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Abstract

The increasing failure of IT projects has led to debate about the way these projects are currently managed and to a search for new concepts and theories about project management in order to decrease the failure rate. We assume that it is important to know how to observe an on-going IT project in order to better understand the issues at stake. For this reason, without rejecting previous studies, our purpose is to present a method that may improve our understanding of IT project failure. We do this by demonstrating the value of observing the IT project as a project network. We show that IT project success or failure can be understood during the on-going project as lying along a continuum between convergence and divergence. We present the four characteristics that describe the trajectory of convergence or divergence. Our analyse is based on a longitudinal case study, The Pupitre Virtuel project, an IT project in the French educational area national. The dynamic observation of interactions of project network entities along a continuum convergent/divergent stresses the difficulty to isolate one or few failure factors. Conversely, our observation allows understanding the evolution of the project by considering the dynamic of interactions over time and the on-going redefinitions of its entities through controversies. From this perspective, it would be possible to correct the project trajectory in real time in order to avoid its collapse.

Keywords: IT project management, Failure, Success, Actor-network Theory, Convergence and divergence.

An SME manager, also a member of a major French IT project in National Education, had this to say when the project was given up by the other actors: "Actually, the die was cast from the very beginning! How could we not have picked this up at any point over the entire project?" (2008). This case is not an exception. While there is some uncertainty about the current IT project failure rates reported in official studies, such as the last CHAOS Report of the Standish Group (2009) (see Sauer et al., 2007), understanding IT project failure remains a relevant concern in the information systems field. Researchers have been then interested in the factors that appear associated with IT project success and failure (Schmidt et al., 2001; Peffers et al., 2003; Nelson, 2007; Mc Manus and Wood-Harper, 2007; Sauer et al., 2007; Al-Ahmad et al., 2009) and a huge literature has been devoted to prescribing how projects should be managed. Each perspective suggests a set of principles about what constitute the most effective way to manage projects (like PMBOK's nine knowledge or the principle of PRINCE 2). Therefore, despite the strengths of the various past researches and their popularity, Sauser et al. (2009) noted that critical success and failure factors studies have had little impact on project management practices. Al-Ahmed et al. (2009) has identified more than one hundred failures factors and Napier et al. (2009) concluded that a project manager needs to be a magician-manager with a remarkable range of competencies to build success and avoid failure. These different reasons have led to search for new approaches to more understanding projects management and their issues (Cicmil et al., 2006).

The aim of this paper is to present one of this other thinking in this context and then to improve the literature on IT project and failure. We propose to help researchers and practitioners to more deeply observe an on-going project, as this is the essential condition for understanding IT project failure/success, in order to draw useful inferences. In other words, we would like to provide researchers and actors project with another pair of glasses to wear as they observe the on-going IT project, rather than seeking to explain the failure at the end of the project. By this aim our research question is:

RQ: How should the IT project be observed in order to identify possible trajectory of failure?

Observation is defined here as "*the ability to notice things, especially significant details"* (Oxford English Dictionary). By using this term, we propose a framework based on Actor-Network Theory that will indicate to researchers and practitioners alike how to observe an on-going project in order to gain a sense of whether the project is on a success or failure trajectory and, if need be, how to correct it. More precisely, the on-going IT project observed here was a project to industrialise a new technology in a French educational area. Our results show the value of observing an IT project as a "project network". We demonstrate that IT project success or failure can be understood during the on-going project on a continuum between convergence and divergence. We present the four characteristics that indicate the degree of convergence or divergence and that thus identify a trajectory towards one or the other. The rest of the paper is structured as follows. The following two sections present our theoretical foundation, and thus our conceptual framework. The research methodology is described in section 3. Section 4 presents the study findings, which are then discussed and concluded in section 5.

1 Literature review

Although ANT is not itself a theory of projects (but initially more for understanding innovation processes), Callon's (1986) analysis of the failure of the French electric car system and Latour's (1996) study on the failed French transport system, Aramis, are now classic works on fledging project networks (Alderman and Ivory, 2011). More specifically, this theory is well recognised by many IS researchers (Doolin and Lowe, 2002; Heeks and Stanforth, 2007; Orlikowski and Scott, 2008) to be "on a list of useful theories to enhance our understanding of IS phenomena" (Lee and Oh, 2006) and a promising theoretical approach to the understanding of IT project (Mähring et al., 2004).

