

Trust within AEC virtual teams

Analysis of different-place collaboration in architectural design

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The virtual teams are largely encouraged by the recent technological devices supporting different-place collaboration and suggest today new forms of organization. This one is geographically dispersed and regroups all the competencies required for the work to be done. In such a context, trust is essential to guarantee the performance of team. It is indeed a necessary component for initiating the work relationship and to overcome the inherent risk. The capacity of the groups to communicate about the objectives and strategies as well as to readjust them according to the context (i.e. reflexivity) is another element important for the group's performance. This article suggests analyzing these notions of trust and reflexivity within virtual teams in the context of an academic experiment where students are geographically dispersed and have to produce an architectural project.

Keywords: *Trust, virtual team, different-place collaboration, social reflexivity, task reflexivity, AEC (Architecture, Engineering and Construction)*

INTRODUCTION

The technology evolution, the nature of work which becomes more complex and dynamic, and the need to become more and more competitive constitutes some elements which have encouraged a new form of "work unit" inside the organizations: the virtual team.

As Hertel (Hertel et al., 2005), we consider that virtual teams are composed of members who "are geographically dispersed and coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, etc.)."

This new configuration of work presents some

advantages: it contributes to reduce time of production and travel costs, to make decisions more effective and rapid, to reduce the informal exchange and focalised the team members on the task to be performed (Nader Ale et al., 2009).

We suggest in this article to analyse two elements that we consider as predominant for guaranteeing a good performance of these virtual teams:

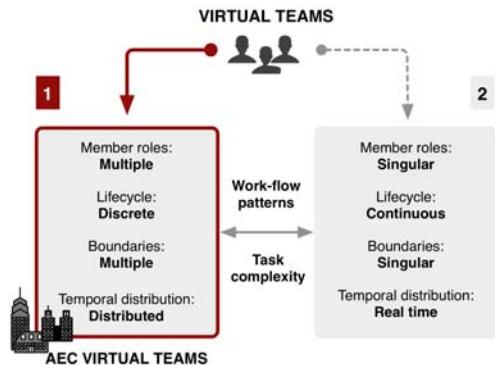
- Trust: This notion is associated to good expectations in the behaviour of the others (Deutsch, 1962) and takes an important role to initiate the collaboration and overcome the risk inherent to the work relationship (Luh-

mann, 1988).

- Reflexivity: This notion allows characterizing the capacity of a group to define its objectives, strategies, and processes as well as to readjust them during the collaboration (West, 2000).

A first study has been conducted during the academic year 2011-2012. It has highlighted the relationship between trust, reflexivity and group's performance (Gronier & al. 2012). A second study has been led during the academic year 2012-2013 in order to finely measure the dynamic and the relationship between the concepts. This article will present the results of this analysis.

COLLABORATION BASED ON VIRTUAL TEAM



A lot of research works have contributed to characterize the virtual teams (e.g. (Bell and Kozlowski, 2002, Jarvenpaa and Leidner, 1999, Zolin et al., 2000). Bell and Kozlowski (Bell and Kozlowski, 2002) identifies two major characteristics distinguishing virtual team from conventional team: spatial distance and communication. Contrary to the conventional teams that work in close proximity, the virtual team includes members who are separated, sometimes by a very long distance. Due to this geographical separation, the members cannot interact in face to face and make

use of technologies in order to mediate the communication. The nature of context of collaboration as well of the nature of the work are at the origin of diverse forms of virtual team.

Bell and Kozlowski highlight the characteristics that can distinguish the different types of virtual teams:

- "Temporal distribution": the work can be executed by the virtual team in real time or distributed across time. The technology used by the team is important to be considered when analysing this characteristic. Synchronous communication technologies (e.g. videoconferencing) allow the members to communicate even if members are separated by long distances and time difference. While asynchronous form of communication technology (e.g. e-mail) contribute to great temporal distribution even if the members are closely localised. The nature of the task and the workflow arrangement are also elements to be analysed. The need of real time exchange become more critical when the task is more complex and the required workflow arrangements are reciprocal. By contrast, virtual team can work in distributed time when the tasks are less complex and dynamic, and workflow arrangements are more sequential.
- "Boundary spanning": Virtual teams can cross diverse types of boundaries: time and geographical boundaries, but also functional, organisational and cultural boundaries.
- "Lifecycle": the virtual teams are often short-lived and created to perform a specific task. But when the task becomes more complex, it is preferable to maintain a continuous lifecycle and a stable team.
- "Member roles": the organization associated to the virtual team is often more flexible than in traditional organisation. The roles attributed in virtual team are more dynamic and

Figure 1
Virtual teams and characteristics, adaptation of (Bell and Kozlowski 2002)

the members have to adapt their actions according to the variety of team situations.

