution or a part of it is found to be satisfactory, then design decisions are made. All these stages are considered to be iterative and cyclical, moving from converging thinking stages – in which concepts and ideas are evaluated and selected, to diverging thinking – where alternative ideas are generated, and vice versa [28]. While this process is believed to be characteristic for general design processes, there is no empirical evidence whether it can be considered to be similar across different design domains.

Mental Models and Creativity in Design Teams

A major approach to theorize and study mental representations in design is the concept of mental models. This theoretical construct enables exploring creative cognitive activities. As internal representations, mental models provide the basic conditions for human beings dealing with the environment, and guide their acts [29]. Since mental models can describe and represent thought processes in problem solving, they can aid predicting and offering explanatory power of how individuals will perform and behave in a specific situation [30]. Thus, mental models can be defined as simplified representations of the world [31] that individuals construct, and adapt for attaining fast performing acts, as well as for gaining and processing new information [32]. The manner in which mental models are developed hinges on the context, and social setting in which they are constructed [33].

Individual mental models are the ingredients of the team mental model which is developed in a team and have a strong influence on team communication and performance [3]. The way team members perceive and understand reality can vary according to their personal background, knowledge, expertise, etc., and these have an effect on their mental models. Team mental models are dependent on the individuals' input, and guide the team how to proceed in terms of process and content. A main characteristic of mental models is that they can aid to coordinate and adapt actions, as demanded by the task, and the team members [34]. As the design progresses, team members interact with each other to exchange opinions and ideas, while their mental models are modified, adapted, and eventually shared within the team. These constructs also direct the behavior of a design team when facing new and unknown situations.

Following the assumption that mental models are partly built from domain-specific knowledge, and partly from not domain-specific procedures, the question is what the differences of mental models constructed by teams in different design disciplines such as engineering and architecture are, and what might be their effect on design creativity.

Types of Mental Models

In general, literature about mental models in teams refers to three major types of representations which are the 'task mental model', the 'process mental model', and the 'team mental model' [35]. The task mental model represents aspects about the facts of the problem at hand. Issues affecting the extent to which task mental models are communicated within the team include making representations of the problem task, defining the problem, generation of ideas, production of explanations and clarifications, as well as analyzes and evaluations of solutions, and taking decisions [32].

The successful achievement of a design outcome also embraces appropriate team coordination, which has to do with a comprehension about the process. Mental models of the process are referred to aspects about rules, strategies, and procedures that need to be considered in order to achieve goals, and arrive at a satisfying outcome. A characteristic of creative problem solving is that there are no clear procedures or routines referring to how design teams should work in collaboration, and how they could organize their processes. Consequently, the selection and application of procedures for dealing with a design task has to be decided as the process develops [35]. These involve a need of information exchange about planning strategies (in what moment to proceed and what to do), procedures (in what way to proceed, as well as which methods to use), and reflection (what the team has achieved so far, and how it should proceed in the coming steps) [32].

Finally, team mental models reflect representations applicable to the way that team members work collaboratively as a group. This mental model is an indicator of the extent to which members are motivated to collaborate, and feel part of the team. Badke-Schaub et al. [32] further focus on team cohesion, which represents the mutual positive feeling in the team reached by the team when dealing with a design task. In terms of activities it includes: appreciation and rejection, referring to the approval or disapproval of other team members or their respective contributions; confirmation, which is a positive evaluation supporting the maintenance of a communication channel among team members; and help, which is the assistance provided by team members to each other. This concept of team cohesion mental model was used in the present paper to study design team activities.

Previous studies have shown that mental models can contribute to gain a better understanding of processes related to team coordination and team behavior [3]. Despite a huge amount on empirical studies on how designers think and behave in real [4] and in a laboratory environment [2, 5]. The way that mental models are used in design in general, and in different design domains in particular, as well as the relation of mental models with design creativity is not well understood yet.

The Empirical Study

Goals of the Study

The study aimed to explore possible commonalities and differences of design team activities across two design disciplines: engineering design and architecture. It provides further insights into the basic cognitive and social processes of the observed teams, by analyzing the transitions of the task, process, and team cohesion mental models developed along the design meetings. In particular, it centers on possible differences regarding the frequencies of the transitions of these mental models to discover whether the design groups show a strategic or a more opportunistic approach. Another goal is to gain a more detailed insight about creativity in engineering and architectural teams. In order to understand the interrelation between mental models and design creativity, the focus is set on the analysis of the frequencies of the transitions between design ideas produced in each team, and the specific design activities corresponding to the different mental models. In this way, it is intended to unveil whether new design ideas could be either preceded or followed by predictable design steps showing a systematic pattern of behavior of the team.