We assumed that ANT (Callon, 1986; Latour, 1988) would be particularly useful for our study for three reasons. First, it provides a framework for conceptualising a project as an emerging network that

extends and transforms over time. This network is social but includes a series of heterogeneous animate and inanimate elements also called "actants". Second, ANT proponents refuse to pre-empt the identity of actors independent of the relations or effects they have within a network (Latour, 1988). Third, from this perspective, the success of a project is considered to be dependent on the active participation of those who are determined to advance and who thus form a convergent network (Callon, 1991). More precisely in the IT project management domain, ANT provides a strategy for tracing the history of a project and for understanding why the action unfolds in the particular way that it does (Ramiller and Wagner, 2009).

Nevertheless, although a growing numbers of IT project management studies have drawn upon ANT (Blackburn, 2002; Mähring et al., 2004; Linde and Linderoth, 2006; Sarker et al., 2006; Ramiller and Wagner, 2009; Sage et al., 2009; Elabanna, 2010), all have been conducted *ex-post*, and have used ANT as an interpretative lens rather than an ontological foundation (Cordella and Shaikh, 2006). They thus explain success or failure *a posteriori* and as noted by Léonard Barton (1990), the most significant limitation of wholly retrospective research is the "difficulty of determining cause and effect from reconstructed events" (*ibidem*, p. 250). For this reason, we propose to mobilize ANT during an on-going project in order to observe a "project in the making". We explain in detail how to understand the dynamics of the project network in real time by proposing a precise method for observing the on-going project. We need thus to respond to two sub-questions: (1) What is the trajectory direction that should be considered as leading to project success or failure (i.e., what to observe)? And (2) how should the trajectory of the project network be followed (i.e., how and where to observe)?

2 Conceptual framework

In this section, we present our conceptual framework to respond to the two above sub-questions.

- **Understanding the successful or unsuccessful trajectory: the convergence or divergence**

For Callon (1991), a network can be developed in two directions, towards convergence or divergence of its components. The success or failure of an IT project can be explained from its degree of convergence and, inversely, divergence.

Convergence measures the extent to which the process of translation and its circulation of intermediaries lead to agreement (Callon, 1991). Convergence in a network does not mean that every element acts or becomes the same but that actors' activities fit together despite their heterogeneity. The network as a whole should be capable of concentrating its efforts towards a single point. Conversely, in a *divergent* project - a weakly convergent project - actors find both that their status is constantly in question and that it is difficult to mobilise other parts of the network. Actors resist the role the network assigns to them and will respond to instruction unpredictably. As a result, key actors may first begin to pursue their interests elsewhere and, if they grow too divergent, they will become vulnerable to collapse (Alderman and Ivory, 2011, p. 18).

Nevertheless, to observe the trajectories of project convergence or divergence, we need to go deeper. For this reason, we present the four dimensions of convergence/divergence. Two of them come from the ANT perspective (*alignment of interests and goals* and *alignment of resources)* and the two other (*co-ordination*; and *alignment of vision*) come from its extension with complementary theories:

- Degree of alignment of interests and goals: concerns individuals' motivations so that their goals and interest are aligned. This work is operated during the translation process with the active work of interessement. A network is aligned when respective interests of each actors and groups actors are aligned on the global interest of the project (Callon, 1991).
- Degree of alignment of the resources: concerns the complementarity between each resource (material or human) and difficulty of substituting one resource for another. Callon (1991) explains that if a network included three actors "X-Y-Z", and relation between X and Z implies necessarily

Y, then the degree of alignment of the network is strong. Intermediaries are passed between the actors to assure a certain degree of convergence among them.

- Degree of the coordination: concerns the different forms of coordination (hierarchy, trust, knowledge sharing, and contract) in the network. Callon (1992) refers to weak coordination when a network has no specific local rules and strong co-ordination to refer to a network shaped by both local and general rules. Grice (1989) noted that coordination like all collective actions are built on *common ground*, that is, mutual knowledge, mutual beliefs and mutual assumptions.
- Degree of alignment of visions and understanding: when human and non-human actors encounter each other they tend to already hold assumptions about the "other" in front of them, so to speak. In other words, through their assumptions or interpretative frames, they already constitute (or enact) the other as a particular sort of entity rather than another (Barad, 2003). The concept of "sense making" espoused by Weick (1995) could be particularly useful to identify these assumptions and their effects on convergence. As noted by Thomas (2000), what it highlights in the context of the projects is that the different groups and actors in the project do not necessary view and understand the project they are working on in the same terms as others.

In order to follow this trajectory during an on-going project, we need to identify where and when look after its four dimensions.

