Abstract: This research seeks to explore some aspects of how control operates as a package of control practices (Malmi and Brown 2008; Ahrens & Chapman 2007 a, Chenhall 2003). Given the pervasiveness of technology use today, we aim at developing an approach that takes into account the role of technology. Our results derive from an empirical work made of an exploratory research and a case study in Product Development (PD) activities using a collaborative database (cPDM). We first place the emphasis on an analysis of control practices and how they support collaboration between functions participating in PD. Building on these findings, we start elaborating further an interpretation of how control unfolds using notions of structures and technology-in-practice (Orlikowski 2007, 2000, Feldman & Orlikowski 2010).

1 Introduction

This paper has at its core the question of how control operate in organizations. It has been repeatedly reminded that management control research has to depart from its traditional focus on control modes and their contingency factors or on specific management control mechanism taken in isolation (Malmi and Brown, 2008; Chenhall, 2003). The more refinement is obtained on a single dimension of control packages or control systems (like for instance budget and its related practices), the further we stay from a comprehensive view of all the sources of influence that operate - and most probably interoperate - in organizations. Once one recognizes the interest of such comprehensive approaches, many research opportunities can be pointed out.

We choose to examine empirically control practices that support collaboration in Product Development Activities (PDA) since these activities have many characteristics of interest for control researchers. First, in looking at issues raised in research regarding product development activities, we see that PDA have characteristics of an heterarchy (Kellog and al 2006) and of lateral relations (Van de Meer-Kooistra and Scapens, 2008) which seems not to be adapted to traditional predefined hierarchical control systems. They require “something else” including control practices that can emerge in the process of interacting (Van de Meer-Kooistra and Scapens, 2008, p368). Second, since PDA represent a collective process, the study of their MCS has the potential to yield ideas that will complement results found from the study of one to one relationships between manager and subordinate like studies of control at a distance of sales representative (Dambrin, 2007) or from the study of lateral relations at company or business unit level (Van-de-Meer-Kooistra and Scapens, 2008). With this in mind, we choose to concentrate on one of the main capabilities that are looked for in PD i.e collaboration. We will address collaboration as an organizationnal capability that allows informational needs of PD participants to be met on a timely basis through the exchange of or through an easy access to relevant, shareable and reliable information (Sosa and al, 2002). Many discourses and tools are developed at managerial level with a view to enhance collaboration between PD participants. This trend is contemporaneous with an increasing reliance on technology (Krishnan and Ulrich, 2001) especially in a range of technologies –
namely cPDM\textsuperscript{1} or equivalent- that claim that they can enhance collaboration. With the conjunction of an environment that is challenging in terms of control and the diffusion of IT in the same environment, we have an opportunity to incorporate the technological dimension in our study of control practices knowing that this seems to be too rarely the case as noted in organizational studies (Orlikowski 2000, p 436) as well as in management control research (Granlund and Mouritsen 2009, Dechow and al 2007a, Dechow and al 2007b, Quattrone and Hopper 2006, Chapman 2005).

From a theoretical perspective, our project implies to be conscious of the possible differences as to what it is that researchers include in a control package. The main distinction here is whether the studies are focused on the systems and devices that managers use or on a broader conception of control with the inclusion of other forms of influences like clan controls, informal controls, interpersonal controls or self-controls. Results found in the latter vein have that in common that they are drawn from a careful look at control practices. This is in line with Van-Der-Meer Kooistra and Scapens (2008) who advocate that much can be learnt from a comprehensive inventory of control practices\textsuperscript{2} as well as from the identification of structural elements that underpin these practices (Ahrens and Chapman 2007a, Burns and Scapens 2000). Such an approach constitutes a promising avenue for those researching how management control system operate and has the potential to be reconciled with the available MCS research that frequently put the emphasis on the meanings, norms, values, mental models or the resource dimensions (Ahrens and Chapman, 2004) of MCS, items which could all be seen as nothing but structural elements that actors draw on to develop their practices. This convinces us to pursue our investigation of how control operates through a practice perspective. As far as the role of technology is concerned, we choose to inform our observations with the latest developments of the structurational perspective set forth by Orlikowski (2000) before she adopted a socio-material practice approach (2010, 2008, 2007).

With this in mind, we focus on two research questions: (1) what are the main control practices that support collaboration in PD activities and how do they operate and (2) what is the role of technology for these control practices? We explore the questions by examining PD practices and related control practices in a company that has adopted a collaborative database. The cPDM was adopted to improve collaboration and the overall efficiency of PD activities but seems to be worked around by most PD participants. We provide some insight as to what are the structural elements that participants draw on in their control practices and as to the role of control practices in shaping these structural elements. Our case also comes in support of a view of control practices as enablers of the elaboration and the exchange of multiple types of accounts of product development.

This paper is organized as follows. In section 2, we discuss the interest of using a practice perspective – here a structurationist perspective - to better understand how control unfolds and we try to open up the way to a recognition of the role of technology in using the concept of technology-in-practice. In section 3, we outline our research method and we present our research site. Section 4 presents the case description and an analysis of the main control practices as instantiations of structural elements that now include a technology-in-practice. In

\textsuperscript{1} cPDM for collaborative Product Data Management sofware, PDM for Product Data Management, CPC for Collaborative Product Commerce and PLM for Product Lifecycle Management software.

\textsuperscript{2} Van De Meer-Koistra and Scapens call them governance practices to contrast their propositions with those that are anchored to the concept of management control system which they think is not suited to lateral relations.
section 5, we discuss some implications of these findings and finally present some conclusions.