Data Collection and Data Coding

The data material has been collected from two case studies – an architectural and an engineering team – in the context of the Design Thinking and Research Symposium, DTRS [36]. The meetings were videotaped, transcribed, parsed into utterances, and coded with regard to a categorization system presented in Table 1. The analysis explored the different types of communication exchanges developed among the team members. The categorization system was organized into three main groups: task, process, and team cohesion where each of these was divided into subcategories. Mangold InterAct (version 9.3.5 http://www.mangold.de) software was used for information coding. This software program supports the coding and rendering of behavioral data per time unit. The first author acted as the main coder. In order to check coding consistency, the second author assessed 30 % of the data independently. All coding categories received acceptable levels of reliability (i.e., Kappa coefficients for inter-coder reliability larger than 0.72).

Architectural Design Meeting

The architectural task dealt with the design of a new municipal crematorium to be located close to an existent one. The brief included a series of functions such as

Table 1 Categorization system for verbal activities in engineering and architectural teams

	Task mental model
Problem definition	Definitions that are mentioned in order to define the problem
New solution idea or new solution aspect	Stating a new idea or a new solution for a problem or a sub-problem, or new aspects of an earlier solution idea
Solution analysis	Analysis of characteristics and potential application of a solution idea
Solution evaluation	Evaluation of a solution idea by assessing its value and feasibility
Explanation	Clarification of aspects and questions related to design issues, i.e., user, technical, budget
Solution decision	A final and definitive decision
	Process mental model
Planning	Aspects related to when to proceed, what to do, and who does it
Procedure	How to proceed to approach the task, strategies which methods may be used
Reflection	What the team has been doing so far and what variables have shown influence
	Team cohesion mental model
Appreciation	Approval of other team members supporting an idea, an explanation or a problem definition
Confirmation	Positive statements confirming other team members' statements
Rejection	Disapproval of other team members about an idea, an explanation or a problem definition
Help	Aid or assistance provided to other team members

cremation facilities, waiting rooms, vestry, parking areas, and a chapel intended for up to 100 people. The architectural team was composed of a municipal architect, the manager of the existing facility, and an officer from the local government on behalf of the municipality.

Engineering Design Meeting

The engineering task was concerned with the design of a new digital pen using novel print-head technology. The pen had to be devised as a kind of artist's tool or as a toy. The design issues discussed in the meeting centered on functional aspects dealing with electronics and software, as well as with features of the pen. Seven members from a technology development company formed the engineering team: a business consultant in the role of a group moderator, an expert in electronics and business development, and another in ergonomics and usability issues, three mechanical engineers, and an industrial design student.

Results

In this section, we present results of the data analysis. First, the analysis of communication provides insights into main differences of mental models in the architectural and engineering groups. Second, transitions of design activities in the two disciplines, and their relation to creativity are analyzed.

Analysis of Frequencies and Communicative Acts in Regard to the Three Mental Models

Figure 2 shows the cumulative frequencies of design activities per design team related to the defined mental models: *Task*, *Process*, and *Team cohesion*. There were a total of 2,256 utterances, 54 % of which corresponded to *Task* activities, 10 % to *Process*, 27 % to *Team cohesion*, and 9 % to other activities. This overview shows that the design activities relating to the *Task* mental model play a key role in both teams, followed by activities in *Team cohesion*.