In the AEC (Architecture, Engineering and Construction) activity (see figure 1), virtual teams dedicated to the design activity are confronted to a task with a high level of complexity. The workflow arrangements are not predefined; they are sometimes reciprocal and sometimes sequential. The team members have multiple roles (i.e. associated to the task under consideration, to the technological devices, etc.) as they contributed to different projects in the same time, and they need to get used to diverse team situations. The lifecycle is discrete. The team is composed for performing a specific design task. The members have not worked together before and it is probable that they will never work again together. At the end of the activity, the team is disbanded. The boundaries are multiple because the members are confronted to diverse practices and culture related to the organizations involved in the project. The members are experts coming from diverse domains (e.g. architect, engineers, etc.) and are often coming from different countries. The virtual team operates essentially in a distributed time based principally on email, and digital platform for exchanging documents. Nevertheless the complexity of the activity requires some interactions in real time based for example on video-conferencing.

TRUST WITHIN VIRTUAL TEAM AND PERFORMANCE

We can see that virtual teams in AEC are associated to complex work environments. As trust can be considered as a device overstepping the complexity of the environment (Luhmann, 1988), it has to be considered as a predominant element for ensuring the performance of the virtual team. Traditionally in literature, the notion of trust is often associated to positive expectations about the behaviour or intentions of another person (Deutsch, 1962).

Diverse elements allow constructing trust inside "traditional" organisations. Kramer identifies six elements as bases for constructing trust relationships

(Kramer, 1999):

- "Dispositional trust". This trust is associated to the predisposition of the individual to trust or distrust. This predisposition is directly linked to people's beliefs about human nature. The prior personal experience in situations of trust relationships allows people to extrapolate general beliefs about others.
- "Category-based trust". This trust is based on internal characteristics of the individual, such as culture and the group which he is involved in, etc. If we consider a building construction activity, this form of trust between actors coming from a same category is predominant. Architects, engineers or contractors constitute 3 groups well marked inside which trust naturally exists.
- "Third party as conduits of trust". This type of trust relies on the notion of reputation. If we consider a building construction activity, teams are short-lived and consequently, reputation plays an important role and determines an "a priori trust" based on exchanges with third parties.
- "History-based trust". This trust is based on past successful references. If we consider a building construction activity, experience coming from former AEC projects strongly conditions trust.
- "Role-based trust". This trust corresponds with a trust relative to the performance of an actor according to the role that he plays within an organization. If we consider a building construction activity, roles are clearly defined. These roles generate precise expectations concerning competences and know-how and condition trust relationships.
- "Rule-based trust". This type of trust is based on contractual mechanisms, rules, certifica-

tion organization or norms. In the AEC sector, a large number of certifications progressively appear (e.g. certifications related to competence of actors, quality of the building elements...), standard contracts (e.g. contracts describing the mission of the stakeholders), norms (e.g. norms concerning the execution of building elements). These certifications strongly condition trust within an organization.

Swift trust

Trust appears as a necessary component for initiating the work relationship and to overcome the inherent risk (Luhmann, 1988). In virtual team, this risk is even bigger than people enter into a relationship without the benefit of traditional rules of communication in face to face, and moreover they are often engaged in collaboration without any anterior experience in common. Otherwise, the distance between the team's members make more difficult the application of control mechanisms.

"Swift trust" has been introduced by Meyerson (Meyerson, 1996) for qualifying trust emerging in temporary groups when people have to combined their skill in order to perform a specific task in a tight deadline and when they have a limited history working together and will never work again together in the future (Meyerson, 1996; Jarvenpaa et al., 1999). These elements characterize the most part of the virtual teams in AEC sector.