2 Theoretical development

The main theoretical constructs used in this development are control practices as well as the notion of technology-in-practice.

Understanding control practices in Product Development Activities

For Davila and al (p 120 ; 2005), « innovation systems are established policies, procedures, and information mechanisms that facilitate the innovation process within and across organizations ». There are a number of issues to consider regarding how the package of existing control practices enables to achieve satisfying level of collaboration within and between product development projects (Dahlgren & Söderlund 2010, p2 and p4, Banker and al, 2006). Much has been learnt since the seminal work of Rockness and Shields (1984) on the dominant forms of control in R&D activities (Abernethy and Brownell 1997) and the broad panel of PD control mechanisms that comprise PD management control systems has now been well described (Brown and Eisenhardt 1997, Dahlgren and Söderlund 2010). But many claim that more knowledge has still to be acquired on how important PD features (Van De Meer-Koistra and Scapens, 2008) like collaboration, flexibility or innovativeness can effectively be supported by an appropriate blend of control mechanisms (Davila, 2000, Kamoche et Cunha 2001, Bisbe et Otley 2004). The latter question echoes many calls within management control literature (Chenhall 2003, Abernethy and Brownell 1997, Otley 1980) so that control mechanisms are not studied in isolation but as a package (Malmi and Brown) to avoid risks of “spurious findings, ambiguity and potential serious model underspecification »(Chenhall 2003). Many have rallied this call and aim at analysing how control mechanisms relate to each other and how they operate in relation with one another. In so doing, they have built up a growing body of results on what can be called the interplay between control mechanisms. Among these, differences arise as to how researchers delineate the range of control mechanisms that comprise the control package and the types of relations they identify between them, since the last point is highly dependent on the first. One distinctive feature of the extant articles is whether they focus on formal control mechanisms which are put in place by the management (Tuomela, 2005, Mundy, 2010, Ferreira & Otley, 2009, Henri, 2006, Simons, 1995, 1987) or whether they examine broader elements of control such as self control (Carlsson-Wall, 2011 Dambrin, 2007), informal control (Pitkänen and Lukka, 2011, Lukka, 2007), social controls (Carlsson-Wall and al, 2011, Brivet and Gendron, 2011) or socio-ideological controls (Collier, 2005, Alvesson and Kärreman, 2004).

The first stream of research is currently driven by concerns about the use of the formal elements that constitutes the control package or rather in this case, the management control system. When mobilizing notions like interactive versus diagnostic use (Tuomela 2005, Widener 2007, Bisbe and Otley 2004) or enabling versus constraining use (Mundy, 2010; Ahrens and Chapman, 2004), it can be considered that authors give us an account of how it is in practice that controls operate through a more and more refined depiction of manager’s practices in various contexts (Mundy, 2010). Beyond the question of MCS use, concerns on relationships between control mechanisms have brought interesting ideas on mutual influences (Abernethy and Chua, 1996) between them as well as patterns of substitution and
complementarity (Kennedy and Widener, 2008). Thanks to the second category of research where different perspectives than the above manager-centered perspective are adopted, we find that formal mechanisms’ influence is not necessarily direct and that it is -to the least- mitigated by other types of influences. This is illustrated by Alvesson and Kärreman (2004) who put forth that formal output or behavioral controls just act as an interface for a socio-ideological form of control. They describe how in a consulting firm these mechanisms are actually enacted in a non-rationale and biased mode and how through the analysis of these particular enactments, one can see that the main role of formal control mechanisms is to help the development of a specific mindset throughout the company. When they engage in control activities like project monitoring, appraising staff or training, people are exposed to meanings, norms and interpretative frameworks that they tend to then use unquestioned. Carlsson-Wall and al (2010) also contribute to nuance the role of formal mechanisms with an example in a domestic care context. They find that coordination is achieved thanks to a complex lattice of intra and inter-organizational social controls rather than through the administrative controls that are used. They show that nurses and home helps resolutely engage in activities like meetings or transmission routines where they mobilize professional codes and loyalties of their respective groups. In these activities, they build team joint values and informal hierarchies with a focus on what they think is best for the patient. These values and hierarchies compete with administrative controls like social care contracts or budgets of the home help units. Rather than competition, some point out at the coupling between formal systems that contribute to the expression of the rule and the ad-hoc routines – often informal – that are developed to accommodate them (Pitkänen and Lukka, 2011). Other contributors (Carlsson-Wall and al, 2010, Dambrin, 2007, Robson, 1992) further argue that analyses of how management control system operate would not be complete if they do not reflect on self control as one important determinant of action with an influence that is subtly intertwined with that of traditional controls. Most of them show that administrative controls contribute to crafting self-controls i.e the norms and values that are internalized and mobilized by individuals.