Table 2 summarizes the cumulative frequencies of design activities per design team according to the mental models sub-categories. From the table can be seen that *Task* activities were mainly characterized by *Solution analysis* and *Explanations* in both teams, and by *Evaluations* in the engineering one. *Procedures* and *Reflections* were dominant in the *Process* activities of the architectural team. Regarding *Team*

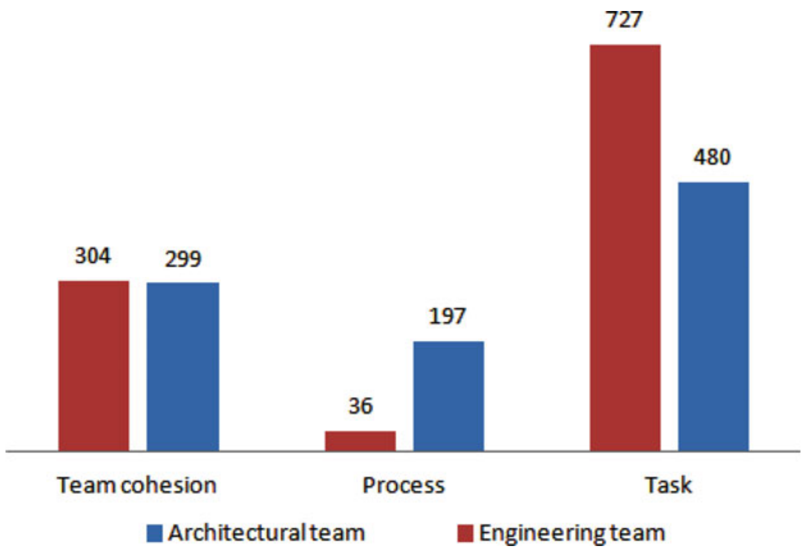

Fig. 2 Cumulative frequencies of design activities per design team

Table 2 Cumulative frequencies of design activities per design team according to mental models sub-categories

Categories		Architectural team	Engineering team
Task mental model	Problem definition	20	90
	New solution idea	36	111
	Solution analysis	285	218
	Solution evaluation	9	122
	Explanations	114	172
	Solution decision	16	14
Process mental model	Planning	51	0
	Procedure	74	19
	Reflection	72	17
Team cohesion mental Model	Appreciation	28	5
	Confirmation	262	287
	Rejection	5	9
	Help	4	3

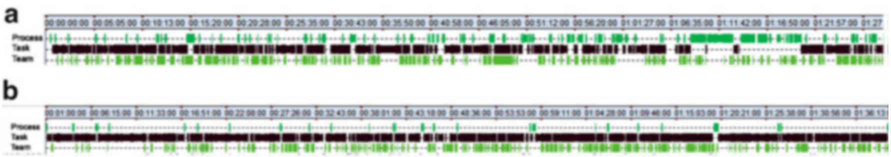

Fig. 3 Activity focus related to utterances in regard to mental models developed over the course of the design meetings– (**a**) architectural team; (**b**) engineering team

cohesion, *Confirmations* were central in both groups, whereas *Appreciations* were dominant in the architectural one.

Figure 3 depicts the sequence of acts in the two teams with regard to the communication issues across the three mental models of *Task*, *Process*, and *Team cohesion* over the complete period of the design meeting. A qualitative analysis indicates that the engineering team largely focused on activities concerned with *Task* and *Team cohesion* along the whole design process. While contributions related to the *Task* were the most dominant activity of this group, much less attention was spent on aspects dealing with the *Process*.

The architectural team, on the other hand, also dedicated their efforts to the design *Task* – albeit to a less extent than the engineers- and to the design *Process*. This activity was constant along the whole period of work, only increasing near the final stages of the meeting. This group also maintained a good *Team cohesion* all over the process. In sum, both teams progressed in their work mainly by focusing on design problem content, supported by a positive atmosphere aiming at mutual understanding. Procedural aspects were also relevant in the architectural session, probably to advance the exchange of communication acts between team members for implementing design ideas and solutions in practice.

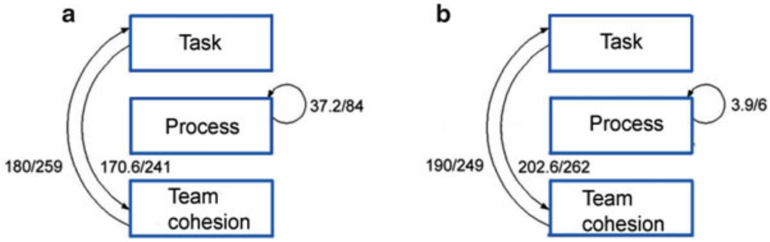

Fig. 4 Transitions between mental model categories – (**a**) architectural team; (**b**) engineering team