- **Following the trajectory of the network: the controversy**

In an on-going project with pressures of time, cost and quality, it seems essential that project actors not only are aware of but that they also know precisely where and when to identify and observe these dimensions. Here the concept of "controversy" in terms of ANT appears to be very helpful. A controversy can be anything (argument, idea, ideology, etc.) that challenges the *status quo* in the network and thus affects and changes the interactions between actors and objects (Latour, 2005). Controversy emerges when things that were taken for granted started to be questioned and discussed. This thus implies very strong interactions in order to redefine the relationship. By this way, researchers and project actors have to look inside each controversy (its components) of the project network because, first, controversies reveal interactions that emphasise the reality that relationships between humans and nonhumans are never fixed and, second, the effects of controversies in the network (positive or negative effects on the four dimensions of convergence) reveal the new definitions and thus the evolution of the trajectories (Section 3.3. specifies the ways to observe controversies).

In conclusion to our theoretical framework, our central proposition based on ANT is that project failure will be those that are divergent in network terms. We can follow the trajectory of the project network by observe controversies.

3 Research methodology

Our findings are based on qualitative research centred on an instrumental case conducting with a longitudinal approach to study the phenomenon throughout time (Benbasat et al., 1987). This case study concerns an ENT project (*Espace Numérique de Travail* – Numerical Space of Work), called The Pupitre Virtuel, from the beginning (2003) to the end of the project (2005). Longitudinal study was needed to observe the trajectory the project network, the dynamics of its assemblages, and its evolution over time. With Yin (1994) a single case is useful in specific instances. Indeed, the case was selected on the basis that it was critical, *i.e.* it had the conditions that allow the application of our framework (Pinsonneault and Kraemer, 1993) and especially we had access in real time. As our analysis was conducted during the on-going project, we were able to avoid the errors of historical and thus retrospective analysis (Léonard Barton; 1990) as numerous ANT studies. We were thus able to identify the dynamic richness of Pupitre Virtuel interactions and gain insight into the practices and real-life experience of the IT project manager during the project. The researcher was a participant

observer from beginning to end to avoid acting on the trajectory of the project. The table 1 synthetises our principles choices.

RESEARCH DESIGN	
Question	How observe an IT project to recognize possible trajectory of failure?
Nature of single-case design	**Longitudinal** and **instrumental single case led in real-time**. Selection of the case: **Critical case** 1. Possibility of observing in real-time the project almost from start to finish. 2. This project enabled to us an intense observation of a situation in its context, and thus the different interactions; we had the opportunity to be embed ourselves "in the heart" of project, to identify and understand interactions between actors and objects belonging to different spheres and thus in real time.
Researcher's statue and context	On one of our authors had **first-hand knowledge**: he participated in project from the beginning (Mars 2003) to the end (December 2005) as internal expert to evaluate specific aspects of the project, and he received recurrent project updates as a member of the project. Despite the involvement in the case, the position of the researcher was as participant observation within the case study approach.
Unit of analysis	Considering IT project as a project network, our analysis focuses on an individual level, on associations and practices between both humans and non-humans inside the project and both formed by the project.
DATA COLLECTION	
• **85 Documents**: Public and official documents like the partnership contract, presentations of the technology and the project; and internal and private documents of the project like the seven versions of the new partnership contract, legal documents, etc. • **More than 110 E-mails** e-mail between actors of the two firms during all the observation period: this mode of collection is seldom placed at the disposal of a researcher. To insure its collection in real time: first, we had access to the project's Intranet; second, ERI's manager agreed to transfer to us all the mails he received from Centile and those he sent to all actors in the project. • **242 Days of** observation including both the actors of the project within different groups in the project. A daily journal was redacted • **35 Interviews:** 26 open interviews and 9 semi-structured interviews, (about one hour), were conducted with actors with different functions and positions within the ENT projects, during three periods (exploratory period -with open interviews-, in-depth period and period of control).	
DATA ANALYSIS	
• **Classification and organisation of the data**: constitution of a chronological database (Van de Ven and Poole, 1995) and classification by theme, cards of synthesis of interviews, documents and description of the case. • **Thematic codification** (Miles and Huberman, 1994): starting from our conceptual approach and using the data analysis software ATLAS/Ti. All data were coded: daily journal, documents, e-mails and interviews. To ensure the stability and reliability of our codes, we coded the data several times at different intervals during the study. • **Identification of the nature of the link in the network:** inventory of intermediaries exchanged between each groups in the project by qualify and quantify these. They could be material (documents as scientific articles or work paper; contract; schedule, computer software, money, etc.) or immaterial (disciplined human bodies, skills, or the knowledge for example). • **Identification of the intensity of the link in the network** Adjacency matrix was constructed to quantify the ties (symmetrical matrix). The accumulation of intermediaries between actors identified the multiplicity Network and gave some measure of the strength of the various ties in the network. To calculate the degree of alignment to give a numerical value, Callon (1991) advocates a method of counting the number of intermediaries circulated between actors, and groups of actors, . This operation was repeated during the analysis after each controversy identified in the network • **Following controversies and identify impacts of the network** To identify and follow the controversies according to Latour's principles (2006), we created a summary table for each controversy including five markers: (1) its nature, i.e. the subject of the controversy and its stakes, (2) the actants (humans and non-humans) involved, (3) its stabilisation whether a compromise seems to have been reached or not, (4) the redefinition of the technical object, and (5) its effects on the network within the four dimensions of convergence. The aim was to observe controversies when they occur within the network (or aside) and their effects. Therefore, after each identified controversy we asked the following questions: Have the groups changed? From the study of intermediaries (adjacencies matrices), have the interactions between actors changed? Has the interessement been changed?	