The above results are essential in the journey towards a comprehensive view of how control operates. In the process of reporting these results, we have tried to highlight what we think is one of their common feature that is the fact that they are all drawn from a careful analysis of organizational practices. In line with what has been observed in organizational studies in general (Orlikowski, 2008), only some articles cited above explicitely refer to a practice theory (Wagner and al, 2011, Jörgensen and Messner, 2010), others don’t but they actively mobilize the concept of practices (Van de Meer-Kooistra and Scapens 2008, Kamoche et Cunha, 2001) or concepts that are close like enactment, routines (Lukka, 2007) and it can be considered that others deploy empirical methods that are centered on practices whether they be general work practices or control practices at managerial, team or individual level. This all comes in support of Ahrens and Chapann (2007a) who advocate that much can be learnt from a comprehensive analysis of control practices rather than that of control systems. This convinces us to pursue our investigation through a practice lens. In our view though, such a perspective should not preclude analyses of the relationship between practices – including control practices - and the structures which scaffolds social interactions. Such analyses prove often relevant for understanding how control operates (Englund and Gerdin 2011, 2008; Killfoyle and Richardson 2011; Van-der-Meer-Kooistra and Scapens 2008; Burns and Scapens 2000) and their explanatory potential is not entirely depleted. The theoretical framework that will therefore be used to make sense of how the MCS operate in our case

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3 Which in the end, is a rather similar line of argument to Alvesson and Kärreman’s (2004)
The role of technology

Many management control researchers (Brivot and Gendron, 2011, Granlund and Mouritsen 2009, Dechow and al 2007a, Dechow and al 2007b, Quattrone and Hopper 2006, 2005, Chapman 2005, Thoresen, 1997, Bloomfield and Vudurbakis, 1997) have tried to understand the implications of IT for control convinced as they were that those who want to understand organizational phenomena should not downplay the technological dimension of practices (Orlikowski, 2000, p436). It is re-emphasized in the recent practice turn of accounting research with the idea that human practices - and therefore control practices - have always been “recurrent, materially mediated and situated social activities” (Schatzki and al, 2001). Researchers try to reflect on the consequences of the new functional affordances that contemporary IT provide organizations with (Markus & Silver, 2008). Among them, it is common to stress their calculation, storage, processing, communication capabilities such as when one contemplates the shift from paper design desks to CAD\(^4\) in Product Development Activities. Another feature that dramatically differentiate IT from other kind of technologies that is often put forth is that information technologies are integrated (Chapman and Kihn, 2008, Barki and Pinsonneault, 2005) which is barely the case for hardwire technologies. They are also based on conceptual models (Dechow and al, 2007a, P 630) like process models or data models and a large part of these models and their material aspects is not accessible (Quattrone and Hopper, 2006, 2005) to users who are often only acquainted with an interface like a serie of screens and a mouse. We find that many research have often been done at inscription level that is by analysing the vision (Bloomfield and Vudurbakis, 1997) or the accounting logic (Wagner and al, 2011, Dechow and al, 2007a et b ; Quattrone and Hopper, 2005) inscribed in the software and the implications of these inscribed features for the control forms in the organizations (Dambrin, 2007). From these types of accounts of IT organizational consequences, we are under the impression that IT embodies structures -like rules, roles distribution, data categories, work processes- and that these structures are what will shape social activities once IT is appropriated. Notwithstanding the importance of these results, we are also informed by MIS researchers of the unanticipated ways that users choose to use technologies (Ciborra, 2002; Kling and Iacono, 1984 Walsham, 1993). This is the reason why we decide to inform our research questions with the theoretical proposition put forth by Orlikowski (2000). She elaborates the concept of technology-in-practice that helps overcome one of the traditional view that sees technology as something external to human actions and that would embody structures. Technology-in-practice represents “what people actually do with a technological artifact in their recurrent situated practice” (Orlikowski, 2000, p408). Following this proposition, there would be no such thing as an appropriation of the technology but multiple enactments of it depending on the person involved or if it is the same person that uses the technology, depending on the moment and the circumstances\(^5\). This then allows her to posit that structures are « virtual, emerging from people’s repeated situated interactions » (Orlikowski, 2000, p407) and that people are implicated in an ongoing process of structuration. These are not Orlikowski’s latest theoretical propositions (Feldman and Orlikowski, 2010) and she has since then evolved towards a sociomaterial view of practices where technology is no longer seen as a separate artifact. Based on where we came from (available results in management control literature and the potentiality of a practice view on

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\(^4\) CAD for Computer Aided Design

\(^5\) This is close to what Wagner and al, call multiple person/technology assemblages (2011, p 183)
MCS operation informed by an identification of structures that underpin these practices) and where we want to go (understanding control practices, how they operate), we decided to keep the analytical distinction between the social and the technological realm that characterizes the technology-in-practice approach. This will be used to try and build a more inclusive view of control practices in the product development activities of a company that has adopted a collaborative database. We next describe the methodology that enables us to analyse PD control practices.

3 Research methods and research site

Since we aimed at generating theoretical insights on how control operates in PDA using information technology, we selected collaborative database technologies because of the alluring claims of technology contenders (like the CIMData consortium\(^6\) or software editors) who put forth that technology will contribute to increased efficiency, collaboration, effective knowledge management and flexibility. This is all the more appealing for us that outside the management information systems literature (Banker et al, 2006) and especially within management control literature, available research (Kamoche & Cunha, 2001, Dahlgren et Soderlund, 2010 Rockness et Shields, 1984) is only marginally interested in the role of technology.

**Research methods**

Our analyses mainly derive from a field work made of an exploratory phase between November 2008 and May 2010 and a case study carried out from May 2010 through to July 2011 (see Appendix). The more intensive phase of data collection took place between September 2010 and February 2011.

The aim of the exploratory phase was to accumulate some knowledge of product development activities\(^7\) in multi-project organizations. Findings were mainly on ways of organizing such activities, possible approaches of project structuration, strategic capabilities that are being developed, degrees of uncertainty, sectorial differences with regards to relationships between development activities and the manufacturing of products, common challenges. We ended up delineating that this research should focus on the conception and development stages (Gokpinar and al, 2010) up until the product is approved for large- serie manufacturing since these stages differ substantially from the concept exploration phases. The second goal assigned to the exploratory phase was to understand the main features of these collaborative tools using approaches such as the Adaptive Structuration Theory (Markus and Silver 2008, De Sanctis and Poole 1994) and the concept of organizing vision (Swanson and Ramiller, 1997) to build a representation of the expected role of CPDM-like technologies within PD management control systems.