This context is not a priori favourable for the development of trust and for initiating trust in the initial stages of collaboration. Teams have no anterior experience in in common and members have at disposal only a few information pieces on each other. Consequently they cannot construct trust based on the history of the relationship. Nevertheless, we can see that notably due to the tight deadlines a form of trust emerges rapidly and is adjusted all along the relationship. This type of trust called by Meyerson "Swift trust" enables to overcome risk and to initiate collaboration. Swift trust is relatively fragile and progressively evolves towards a trust based on his-

tory, which is more stable and readjusted all along the collaborative relationship (Robert et al., 2009). Swift trust is essential in AEC virtual teams to surmount the risk inherent to this working context and focuses the team on the common objectives related to the construction project. Two of the six elements referenced by (Kramer, 1999) and described above are predominant for constructing swift trust: dispositional trust and category-based trust (Robert et al., 2009). According to Meyerson (Meyerson, 1996), the lack of personal information about the members of the team as well as the necessity to rapidly beginning to work for respecting tight deadlines conduct people to base trust on the category information to manage the risk and the vulnerability when they engage in the relationship. People are consequently considered as members of a category rather than people (Robert et al., 2009). The behaviour of the members is deduced from the practices generally associated to the categories.

Performance and reflexivity

Trust is a concept directly linked to the notion of performance. When a person engage with another person, he or she has to overcome a "cooperation threshold" corresponding to "a threshold value, above which it is possible to say that something or someone 'is trusted,' below which it is possible to say that it 'is not trusted.'" (Marsh, 1994). This threshold value is directly linked to the people and to the circumstances (Gambetta, 1990, Marsh, 1992). When the relationship is engaged, trust is not definitely static but it is integrated in a dynamic process (Zolin et al., 2000). The performance is regularly assessed in order to reconsider the trust level. If the performance is high, the trust value increases but if the performance is weak, the trust value can decrease and the relationship can be deteriorated.

The notion of performance of the group has been analysed by a lot of researchers (Salas et al., 2005, Facchin et al., 2006, West, 2000). It appears that the success of group depends on its ability to readily adapt its actions to the changes that could appear

without the creation of conflicts (Facchin et al., 2006). The concept of "reflexivity" proposed by West refers to "the extent to which group members overtly reflect upon, and communicate about the group's objectives, strategies (e.g., decision-making) and processes (e.g., communication), and adapt them to current or anticipated circumstances" (West, 2000). In other words, to be effective, teams must respond to changing circumstances and environments in an appropriate way.

The authors distinguished between two aspects of the reflexivity (Facchin, 2008):

- Task reflexivity, which "is believed to enable teams to develop optimal performance strategies, to detect deviation from expected results, and to adapt team functioning to changing demands",
- Social reflexivity, which "enables teams to integrate divergent opinions and constructively deal with conflict".

These two facets of the reflexivity considerably impact the performance of the group, and consequently the trust inside the team. In virtual teams, the group's ability of reflexivity is even more important than the distance between members makes communication more difficult.

METHOD AND CASE STUDY

Context

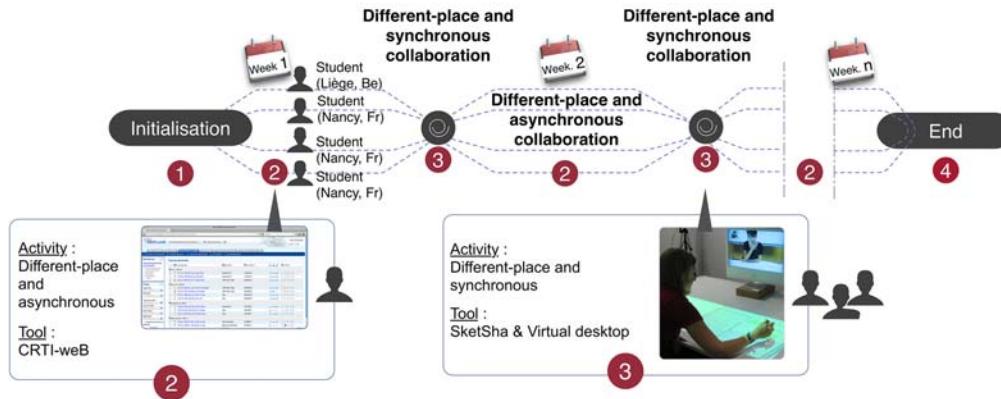
In order to analyse the development and the evolution of trust in AEC virtual teams, we have conducted a survey during a pedagogical experiment where students have to collaborate at distance. This experiment regroups students from the University of Liège (Belgium) and students from the National Architecture School of Nancy (France) during more or less 3 months in order to design a common architectural project. This experiment is called "Cooperative Digital Studio". In the course of this period of time, students make use of a virtual desktop based on a sketching tool to simultaneously collaborate at