Table 1: Methodological frame

4 Case findings

The Pupitre Virtuel project was a project to industrialise a new technology, the Pupitre Virtuel, in all French schools. It began in 2003 and was cancelled at the end of 2005. The reasons for its failures were numerous and various and ultimately very unclear. As usual, different stakeholders shared different interpretations of the failure (Mc Manus and Wood-Harper, 2007). For the project manager,

the main reason had to do with one the partner, ERI, who had not met its obligation (to invest in the technology). For ERI, failure was due to cultural differences between the project actors. For the external actors and the press, the main reason had to do with the technology Pupitre Virtuel: its novelty ("precursor") and the overly expectations for it. We propose to transcribe the on-going trajectory of the Pupitre Virtuel project with our pairs of glasses, (our conceptual framework of project network), to more properly observe the emergence of the project (4.1.) and its trajectory (4.2.) from convergence to the weakening of the convergence, and finally its collapse.

4.1 Building of the project

The Pupitre Virtuel was initially developed in 1999 by a French Region (Alpha) and its university team researchers and was financially supported by the Local Government (LG). Concretely, this technology, an ENT (*Espace Numérique de Travail* - Numerical Space of Work), called the "Pupitre Virtuel", is supposed to make information, resources, and services available everywhere in real time to students using a login and a password. This local project was part of a broad national project framed by the French Ministry of National Education (MEN) to develop and establish ENT in all French schools. Since 2000, this innovation has been tested by 11 schools in the Alpha Region, chosen as pilot users. In 2003, the project team (the LG and some researchers of the University) wanted to generalise its use over the national territory. The LG aimed to industrialise the Pupitre Virtuel for the pupils of most French colleges and universities (it is the problematisation in the ANT vocabulary). Thus, they needed to improve the software to ensure that a large number of students could use the program at the same time. To do so, the LG identified the actors that needed to industrialise the Pupitre Virtuel (e.g. private actors with expertise and funding, the ministry, the researchers and their universities, pilot users and the experimental technology) and got them interested in the project. For this reason, they decided to resort to private funding for the industrialisation. In October of 2003, a private company, ERI a SME, met the requirement and was selected by the LG to integrate the project. The actors' interessement in the project occurred over two months of on-going negotiations among the identified actors. A partnership contract was signed in February of 2004. At this moment, the partners' respective interests and goals were aligned for their mutual collaboration. Indeed, the inventor of the Pupitre Virtuel and his team (University researchers and designers) wanted to spread its innovation and offer a structure for deployment throughout the country. This deployment could not take place without the presence of a partner committed to this purpose. This partner was ERI, recognised for innovative technology projects and providing funds. The profitability of the ERI's investment in the project depended on the technology invented by the team's researcher and his business knowledge. The technology, Pupitre Virtuel, required both the technical competencies of researchers and the market competencies of the firm ERI to be industrialised. The experiments with the Pupitre Virtuel technology in the schools were included in the project in order to test the technical evolutions of the Pupitre Virtuel. Lastly, for the LG (Project Manager), the project's success would lead to the high visibility of the Alpha Region as a precursor in an innovative project in National Education. This success would be dependent on the technical (performed by designers) and commercial (done by ERI) quality. The interessement was successful and the definition and coordination of the roles of each of the entities in the newly created actor-network occurred (the enrolment). Thus, ERI had an exclusive exploitation license for the Pupitre Virtuel, and was responsible, at the same time, for the commercialization and technical developments of the Pupitre Virtuel. ERI's manager assumptions about the Pupitre Virtuel technology were very strong. The technology was tested by pilot users for four years and was well recognized by the French Ministry.