An empirical case study was chosen to better understand practices and the role of technology (Myers and Avison, 2002) since it enables to grasp the contextual dimensions as well as the circumstantial and historical dimensions of this phenomenon (Ahrens and Chapman, 2006). Among the companies that we met during the exploratory phase, we negotiated an access to Zeltron because we “understood” the product and because of the size of the PDA. We thought

\(^6\) Consortium of software editors, integrators, consultants that promotes the Product-Lifecycle Management concept and the associated tools like cPDM.

\(^7\) Also to balance and update knowledge and possible misconception acquired when in charge of controlling development activities in a software company.
it was not too big and that we would therefore be able to capture most of the dimensions of collaboration. Thanks to the exploratory phase and an initial kick-off interview with the R&D manager of the host company, we were able to target at key interviewees for our first round of formal interviews in the host company. Then we started spending time on-site for non participant observations (reviewing documents, attending meetings, shadowing tasks, attending informal talks at lunch, coffee machine, in total 14 whole days on 6 months). Formal interviews (see Appendix) were conducted individually with participants within the five main PD groups (Kellog and al, 2006) which were characterized as Marketers, Developers, Project Managers, Product Data Managers, Operations. But we also carried out interviews with people outside these communities (Finance, Sales, MIS, Quality, cPDM Project manager).

Many informal interviews were also conducted during the days spent on-site (mainly with the developers). Participants were asked to describe their everyday activity, evolutions in this activity, which technology they mobilize in their activity and how. Another focus of our interviews was on the tools that were used to manage the projects and communicate with others. It is only in the observations and the later stage informal interviews that the focus was put on the practice (how they interact with other persons involved in PD at Zeltron but also outside, like suppliers, customers, subcontractors). Interviews at the beginning were more open-ended than at the end of the six months time period of intensive data collection. We particularly tried to understand what was going on on two projects: one that was about to reach an approval in terms of product specification (end of phase 1, gate 1) and one that was reaching the end of the development process (end of phase 4, gate 4). In addition to interviews and observations, we collected data by reviewing some of the extensive documentation generated in the organization including meeting minutes, project binders, cPDM training documents, cPDM project reports, PD procedures, company institutional documentation and website, resource follow-up excel tool, budget follow-up documents, project reports for gates progression, weekly project reports. We also shadowed one product data manager as well as a product designer when they were using the cPDM software. The focus during the second stage of the data collection was to understand how in practice does the MCS operate and how do participants in PD engage in control practices involving or not the technology. Working abductively with our interview transcriptions and reports elaborated systematically after each day spent on-site, we elaborated a broad narrative enriched by parallel theoretical work. This narrative is tied with our main research questions and our main broad theoretical constructs so that we are not constrained by a prior tight analysis scheme. We sought to categorize data (with categories that emerge rather than preestablished), to fragment them (especially documents), to elaborate on metaphors (especially after meetings observations) and to always contrast discourse and actual information sharing patterns. This is how we were able to give sense to our data (Ahrens and Chapman 2006) and to elaborate an analysis of MCS operation.

Due to the usual length of projects at Zeltron, we were not in a position to observe the whole range of interactions between PD participants throughout the life of a project. We could overcome this because the project portfolio at that time included projects representing all stages of a PD lifecycle.

Research site

Zeltron is a business unit (BU) of a large international manufacturing group after having been and independent company. Zeltron develops and sells worldwide appliances that help protect electrical and electronic installations. Since its is in the group, activities that are close in terms of markets and technologies have been added in the BU. Customers are either distributors of electrical and electronic appliances and parts or manufacturers of large electrical installations.
in which case Zeltron acts as a so-called OEM (original equipment manufacturer) or the customers of these manufacturers when this is for replacement parts. Zeltron has adopted a geographical structure. Our case study is focused on the European compartment of the historical activity which is run from France with the main support functions (general management, marketing, sales, R&D, HR, Finance etc.) based in France on the main manufacturing site. 3 other manufacturing sites are located in Tunis, India and China. The technology is mature and innovation is not the main focus. Focus is on being able to attend to customers needs both by maintaining a large and up-to-date catalogue of generic parts and devices for distributors (adjusted to always evolving norms and to innovations in the very large range of electrical and electronic appliances that goes from the “laundry machine to the nuclear power plant”) with satisfying margins and by conceiving specific solutions as an OEM that will be manufactured in small or large series with a high degree of adaptation to customers’ needs. Zeltron competes on this mature technology by seeking to be reactive to customers’ demands and proactive in terms of catalogue whilst remaining profitable. Product Development Activities are at the heart of Zeltron’s strategy. Resources are mobilized on product developments everywhere in the company with an emphasis on Marketing, R&D, Methods, Purchases and Manufacturing. As opposed to other groups, the R&D group is exclusively dedicated to product development and can be seen as a hub in each product development projects whereas Marketing has other missions such as bringing the product to the market, supporting sales etc. The headcount in R&D is thirty-one (of which 20 are “full development, 2 are “research” and 9 are the “tests”). Zeltron has adopted for long a project-based mode of organizing (Dahlgren and Söderlund 2010) that includes many elements of an heterarchy (Kellogg and al, 2006) and of lateral relations (Van De Meer-Koistra and Scapens). Each group “perform distinct activities and engage unique areas of expertise” (Kellogg and al, 2006) and they are now supposed to work collaboratively with one another. At the beginning of our field-work, 19 projects were on-going. Challenges to collaboration that have been identified are a relative scarcity in resources (as opposed to prior time period) and massive retirement of senior staff, increased distances (in space, in resources), acceleration in market cycles (new product have to be released more frequently and more quickly), increased technological complexity that brings with it increased scope complexity (Davila, 2000) with expertise dispersed between Zeltron, its customers, its suppliers or the other OEMs, alternative manufacturing sites in the BU, high normative pressure (new norms, low international convergence), emergence of credible alternative development resources, convergences sought for with the new activities, increased attention placed on the management of the product allthrough its lifecycle.