Transition Steps in Architectural and Engineering Teams

Transitions between design activities in relation to *Task*, *Process*, and *Team Cohesion mental models* were examined to find out whether combined phases of activities – patterns – could be observed. It would be interesting to see which group shows a more strategic approach; or whether the groups choose a more opportunistic approach, and change often between the different design activities. Thus, this analysis might also provide evidence in how far the design process is characterized by an unpredictable sequence of design activities, or whether there are certain patterns of behavior that appear systematically. In order to answer this question, the transition probabilities between all utterances were calculated, and then compared to the related baselines. As a way of exemplification: if *Task* utterances occur in 50 % of all team communication, but after a *Task* verbalization in 62 % of all cases a *Process* verbalization takes place, this implies that there will be a higher probability that sequences of *Task-Process* verbalization will occur more often than *Task-Task* utterances. A chi-squared test was used for calculating whether the observed transition probability is significantly higher in comparison to the baseline of the categories.

Figure 4 depicts transition probabilities of the three mental models of *Task*, *Process*, and *Team cohesion*, in the two teams. A connection that ends with an arrow represents a transition that is significantly more likely to occur compared to the expected count. The first number aside the connection represents the expected count, and the second number refers to the transition count. As it can be seen in Fig. 4, in the two groups a transition within the same pattern of behavior is highly likely.

Mental Models and Creativity in Architectural and Engineering Teams

We further explored the mental models in each design team, with a particular focus on design creativity. In the present study, we defined and measured creativity as the

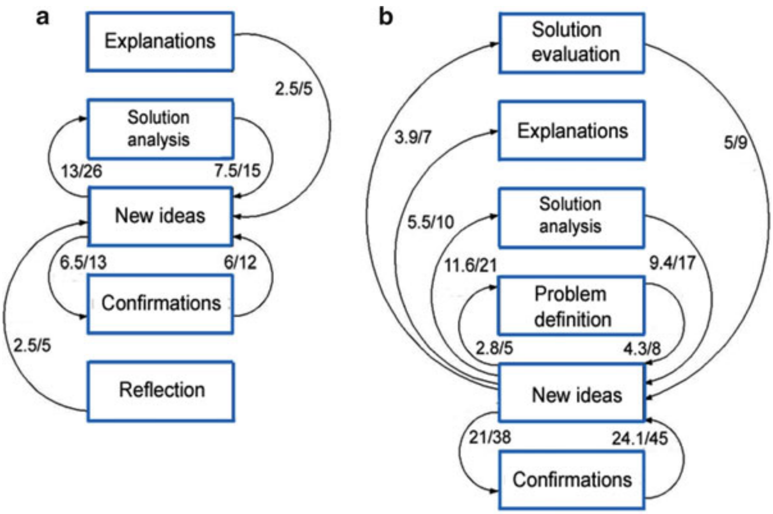

Fig. 5 Transitions between design activities– (**a**) architectural team; (**b**) engineering team

number of ideas generated by the team during the design meeting. Accordingly, we investigated if the generation of design ideas might be either preceded or followed by predictable design steps reflecting certain systematic pattern of behavior. Thus, we analyzed the transitions of utterances between the *New ideas* generated during the design activity, and the other design activities. The transition probabilities between all of the activities were calculated, and compared to the baselines of the activities. For the entire sessions, a chi-squared test of independence showed that the observed frequencies were significantly different than the expected ones for both design teams, chi^2 (14, 2256) = 212, $p < 0.001$, two tailed).

Figure 5 shows transition probabilities between utterances related to *New ideas* and design activities. In the architectural team, *Confirmations*, *Solution analysis*, *Reflections*, and *Clarifications* were the most frequent steps that preceded the generation of *New ideas* ($p < 0.05$*, and* $p < 0.001$, two tailed). On the other hand, *New ideas* were followed by *Confirmations* and *Solution analysis* ($p < 0.001$, two tailed).

In the engineering team, *New ideas* were preceded by *Problem definitions*, *Solution analysis*, *Solution evaluations*, as well as *Confirmations* ($p < 0.05$, $p < 0.01$, *and* $p < 0.001$, two tailed). Likewise, *New ideas* were continued by further *Problem definitions*, *Confirmations*, *Solution analysis*, *Explanations*, and *Solution evaluations* ($p < 0.05$, $p < 0.01$, *and* $p < 0.001$, two tailed); see Fig. 6.