From this point on, ERI had to order technical developments from the Pupitre Virtuel designers, collected by a new company, the data-processing company of Centile engineering. This company was directed by the inventor of the Pupitre Virtuel and was exclusively dedicated to the project. The LG was responsible for the project in his region. The university continued to work with the designers and used the Pupitre Virtuel. The French Educational Ministry published recommendations for the technical and commercial developments of the Pupitre Virtuel. The Pupitre Virtuel was to be

improved by the developers and tested by users in the region. Therefore, at this step of the project, we observed a convergent network with the four dimensions (Cf. Table 2).

Alignment of interest	*Alignment of resources*	*Alignment of coordination*	*Alignment of vision*
+	+	+ -	+
Process of translation revealed that actors' interests were aligned, each entity had a strong interest to attempt the project.	Roles and tasks were clearly assigned and well defined in the partnership contract. Each skill of actors on the project were essential to the projects' goal and complementary.	Local rules and strong informal link existed between entities of the network because most of them had already worked together except the firm ERI which had no common ground at the beginning with other actors	Actors-project shared the same vision of the project: Industrialize the Pupitre Virtuel to generalize.

Table 2 The four Convergence dimensions during the build of the Pupitre Virtuel network

Nevertheless, the stage of mobilization, where the initiators used methods to ensure that allies acted according to the agreement and did not betray the initiator interest, became very complicated. The achievement of the stability of the Pupitre Virtuel project network became controversial. We observed five primary controversies, which we present below.

4.2 Trajectory of the Pupitre Virtuel network: from convergence to collapse

During the Pupitre Virtuel project, we identified five controversies. From our conceptual framework and methodology, we noted the several characteristics for each controversy: its nature, *i.e.* its subject; the actors involved; its eventual stabilisation; the redefinition of the technical object, and its effects on the network within the four dimensions of convergence.

- ***First controversy: Coordination and common ground***

In March of 2004, the first controversy appeared. This controversy concerned the specificity of the technical developments that required the Pupitre Virtuel's components to be industrialised, as well as its development costs. The ERI's manager requested more detail about the transactions between the two firms. According to him, the Centile invoices to ERI about Pupitre Virtuel developments were not justified. Thus, the technical development costs appeared to be very expensive.

For Centile's manager, the Pupitre Virtuel content did not allow for detailed specifications of all the developments. Pupitre Virtuel components involved specific developments. Only Centile was directly interacting with the technology and let ERI know about its assumptions about the technology: it is supposed to get provide improvements without difficulty. The Pupitre Virtuel revealed the complexity of its components merger. Therefore, stakeholders reached compromises, because the two companies had to collaborate to industrialize the technology. A mail exchange between the two managers expressed their willingness to work together

"The difficulties we encounter are from my perspective basically due to a lack of common practices and we must each make the necessary effort to iron out these differences in opinion and work methods. We will soon forget our initial 'hiccups' and the only thing that matters is the will to work together and to succeed in our projects to the best of our respective interests." (ERI's manager, May 2004).

"We would like to thank M.B. [ERI director] for his initiative and to reaffirm our total support for the aim of success that he points out, as well as our confidence in the prospects which will open for both companies with which we are associated. The strong ties which unit our two companies should not make us forget the need to formalize their relations and the perspective of M.B.'s email is a major and encouraging contribution to the strengthening of these relations." (Centile's manager, May 2004).

Effects on the network: the compromise strengthened the convergence, even if the controversy had redefined one part of the relationship among the ERI, Centile and the Pupitre Virtuel. Indeed, the alignment of resources was weakening, from complementarity roles between the ERI, Centile and the Pupitre Virtuel to the path dependency of the ERI with Centile and the Pupitre Virtuel. However, the

compromise was carried out by their strong vision for the project and the need to reinforce the convergence. Here, the actors and the technology built their common ground.

- ***Second controversy: questioning the quality and reliability of the Pupitre Virtuel components***

In July of 2004, a new controversy appeared between ERI, Centile and the Pupitre Virtuel. It questioned the quality and reliability of the Pupitre Virtuel components and asked if it should be overhauled. Indeed, the project actors were informed that they had lost two answers to invitations to tender in other schools, necessary for the visibility of the project and its industrialization. It appeared that the members of the invitation to tender had doubt about the quality and reliability of the Pupitre Virtuel. Interactions between the Pupitre Virtuel and the external actors of the project implied questions about its reliability. In addition, the technologies chosen in the invitation to tender had not yet been tested. These choices called into question one reason why ERI was interested in this project: the reputation, the experience and the quality of the Pupitre Virtuel. The technology would not be able to keep its promises? ERI wanted to build new Pupitre Virtuel foundations:

«While the main advantage of the Pupitre Virtuel is its three years' experimentation and our technical know-how, they are not convinced of the scalability capacity of our solution. Our growing business skills of Pupitre Virtuel improved with three years of experimentation is useless». (ERI's manager, meeting, June 2004).