4 Case study of product development in a manufacturing company

In this section, we seek to elaborate a definition of the concept of collaboration that echoes the multiple dimensions associated to it by our respondents on the field. We then provide some background information on the Collaborative Product Data Management Software that is used at Zeltron’s. This will guide our description of control practices whether they be associated with traditional control systems or built into the technology.

The multiple dimensions of collaboration

For our respondents, product development activities consists in multiple interactions between teams whose actions are all interdependent (Banker et al, 2006; Brown & Eisenhardt, 95).
and whose output is a bundle of formal descriptions, prescriptions and instructions aimed at all the parties that will produce, buy, supply and use the company’s products. In such contexts, collaborative work or collaboration has become everyone’s motto but one that has multiple meanings. For some, collaboration is associated with the idea of intensive communication (Tushman, 1977) and with the idea of coordination (Gokpinar et al, 2010).

We hear that collaboration is achieved if teams, tasks and project scheduling are organized in order to achieve objectives with an appropriate level of resources and if there is quick and intensive information sharing. Our discussions show that collaboration is also a matter of cooperation (Pollard, 2001) since we are told that participants in the process have to admit that there is a mutual benefit associated with bringing their resources together rather than competing. For respondents, collaboration is a way to moderate the impact of uncertainty and to reduce ambiguity (Sosa et al, 2002; Clark and Fujimoto, 1991) associated with two types of information which are product design information or development process information (Banker and al, p352). We are reminded that goals and specifications are discovered through action (Lukka, 2007; Kamoche and Cunha, 2001) and have to be communicated as quickly as possible (Kellog and al, 2006) or « as they become known » (Banker and al, p 352).

PDA groups are interdependent in terms of knowledge, components and resources (Dahlgren and Söderlund, 2010) this is why it is so important to synchronize information between the concurring work streams and to share knowledge between them (Banker and al, p 355, 2006). Consultants experts in PDA stress that we now have multiple-projects organizations (Banker and al, p353) that are now commanded to follow-up their products although their lifecycle so we would also need to envisage collaboration as an effort that embraces the whole project portfolio both now and across time. One thing we hear is that participants have to take, in as much as possible, into account other participant’s needs or constraints beforehand in their actions or in how they design interfaces that they will share with one another (Kellog and al 2006) what is equivalent to reaching a certain degree of integration between the different teams (Dahlgren and Söderlund, 2010). Since collaboration is such a multi-faceted concept, we choose in this research to focus on the information and knowledge sharing dimension of collaboration. More precisely, what is of interest to us here is how control practices within the control package enable that informational needs of PD participants are addressed on a timely basis through the exchange of or through an easy access to relevant, shareable and reliable information on all the dimensions that are listed above.

**Background : Neo, Zeltron's collaborative software**

A cPDM software is a “relatively-new technology used to streamline product design and development processes”. Its database and other functionalities “enable product design engineers to collaborate by facilitating the sharing of product data used in the design, development and management of products” (Banker and al, p 352, 2006). Neo is the name of the cPDM that was adopted four years ago by Zeltron to improve collaboration and the overall efficiency of PD activities. Europe R&D initiated the adoption process and was disillusioned when General Management eventually decided to go for Neo instead of another software. Since then, R&D participants keep referring to Neo as “what d’ye call it, by the way”. The official focus at the start was on information sharing through a database. PD participants were supposed to take part in the construction of the Neo database by uploading product and project information during projects so that everyone else in the organization can have access to it, especially Operations and Marketing. To achieve this, it was decided that

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8 Here, we are referring to functional integration as opposed to technological integration (Barki and Pinsonneault, 2005)
Neo would replace Oldsoft the company home-made ERP for product code creation. Except for the product code creation by marketing, it turned out that no document apart from the final drawings were uploaded in Neo. This is enough for Operations to create the operating parts list and operating sequence in Neo so that the ERP-driven manufacturing process can start. But this is a very limited use of a cPDM. Neo also features a built-in electronic validation workflow called Product Lifecycle. It is based on the assignement of approval responsibilities regarding changes in product status including the transfer of the product from the Approved to the Release status that marks the start of the manufacturing process and the transfer of responsibility between R&D and Operations (also called gate 4). Although largely circumvented, we will see how this workflow has modified collaboration patterns between R&D and Operations. After one year, a dedicated team called Doc Control was created to overcome the under-utilization of Neo. This team reports to the Operations’ head. It’s mission is threefolds: building-on information available within R&D (final drawing and the corresponding parts lists) to create in Neo all the files that are necessary for the start of the manufacturing process (like the operating range, the operating parts lists); recreate past product information in Neo; advocate for an in-depth use of Neo by all PD participants. This context sets the stage for investigating people’s engagement in control practices everyday (Wagner and al. 2011, p 187).