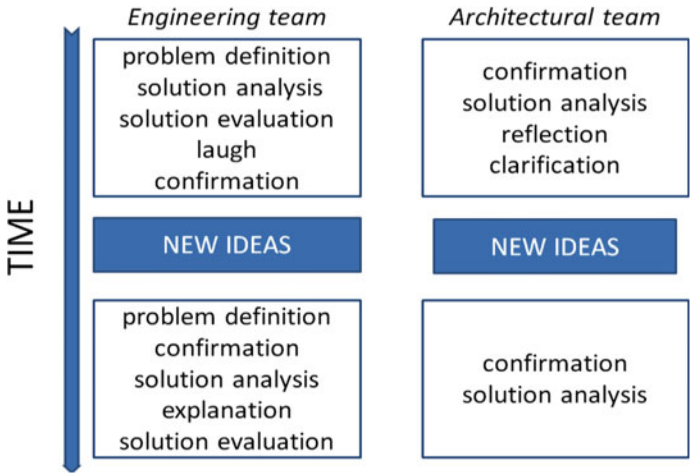

Fig. 6 Transitions of design activities before and after the generation of design ideas: engineering and architectural teams

Discussion

Mental Models in Architectural and Engineering Teams

Considering the exploratory nature of the study and the small number of groups, we do not intend to generalize the outcomes observed in the two groups of designers. However, there were some interesting results in regard to the differences in the distribution of the design activities about the mental models in both teams. These suggest that in each team certain design activities were more important than others.

Results about the distribution of design actions of the mental models showed further remarkable differences between the teams. Particularly, *Task* utterances occurred more often in the engineering team, and more *Process* utterances took place in the architectural team. This result indicates that the engineering team dedicated most of their communication efforts to advance activities related to the successful completion of the problem at hand by transmitting task related content. In contrast, the architectural team mainly focused on team coordination [3], and therefore they attempted to gain a better understanding about the process, which included issues related to strategies and procedures [35]. An alternative explanation is that the engineering design process was more structured than the architectural one, and thus larger agreement was attained among team members. On the other hand, the engineering task could have been less clear than the architectural one, and as a result the engineering team needed to focus more on the task, while the architectural team mainly explored and agreed upon the process with which to proceed. Generally speaking, *Task* mental model was the most developed model in both groups as compared to the other ones, indicating the importance of investing on task contents over any other design aspect. On the other hand, both teams showed to strive for reaching a general understanding while dealing with the design problem. Therefore, *Team cohesion* was the second dominant mental model in both design groups.

Further results concerned with the distribution of design activities belonging to the different mental models showed interesting similarities and differences. *Analysis of solutions* and *Explanations* were the most dominant activities in both teams. Whereas *Solution analysis, Appreciations*, *Reflection, Planning, and Procedure* utterances occurred more often in the architectural team, *Problem definition*, *New ideas*, *Explanations*, and *Solution evaluations* were more frequent in the engineering team. These results indicate that the pattern of behavior of the engineers which was the more creative team in terms of the number of ideas produced was largely characterized by the framing of *Design problems*, and the generation of *Explanations*, *Analysis,* and *Evaluations* of solution ideas. Nevertheless, the high number of evaluations in this group is unexpected considering that designers were requested to generate and discuss ideas mainly by brainstorming techniques [37]. Creativity techniques such as brainstorming warn against earlier evaluations of ideas without previous analysis. It is possible and desirable that an even higher number of design ideas would have generated if fewer evaluations have been made at so early stage [38]. What concerns the architectural team, the high number of activities related to *Analysis*, *Reflections*, *Planning*, and *Procedural* aspects can be seen as a core channel used for communicating and exchanging information in this group. This might be due that an aim of the meeting was to present and discuss the development and modifications of the design project.

Mental Models and Transition Steps in Architectural and Engineering Teams

The analysis carried out on the transition of design activities related to *Task*, *Process*, and *Team Cohesion* mental models showed a similar pattern of behavior in the design teams. This finding is remarkable considering the differences in terms of background, domain interest, and creativity between the groups. It was found that once designers in each team intertwined between *Task* and *Team Cohesion*, they tend to remain engaged to this pattern of behavior for several communicative acts, before switching to another behavior. The repeated loop of task and team cohesion seems to reflect a structuring pattern of behavior in the observed teams. These findings reveal that a good understanding between team members is necessary to progress with the design task. A successful completion of the task needs to be both preceded and followed by positive feedback supporting communication among the team members [32]. This may serve to explain the reason that task actions were not recursive (that is not within the same step). In contrast, design steps concerned with process were dominantly recursive, and not directly related to task or team cohesion actions. This means that with regard to *Process*, teams tend to stick to the same communicative behavior and use to spend more than one communicative act on the same activity before switching to another.