distance (i.e. Sketsha developed by the University of Liège, Belgium). They also use a document exchange platform to asynchronously collaborate (i.e. CRTI-weB developed by the CRP Henri Tudor, Luxembourg). The Figure 1 describes the use of these 2 tools all along the pedagogical experiment.

The collaborative process is composed of four distinguished steps (Kubicki et al., 2009a), see figure 2:

1. "Initialisation": The students meet together in same place / same time and are informed about the subject of the architectural design exercise. Teachers constitute groups and students affect the roles inside their team (e.g. Architecture expert, Environmental expert, Engineering expert).
2. "Different-place and asynchronous collaboration". Students make use of CRTI-weB (i.e. a platform developed by the CRP Henri Tudor (Kubicki et al., 2009b)) in order to exchange documents between the stages of synchronisation. They share the progress of their work to the other members of the group.
3. "Different-place and synchronous collaboration". A device of synchronous and multimodal collaboration named "Virtual desktop" allows the students to validate architectural and technical choices and coordinate the collective activity. This device is composed of (1) a space of graphical work, (2) a sketch software developed by the University of Liège (Safin et al., 2012), and (3) a videoconferencing tool.
4. "End". At the end of the exercise, students are gathered a last time on the same place in order to present together the common result. A jury evaluates the quality of the produced architectural project and examines the process of collaboration deployed by the students during the experiment.

Figure 2
Collaboration during the pedagogical experiment "Cooperative Digital Studio"



Survey questionnaire and data collection

The data collection has been carried out during the academic year 2012-2013 in the framework of the "Cooperative Digital Studio". The students were invited to answer to a questionnaire during the experiment. This questionnaire is structured in two parts:

- "Trust analysis": this part relies on a survey questionnaire including 15 questions based on (Mayer et al., 1995, Robert et al., 2009) enabling to measure trust between team's members. This questionnaire has been submitted 5 times to the students at steps S1, S2, S3, S4, S5.
- "Reflexivity analysis": this second part aims at measuring the task and social reflexivity based the Carter and West scale (Carter and West, 1998) in this French version (Facchin, 2008, Facchin et al., 2006). This scale consisted of 16 items (8 for task reflexivity and 8 for social reflexivity) that examine the extent to which a team refines its objectives, strategies and team processes (Carter et al., 1998). This questionnaire has been submitted four times to the students during the project, at the steps S2, S3, S4 and S5.

The questionnaire was available on line. A collection interface has been developed thanks to the software LIMESURVEY. This software is hosted on the secured servers of the CRP Henri Tudor. This configuration assures data security.

In total 27 students divided in 6 groups have contributed to this survey.

RESULTS

Analysis of trust

During the academic year 2011-2012, we had already deployed the questionnaire of trust assessment. We had highlighted the relationship between trust and group's performance.

The results of the academic year 2012-2013 confirms this relationship. As seen in the figure 3, the groups with lower trust are associated to the lowest appreciation, and reciprocally groups characterized by a highest level of trust are associated to the best appreciations.

The analysis of graphs of trust all along the collaborative process (see figure 4) allows us to highlight that when trust level is high and relatively stable (See Team 1 and 4) or progressively increasing until step 5 (See Team 3), the performance is high. Moreover, we can identify that in these groups the reciprocal opin-