**Control practices associated with traditional control systems**

In the following sub-section, we will use a focus on practices surrounding administrative, cybernetic and cultural controls (as per Malmi and Brown’s typology of managerial control systems, p 291, 2008) as a start point for understanding what drives collaboration in Zeltron’s PDA. In describing these practices, the influence of social controls will be recognized.

Collaboration seems to be dictated by the ISO procedure (called PROC) that describes step by step Zeltron’s stage-gate process called PAC: the purposes and « actions » of the five stages of the projects, the accountability at each stage of the projects, the so-called deliverables for each of the stages. Many deliverables are themselves subject to formal procedures some of which refering explicitly to existing professional methodology\(^9\). According to the PROC, output deliverables of one stage of the project become the input materials for another stage, each input information representing the informational needs of one or many other groups in the organization. The whole set of procedures is available to the staff on paper only and is filed in binders. The binders shelves are the first thing you see when you visit the R&D offices\(^10\) and they are the first thing that newcomers to the team have to read. When elaborating the PROC some years ago, participants recall that all groups have had the opportunity to describe the way they were working and the interfaces they were using or would like to use to communicate with other groups. There has been a constant redesign of the template by PD participants since then (Orlikowski, 2007). These adjustments constitute examples of enactments by PD participants of the procedure. Citations below show that the PROC is constantly used as a reference and that it is enacted in PD participants’ day-to-day activities.

« It’s good that the PROC lists what everyone’s supposed to do phase by phase. On project X, for example, it was like clockwork, we had everything that we needed on time from the marketing lads without even asking. Whereas on project Y where I was acting as PM, it was smaller and I did only what would be looked at during the Design Review » (A designer).

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\(^9\) Like the AMDEC methodology that aims to identify how the product could fail.

\(^10\) When the marketing project manager has a hard time finding them in a rear-end cupboard when we first met.
The procedure is fine but it’s standard. Personally, I have designed additional tools that I share with my team and all the people who work on project B at the moment » (A Project Manager)

« No, really, the procedure has helped a lot. But you know, you always have to chase some people to get things done, to have the documents or the info you’re searching for » (A Doc Control team member).

Writing the PROC, updating it, making it available to PD participants are control practices in which all groups are involved. In doing so, they share a model, a template (Kamoche et Cunha, 2001) that shapes their representations of a generic PD process. As can be seen in these examples, the template does not ensure that the actions listed will actually be carried out. The procedure does not ensure either that if the actions are carried out, the formal outputs will be made available in a timely fashion, that these formal interfaces when available are the « right » ones (up to date, complete, approved). Indeed despite a clear focus on formalization, we saw that the procedure gives very little direction on ways of coding, validating, storing or exchanging the formal interfaces. Collaboration as we saw is a lot about these formal interfaces but it’s also a lot about information that emerges and that has to be exchanged as it comes in the way. Other practices contribute to enforce the PROC and attend to emergent, informal information like practices associated with the designation of Project Managers (PM) and project management practices.

Zeltron like most organizations has adopted an organizationnal structure that heavily relies on project managers. Terms like “steering wheel” or “leader” are used among PD participants who acknowledge that PMs play a key role in fostering collaboration. In our view, collaboration between the groups starts (Dahlgren and Söderlund, 2010) with the appointment of the PM. Officially, this is simply the R&D manager’s decision. In reality, we saw that the R&D manager initiates a consultation of his staff which enables him to ponder different parameters such as interpersonal preferences, technical skills, time availability and applications. Eventually, the R&D manager picked up someone who is in good terms with the marketing PM and openly admitted he did so to favor collaboration on the project. PM contribute to collaboration because they are a turntable for capturing information, formalizing and reprocessing it as well as diffusing it. Most PM use weekly project supervision meetings to capture project information and to diffuse it. These meetings are not codified, PM invite other groups’ representatives depending on the main subject matter at a point in time. Meeting discussions allow them to interactively identify strategic uncertainties (Simons, 1994) both through formal and informal feedbacks (Pitkänen and Lukka, 2011, Jörgensen and Messner, 2010) like when the absence of the supply-chain person informed the PM of an issue on the availability of a component before the launch of a pre-serie. During these meetings, they only chase participants for the provision of the deliverables requested in the PROC if this is necessary for making decisions. The PROC, as will be shown, is articulated with institutionalized governance meetings called the PAC and the Design Review where the availability of these deliverables is rigourously checked. Citation below shows that it is generally accepted within R&D to defer formalization until these two meetings take place:

« Procedures are OK. But when you have changes all along the way, you don’t want to spend time updating papers, you go ahead and then at the end, you know, when we have to convene the Design Review, you prepare the documents. » « The others?... How can they move ahead if I don’t tell them what’s going on?... Well, you make phone calls, you go and see ’em and they can move ahead ». « I surely don’t want them to stay stuck, and you can count on them to let me know if they’re stuck » (A PM).