Mental Models, Transition Steps, and Creativity in Architectural and Engineering Teams

Given the additional interest of this study on creativity, further analyses were carried out for the transitions of design steps established between design ideas generated during the design activity, and the different design activities of the mental models. One interesting result common to both design teams is that the generation of *New ideas* was related to a loop of transition steps of *Confirmations* and *Solution analyses*. It is noteworthy that when designers in each team intertwined *New ideas* with *Solution analyses* and *Confirmations*, they use to stay engaged to these patterns of behavior for a number of communicative acts before changing to other patterns. These repeated loops, which seem to represent a structuring pattern of creative behavior is known to allow enlarging the metaphorical space of possible solutions [39], and leading at the end to more creative solutions. Such structuring pattern can be associated with domain-general creativity, which encompasses knowledge of general problem solving strategies that are common to both disciplines [9]. In addition to these, a pattern of behavior related to domain-specific creativity was observed in the engineering team, which included repeated loops of *New ideas* with *Problem definitions* and *Evaluations*. From the viewpoint of creativity, the framing of problems can help to an understanding of the design situation, contributing to promote the production of ideas. In turn, the generation of new ideas can lead to the restructuring of the problem from new perspectives, and again to new ideas. Nevertheless, this design behavior seems to be in contradiction with the early evaluation of design ideas. As noted previously, the immediate judgment after the generation of ideas can prevent the production of additional ideas. The premature evaluation of design ideas was noticed by Stempfle and Badke-Schaub [40] in their study on design team communication. These researchers argued that precipitated evaluations can lead to early rejection of ideas that in later stages could prove to be appropriate to solve the problem. Another mistake that can occur as a result of too early evaluation of ideas is the early implementation of solutions that in later stages may show to be unsuitable. Finally, it was also observed that the architectural team spent more time on *Reflections* and *Explanations* that led to design ideas. Considering the heterogeneous background of the team, these types of design activities are necessary to enhance the communication and understanding, and as a trigger to reach agreement between team members.

Conclusions

A main goal of this study was to explore how design teams from different disciplines deal with design problems, mainly in the early phases of design and with special emphasis on creativity. Thus, all utterances during the design process were defined as cognitive design activities belonging to different mental models: task, process, and team cohesion, and their relation to creativity as a collective ability [42]. Due to the small sample size used in this study we do not intend to generalize the outcomes. Despite the limitations, findings showed interesting results regarding the design activities about the mental models in each design discipline. The study also contributed to introduce and illustrate a new approach to analyze mental models in design teams, and their relation to creativity.

Differences but also similarities in design activities identified in the engineering and architectural groups shed light on how teams with different disciplinary background behave and use their knowledge to solve problems [34], and [41] during the design activity. Remarkably, whereas on a higher level many similarities were found between the design teams, large differences existed on a detailed level when focusing on the design activities corresponding to the mental models. Moreover, it was possible to gain insight into what mental models and what design activities can be characterized by patterns of behavior that appear systematically along the design process, and what activities were more opportunistic, and therefore more difficult to predict. On the other hand, further understanding into the relationship between the mental models and design creativity was gained. While a number of similar design actions occurred as new ideas were identified in each team, major differences were also observed in each domain. This reopens the question of whether creativity is domain-general, or domain-specific [6–8]. Results suggest that while some design activities leading to creativity might be shared across the two design disciplines, some patterns of activities were related to each specific design domain.

These findings are important for educational programs, in particular those aiming to promote creativity in teams across the design disciplines. Training teams would enable to deal with those design activities that were not found to be prolific. Similarities and differences in the pattern of behavior observed in the mental models of the two disciplines have to be considered when couching teams with different design backgrounds. Whereas existing differences in design activities should be considered by intervention programs aiming to enhance domain-specific creativity, similarities in design activities would be also important for the promotion of general creativity across the disciplines. Moreover, the predictable sequences will help to understand how teams behave and act when dealing with problems demanding creativity.

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