Centile's manager was opposed to this decision:

« Pupitre Virtuel components need not be called into question. They have proven their reliability and are recognised by a strong and large community of developers. Actors in the invitation to tenders know nothing! » (Centile's manager, meeting, June 2004).

Effects on the network: There was a weakening of the convergence between ERI, Centile and the Pupitre Virtuel. The ERI's manager desired more transparency on the technical functioning of the technology. He wanted to open the black box of the Pupitre Virtuel. For this reason, ERI initially asked Centile for the code source of the technology. They then recruited a computer developer who would work exclusively for the ERI. At this point in time, ERI decided that Centile was no longer a credible spokesperson of the Pupitre Virtuel. ERI decided that its new engineer would be the spokesperson for the innovative technology.

- ***Third controversy : assignments of responsibilities***

In November of 2004, the Pupitre Virtuel encountered technical difficulties. It was impossible for the students to access the Pupitre Virtuel services. The LG was worried and wanted to rapidly find a solution:

« *Everything goes wrong!! Many users cannot access to their Pupitre Virtuel. Everyone complains! »* (Member of the LG the 5 December 2004).

ERI and Centile blamed each other for the technical questions. During this controversy, the technology Pupitre Virtuel was looking for a spokesperson. The involved actors could not compromised. In front of the technical *status quo* and the distress of the users, the project manager entrusted the exploitation of the technology to another company that was external to the project.

Effects on the network: this third controversy weakened the convergence, and thus, strengthened the divergence. It revealed the dissolution of the initial organisational structure of the project network.

- ***Fourth Controversy : questioning the technology components***

In December of 2004, the French Ministry edited a formal report that revealed the national recommendations and norms that must be respected in these types of projects. The French Ministry argued that the Pupitre Virtuel components were not reliable and sustainable enough. For Centiles' manager, the components were reliable and no modification was necessary. Conversely, for ERI's manager, the future of the Pupitre Virtuel was unthinkable without the support of the Ministry. Therefore, he wanted to rebuild the Pupitre Virtuel in order to be consistent with the Ministry's recommendations. Centile was opposed to this decision, arguing that the reinforcement of the

components would be enough. The controversy that concerned the reliability of the components of the virtual desk was essentially redefined around the components and the reliability.

Effects on the network: this controversy reinforced the weakening of the convergence and the divergence of the network. ERI was looking for a new partner outside the Pupitre Virtuel network for help with developing a new platform for the Pupitre Virtuel, while Centile worked on the initial Pupitre Virtuel. Entities in the network shared the same common goal (e.g. the industrialisation of the Pupitre Virtuel), but the vision of each organisation was completely different.

- ***Fifth controversy: questioning the partnership contract***

When ERI received the source code of the Pupitre Virtuel, in December of 2004, the engineer realized that the software technology included both the open source software, covered by the General Public License (GPL), and the private license software. Alerted to this discovery, ERI was worried about the legitimacy of the partnership contract. Following this discovery, controversies arose between all members of the project over the nature of the licenses covering the components of the Pupitre Virtuel.

According to ERI, the presence of free software in the technology called for the reconsideration of the partnership contract, as the validity of the exclusive exploitation license seemed questionable. Conversely, for the LG, the university and Centile, the partnership contract was still relevant. Each company requested technical and legal experts to detail the contents of the Pupitre Virtuel and to assess the lawfulness of the contract. The Pupitre Virtuel essentially defined here according to the nature of its components and their contagion (public or private) was looking for a spokesperson who would be reliable.

In January of 2005, the conclusions of the respective experts' reports disagreed on the validity of the exclusive license exploitation and reinforced the controversy. Therefore, project's members decided to negotiate a redefinition of the relevant clauses in their partnership contract. Fundamentally, ERI's manager was not against the use of open source licenses. He recognized that it could be a competitive advantage against property licenses in the public sector. The aim is to find another compensation method for the exclusive license exploitation on the Pupitre Virtuel for ERI and to redefine the modalities of their collaboration

"I don't want the partnership contract to be broken; in the national context we have no interest in revealing these tensions about our partnership. The main thing is for us to reach compromises without breaking the partnership in order to pursue the project." (ERI's manager, March 2005)

In vain, after seven versions of a new contract, the stakeholders could not reach an agreement. They decided to send its resolution to a new actor in the network: the court. Finally, in December of 2005, after two years, the project had only one remaining major supporter: the ERI. Consequently, the Pupitre Virtuel project was cancelled by the LG and the University of the Alpha Region.