PM interpret the information gained in these meetings and decide how information should be diffused that is: either on a push mode using recurring or specific project meetings or through phone calls, emails and informal talks or upon demand or on a differed mode through
information storage on servers. These meetings and the exchange of formal interfaces are essential since they enable PMs to elaborate accounts of project progresses in the form of reports or updated synthetic objects like the product drawings or the parts lists. Despite these reports, we witnessed that a large part of PMs’ time is spent on consultation by other participants on project status and on the status of related documents or prototypes. Parallel to the supervision meetings, there are other governance practices that play a key role in supporting collaboration. Within R&D, it’s the weekly meeting for which the PM prepares a report called COPIL file. This meeting is intended to align all senior members of the R&D team on all projects progresses and to force PM to report key issues on their projects. The main transversal meeting (called PAC committee meeting or simply “the PAC” like the stage-gate process) takes place every month and examines all projects that apply for stage progression. Managers of all the groups involved in PDA and the finance manager attend the meeting. Each PM presents an account of project progresses which allow managers to make a decision on stage progression (there are three possible decisions: Pass, Redirect, Reject). This account is based on a report that highlights critical points and possible solutions in the technical realm as well as updates on resources consumption, product costs and planning. Given the limited timeframe and the number of projects, participants make it clear to us that the meeting acts like a catalyst of prior discussions between parties where solutions are usually elaborated as illustrated below:

“Before going to the PAC, we discuss possible solutions with one another, who will take the lead, which CAD technician will be appointed ?… ” (a PM) or “No one wants to go to the PAC to hear that we didn’t handle the project well, that information was not shared, we prefer fixing things before” (a PM).

One can therefore say that the committee appraises if the PM is “convincingly making the case for continuing the project (Jörgensen and Messner, p14). Further, we have noticed an intensive use of a document called “European Gating Map” that is issued by the Marketing each month after the PAC meeting and that represents in a snapshot all the projects underway on a time axis. We are told that this relatively new practice is really useful for the PD community as they used to lack an overall picture of ongoing PD activities. But PAC’s influence on collaboration extends beyond the abovementioned effects on multi-directional information exchange or on the structuring of a common representation of the PD activity as a whole. Participants engage into so-called Design Reviews before the PAC meeting each time a gate progression decision is under discussion. The official purpose of these reviews (which culminate in a meeting where the R&D manager accepts that the project “goes to the PAC”) is to check that all the formal outputs corresponding to the actions of the phase are available, that they comply with the procedure and the methodologies. The PM progressively prepares the review in a dedicated paper binder called a Design Control File with its mirror shared electronic directory. The review is carried out by another PM who makes a report to the R&D manager before the Design Review Meeting takes place. It allows the R&D manager to be aware of project status before he attends the PAC so that he can actively participate in decisions. This is also an indirect supervision practice of PMs’ work. If the project is clear for the PAC, it means that standard diligences have been carried out which ensures a certain degree of progression of the project and command over uncertainties as well as a relative transferrability of the project.

Cybernetic types of control are rudimentary. A budget of expenses and capital expenditures is elaborated once a year and revised semesterly. R&D uses an excel file called Resources Follow-up to capture what each person will be at to in the following twelve months. It is

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11 No one actually reads the COPIL files, they are stored by the R&D manager on a server who opens the file on his PC while the PM makes his report during the weekly meeting. A weather metaphor is used on the first page of the report. It’s up to the PM to use the bad weather icon when the project is at stake.
updated monthly and subject to a more thorough assessment of the project pipeline and projects timelines as well as people allocation to project for the budget elaboration process. The budget is therefore an extension of the R&D regular management processes. These include since recently a time follow-up software that the R&D manager uses to challenge PMs on the actual time spent on the project per capita versus the plan. This cybernetic system supports collaboration in so far as it puts finance “into the loop” with the negotiation of resources and monitoring of their consumption. Collaboration is also supported because it enforces twice a year a certain transparency and an alignment of all groups on the same action plan and in so doing it provides a basis against which rediscussing this alignment throughout the year. There is no systematic incentive associated with the achievement of project objectives on costs, time and quality. “Human capital” sits among the criteria used for subjectively assessing individual performance in R&D. This includes the collaborative capabilities of individuals. It turns out in practice that this criteria is outweighted by other criteria and the subjectivity of the evaluation. Its influence remains symbolic.

We end up this review of control practices by looking at cultural controls (i.e how management directs collaboration through communication, HR management and the use of space) and at the main social control practices according to the definitions synthetized by Alvesson and Kärreman (2004). Participants tell us that they are aware of company’s orientation through the R&D manager who has every week an “info-company” section in his R&D meeting. They admit that they are sensitive to internal communication discourses which for example now promote collaboration with the non-historical activities and close collaboration between R&D and marketing¹². HR practices and surrounding discourses are other vectors of cultural control. Recent adjustments on the headcount were officially on people displaying low collaborative skills (in fact, senior R&D with more traditional one-to-one, low formalization methods). We find that recruitment is less and less collegially approved and goes more towards professional project managers and when possible female rather than peers from the same engineering schools. Internal mobility is also favored as a vector of collaboration through trust and awareness of reciprocal issues. Open space has been used for several years within R&D to try and abolish hierarchies and distances and to promote collaboration between projects. Marketing staff was also moved closer to R&D on the same site. An obeya room has been discussed for months as a way to make project management facts accessible to all the team and to management. For the moment, the effects of this project are just symbolic. But it’s in the air. The signal is that the company seeks new forms of collaboration rather than more of the past collaboration. Social controls are outside Malmi and Brown’s typology but they are part of the package of organizational controls (Hopwood 1974). A web of norms and reciprocal commitments is at play within the R&D community. It is visible in practices like having lunch altogether everyday without the R&D manager, mentoring junior technicians of the same school, collegially appraising and approving new recruits, reverting to legitimate senior experts when problems arise, not disturbing an always quiet atmosphere and looking sober. It is also visible in the fact that important decisions at R&D level are taken collegially in the R&D manager’s office with transparent walls, open door and people sitting or standing there in a casual way. The awareness of informational needs and commitment to provide information that is needed derive from these solidarities and this a-hierarchical atmosphere.