Figure 3
Analysis of trust and performance

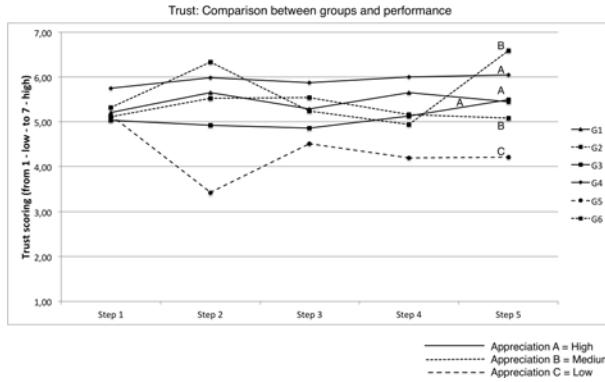
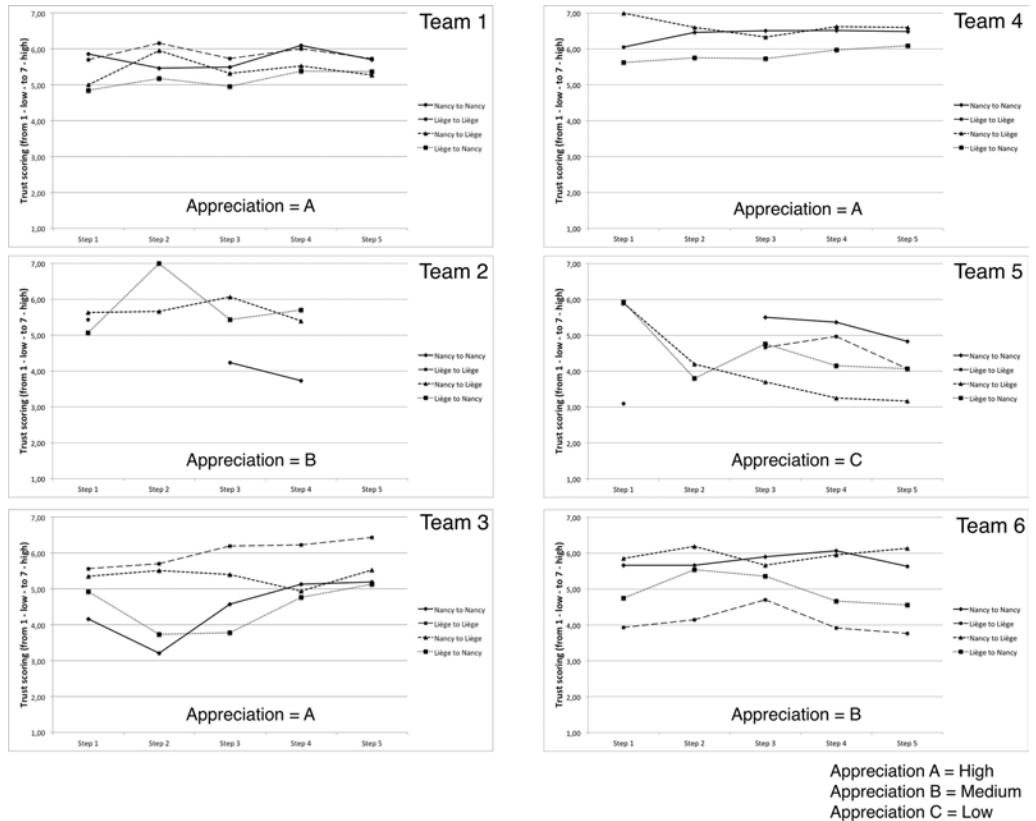


Figure 4
Analysis of trust:
detailed view by team



ions on the distant teams (Nancy-Liège, and Liège-Nancy) reflects a high and equilibrated level of trust.

In the team where trust decreases progressively until the step 5, the performance is lower.

More generally, we can identify that trust at the beginning is relatively high even if at this step students have not a lot of information allowing them to construct trust. This observation is in line with the works of Meyerson (Meyerson et al., 1996) about "swift trust". The context of this academic experiment characterized by tight deadlines and the technological devices for different-place collaboration is a challenge for students who are really motivated to produce a common project. At this time (S1), trust is generally high and required for initiating the collaboration. Then, student are confronted to the production of the other members, to some communication difficulty and trust is readjusted all along the collaborative process until the end of the experiment (S5).