Effects on the network: this controversy stressed the collapse of the Pupitre Virtuel network. The actors were placed in a "controversial situation irreversible" where they were unable to come to a compromise.

Synthesis:

The longitudinal follow-up of these five controversies reveal the trajectory of the Pupitre Virtuel network along a convergent/divergent continuum. This type of observation allows for the visualisation of its trajectory: from its convergence to its progressive divergence, and finally, its collapse.

During its building, the Pupitre Virtuel network was convergent, because through the process of translation, the key actors and their interests were well identified and aligned, the resources were complementary, the coordination was strong and the visions of each of the actors was aligned. Along the string of the five controversies, the network was faced with convergence weakening, which eventually led to its extreme divergence, leading to its collapse by the continued weakening of the alignments of the vision, coordination, resources and interests. More precisely, we can note that two actors (e.g. the ERI and the Pupitre Virtuel technology) resisted the role the network assigned to them

and responded unpredictably to the instructions, even though they had accepted their roles during the construction of the Pupitre Virtuel network.

Throughout the entire Pupitre Virtuel project, ERI resisted the role assigned by the network (*e.g.* commercial developments and promotion of the project) and extended it to the technical developments. In addition, the Pupitre Virtuel technology also resisted its assigned role in the network. Hence, the assemblage of its components appeared to be more difficult than expected and the reliability of its components were constantly called into question by a part of the network and from outside the network. The Pupitre Virtuel technology could not be as easily industrialised. Thus, although the interests at the beginning were aligned, these key actors later began to pursue their interests elsewhere. As they grew too divergent, the Pupitre Virtuel network became vulnerable to collapse. The collapse eventually occurred when the important actors (*e.g.* ERI, the technology, and Centile) ceased to be mobilised by the network's intermediaries: they no longer perceived their interests to be served by the project and thus withdrew.

	Alignment of interests	***Alignment of resources***	***Coordination***	***Alignment of visions***	
Controversy 1	+	-	+	+	**CONVERGENCE**
Controversy 2	+	-	-	-	**Weakening of the CONVERGENCE**
Controversy 3	+	-	-	-	**DIVERGENCE**
Controversy 4	-	-	-	-	**DIVERGENCE**
Controversy 5	-	-	-	-	**COLLAPSE**

Table 3: Pupitre Virtuel network trajectory

5 Discussion and conclusion

From our conceptual framework, tested on a longitudinal real-time case of a failed IT project (the Pupitre Virtuel project), we have shown the relevance of observing an IT project as a project network in order to improve its understanding. In response to our two sub-questions:

(1) **What is the direction of the trajectory that indicates the eventual success or failure of the project (what is observed)?** The direction of the trajectory that indicates the eventual success or failure can be seen along a continuum of project divergence to convergence. Our observation of an IT project reveals the role that translation and controversies play in achieving convergence or divergence in a project. Working within the framework of ANT and using the complementary theories as sense-making from Weick (1995) and coordination from Grice (1989), we identified four main characteristics of convergence: the alignment of interests, alignment of resources, coordination, and alignment of vision.

(2) **How to follow the trajectory of the project network (how and where to observe)**? To follow the trajectory of project convergence or divergence, we have to follow controversies and their impacts on the network. More precisely, an IT project can be observed in two dynamic and interlinked phases: the emergence of the project network, i.e. how the sociomaterial network is built (the process of translation) by identifying intermediaries and, second, the development - also called the trajectory - of the project network, i.e. the convergence or divergence of its entities by following the controversies.