Before this experiment, we had imagined that behaviours within groups geographically dispersed (i.e. curves related to Liège-Nancy and Nancy-Liège) and the groups composed of members localised in same place (i.e. curves related to Nancy-Nancy and

Liège-Liège) will be completely different. In the works of (Zolin et al., 2000), it appears that a configuration of team which is geographically distributed contributes to reduce personal communication. That consequently reduces perceived trustworthiness and the level of trust appears as lower. In our experiment, we cannot really confirm this position but we frequently observe that the level of trust related to the curves Nancy-Liège and Liège-Nancy are often lower. It is important to note that in the case of the members coming from the University of Liège, students have an important common background due to the large history of the relationship inside the university. In the case of the students coming from the Architectural School of Nancy, a lot of students are coming from different schools in order to attend the master "Global design". The students construct trust progressively based on the results. That can be an explication of the variation of the curves in certain groups (e.g. team 3).

Analysis of reflexivity

With regard to levels of reflexivity (refer to figure 5), these vary according to the stages of the project and

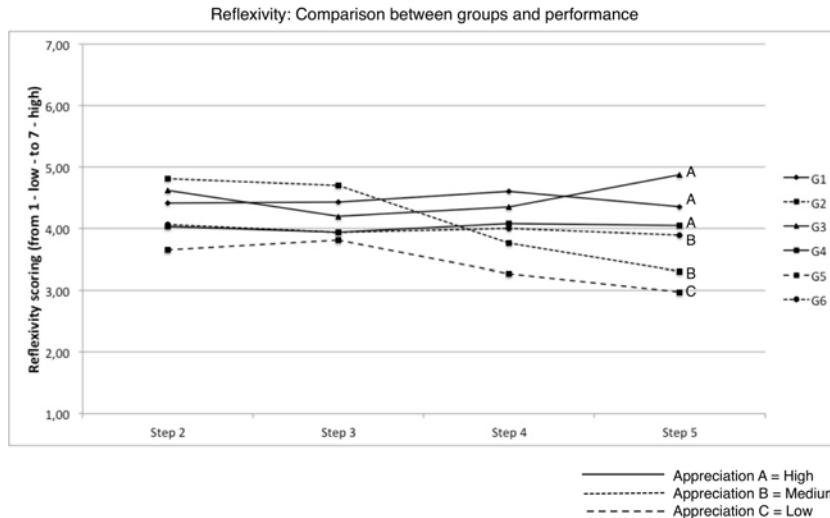


Figure 5
Analysis of reflexivity

are different from one team to another. We note that the team having obtained the best evaluation are those that have also seen their effectiveness as more important (G1, G3, G4). Similarly, the team having obtained the worst assessment to review is one that presents the lowest reflectivity rating (G2, G5). Moreover, it is also one whose reflectivity rating decreases gradually at each stage of the project.

More precisely, this is the team 3 that has the score the more high reflectivity overall ($M = 4.52$), followed by the team 1 ($M = 4.46$). Team 5 is one who has the lowest score ($M = 3.43$), just like the Group 6 ($M = 3.98$).

The evolution of reflexivity is also an important element of the performance of the teams. On average, the reflexivity for all teams decreased with steps ($M = 4.27$ in step 2, $M = 4.18$ in step 3, $M = 4.02$ in step 4, $M = 3.91$ in step 5). Teams 2 and 6 are the ones that get the most important limbs. This means that these 2 teams feel less and less efficient, and are struggling to cope with the difficulties of the project, both for the internal management of the conflicts within the group for achieving tasks. Conversely, team 3 is progressing during the project, and gets a score of reflexivity higher at the end of the project in its early stages.

CONCLUSION AND PROSPECTS

In this article, we have analysed the notion of trust and reflexivity in the AEC virtual teams. The analysis takes place in the context of an academic experiment during which students from the University of Liège (Belgium) and the Architecture School of Nancy (France) collaborate based on technological devices (synchronous and asynchronous collaboration) during more or less 3 months in order to produce a common architectural project.

This analysis has allowed us to highlight the relation between trust, reflexivity and performance. We can conclude that the ability of a group to trust the members and communicate about the objectives and strategy, as well as adapt them when needed are associated to the group's performance. When

trust and reflexivity are increased, the performance is high. This conclusion consolidated the first results obtained in our first study (Gronier et al., 2012).

Nevertheless we have to consider that some limits exist in our study: we have only one case study, and 27 people and sometimes, we have only partial answers. Moreover, the appreciation of an architectural project as value reflecting the group's performance can be questionable, because this appreciation can be subjective.

These limits encourage us to formulate only tendencies as well as formal conclusion. We expect now conducting our survey in another case study including more people to refine these tendencies and provide more formal conclusions.

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