Finally, our research brings about three theoretical contributions. First, our study stresses the difficulty to isolate one or few project failure factors because causality is related to interacting causes, effects and choices. We thus propose to understand the evolution of the project by considering the dynamic of

interactions over time and the on-going redefinitions of its entities through controversies. The literature in Information Systems provides recommendations and expresses key reasons why projects get cancelled (Schmidt et al., 2001; Mc Manus and Wood-Harper, 2007). However, as noted in the introduction, these approaches are not really applied (Sauser et al., 2009). In our case, the Pupitre Virtuel network project reveals great difficulty in isolating one or two primary reasons for the Pupitre Virtuel project failure. Indeed, the responsibility for the failure cannot be assigned to one critical factor, or categories of factors, such as those identified in the IS research: inappropriate technical designs, insufficient end-user management, poor stakeholder communication or poor leadership in project delivery. It is not because of the lack of pertinence of our observation, but because these technological, managerial and organizational factors are interlinked. In addition, their interactions lead events which, in turn, have consequences. The interactions observed inside the controversies between the entities of the Pupitre Virtuel network have consequences on the network. More specifically, each entity, its place, role and boundaries are redefined inside and outside the network and transformed. As such, these interactions have changed the alignment of the vision, resources, interests and coordination, and have weakened the convergence in the Pupitre Virtuel project network. This study illustrates the string of controversies which reveals what happens in the project network. In this way, our results share and illustrate the thoughts of Barad (2007), for whom causality is related to interacting causes, effects and choices. Our type of observation, according the divergence/convergence continuum, concerns the reworking of the traditional notion of causality, where the future is determinated in a linear causality. Thus, there are no predetermined, unchanging agents that can cause something to happen: agencies are dependent on their mutual inextricability. The causes and effects emerge through the interactions. The observation is thus inscribed in a strong relational ontology (Slife, 2004), where the "very nature of change and the possibilities for change in an ongoing fashion as part of the world intra-active dynamism" (Barad, 2007, p. 179). In this way, our type of observation of the project network, stresses how an actor is defined by his or her relationships: the thoughts, feelings, actions, and even identity of any actor (such as the project managers) are the result of the actions that the actor can and does form with other entities, which may be human, such as the team members and the French Ministry, or non-human, such as computer systems, contracts, or open source software.

Second, we complement the sociomaterial stream by using the concept of controversy. Our study is very close to the sociomaterial stream that has recently emerged in organization studies and IS research, as well as in the writings of Orlikowski and Scott (2008). It can be used as a way to make a move away from focusing on "how technologies influence humans, to examining how materiality is intrinsic to everyday activities and relations" (*ibidem*, p. 455). We argue that the concept of controversy can also help researchers to follow the trajectory of a project network by observing the materiality as an active participant, while bearing in mind that relationships between humans and non-humans are never fixed. In other words, controversies help to stress the concept of performativity, i.e. how relationships and boundaries between humans and technologies are never fixed, but emerge from practice, and how the practice is defined (Wagner et al., 2010). To look at the performativity, Wagner et al. (2010) used the dialectic process of accommodation and resistance from Pickering (1995). We consider Pickering's approach to be more simplistic, because it assumes the relative passivity of materiality (it only resists). For this reason, we prefer the concept of controversy.

Third, our framework allows for the project to be observed "in the making" and avoids some of the errors of *a posteriori* analysis; for example, some of the main studies using ANT reinterpreted failed or successful projects (Sarker et al., 2006; Alderman and Ivory, 2011). Thus, with our approach, the understanding of the IT project issue is improved, because we see the project in progress and provide each project actor with a method for observation that includes their real life. In the Pupitre Virtuel, we were able to see very early on that the project trajectory was tending towards weak convergence and the risk of divergence. As observed quite early on, the project network was following a trajectory. Therefore, managing an IT project as a project network involves considerable management challenges in terms of maintaining or correcting its trajectory. This perspective introduces a more nuanced way of thinking through the problems faced by project managers. We believe that this perspective elucidates a

crucial point: simply monitoring the work tasks to ensure adherence to time, quality and cost objectives is inadequate. Instead, the role of the project manager is primarily one of initiating and managing interactions and then be aware of the alignment of interests and goals, visions, resources and coordination across an extended network of actors (human and non-human): the project network. After each controversy is identified, it is possible for the project actors to ask questions related to the four dimensions of convergence and to identify a convergence or divergence trajectory in order to act before a collapse.

All research studies have limitations and this study is no different. This study provides a single case study of a failed IT French Education project. As such, to ensure the scope of our framework, our method requires more case studies. However, it is emphasized that, for the sake of brevity of the statement, we have chosen to present only one case study here. This perspective has been applied to a second IT project that was, in turn, a success. We would like to also specify that, as participant observers, we conducted our study without informing the project actors of the research goals, because we did not want to act on any aspect of the project. Further researcher is now required to see how the convergence/divergence couple acts. More precisely, our study recommends new future questions and improvements, such as *whether the trajectory always being convergent or conversely divergence is one of the parts of the success* and *when does the passage from convergence to divergence occur*?

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