Control practices associated with technology use

¹² Discourses are supported by a revised organizational chart where the R&D manager also becomes the head of these activities’ R&D and where marketing and R&D are now both structured according to strategical domains.
Control practices that have been contemplated up to this point attend either to emergent, unstructured or to the structured formal information. What we can see from the above description is that these practices either aim at (1) specifying the nature and characteristics of the information to be shared or at (2) the timely production of this information. As was seen collaboration also implies that participants have access to the information produced by other participants and that they can interpret this information. Questions raised are: who holds this information, where can I find it, is it the last version, what are the ties between this document and another, is it approved? Through these questions, most interview respondents talk about the importance of the diffusion of information and of its qualification. These last two dimensions of information sharing are still essentially dealt with through the PMs with the support of their CAD technicians (constituting a “tandem”) as well as on a long lasting codification and indexing system that help participants interpret the information they have at hand. First principle is that each product or component has a code and that components, drawings and all the documents related to the product have a code of their own that tie them to the product through its code. Second principle is that each version of a document has an index that informs on the status of the document (first or last version etc.). Codes and indexes have been maintained for long in Oldsoft. They are now maintained in Neo. Codification is essential to mark out the way for PD participants who also need to know whether the information at hand has been duly approved. Observations are that participants maintain more or less complex on-paper visa systems that seem to reach some limits as illustrated by the following citation “I don’t care about visa, they are always provided too late and you’re never sure, I go and check my info with the PM” (test manager). Most PD participants do not trust codes and they always revert to the “tandem” to be sure that what they are working on is the “right”version. The “tandem” is still cardinal thanks to their different information repositories, their intimate knowledge of the underlying logics and their memory of the development process. If it were just for the coding aspects, Neo would have no consequences with regards to the qualification of information at Zeltron’s since the codification logics embedded in Neo are exactly the same as those that were embedded in Oldsoft. Change is introduced by four new statuses of product data in Neo electronic approval workflow. In this workflow, each product has five possible status which are preliminary, review, approved, release and obsolete. To pass from one status to another, intermediate electronic validation workflows, called “routes” are used which mobilize the persons in charge as set-up when the product code is created. What happens basically is that this is the “release” workflow that triggers the initiation of the two others. When the R&D PM wants the product to pass on under Operations’ responsibility, it means that the Operations manager has to approve the progression of the product from the Approved Status to the Release Status. Since R&D wants this to suffer no delay (it is committed to a plan) and since this progression can only take place if the two others have occurred, the PM validates (it’s an auto-validation) the progression from Preliminary to Review. He then has to make sure he obtains the validation of the other parties, ranging from marketing to operations, QSE and purchases, to go from Review to Approved. This clearly forces R&D to disclose as many information as needed by these parties and to check on their implication in the process as early and completely as possible as illustrated in the citation below.

“I just can’t allow for the purchase person to tell me that they can’t supply such and such component just because I put them in the loop too late on just this thing. If I do so, you bet they won’t approve that we go live. Problem is also with all this QSE stuff. They can also block the release of the product in the system just because we have not issued the qualification plans and the qualification reports. We are bound to do things right but hell, it

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13 Four progressions are possible in this « lifecycle » but we leave the fourth one aside as it takes place after the end of the PD process (when the product is not longer manufactured nor kept in the company inventories).
becomes always harder like with this qualification stuff. It’s really a pain for us. It takes so much time and fundamentally it’s not our job (a PM).

Submitting the transfer of responsibility (and therefore the start of manufacturing) to this progression from Approved to Release is one of the main change in terms of collaboration control practices. With these new collaborative patterns during the project, the constitution of the database is underway and it will soon be that Operations and other groups outside R&D no longer depend on R&D to have access to product information which will also represent a major evolution for collaboration at Zeltron. The organizational structure was also subject to a significant change when it was decided to create a dedicated product data management team – Doc Control. The product data management role is now associated to a dedicated group and collaboration is modified accordingly. R&D now has to attend to Doc control needs which are still basic (i.e. supply them with the final parts lists and final drawings). Information sharing between Operations and R&D now flows to a significant extent through Neo with progresses praised by the Operations manager. “With Neo and Doc Control, we finally have quality information in the system, you know. Doc control really checks the nomenclature, they are complete and they fit with the ERP format, that’s critical, with Newsoft coming soon. “This is far from perfect, especially because we could have much more info in Neo and we could have them sooner but let’s be patient, it’ll come”. “At the moment, what I see, is that we have much less surprises and disruption with all the mismatches between components, supplies and all…”

Eventually, only a few documents are uploaded in Neo among the documents that were supposed to be uploaded when the cPDM was implemented. This situation has kept going now for four years. Managerial attention to this issue seems very low and resources dedicated to overcoming this situation are rare. Neo project manager is isolated and seems to lack legitimacy and R&D manager is overtly opposed to the software (he rather invokes that as soon as he has an opportunity he will promote another solution or take over the cPDM project). It is interesting to see that despite this overall apparent work-around of the Neo technology, Operations invite themselves in a more balanced collaboration where their constraints are much more taken into account by R&D thanks to Neo. Initially analysed for its effects on the qualification of information and on its diffusion, we now see that Neo plays a role towards specifying which information is at stake between R&D and Operations and towards the effective elaboration and diffusion of such information (that is not necessarily an information that has to be uploaded in the system). The description that preceeds sheds some light on technologically supported control practices. A review of the structural influences at play is presented hereafter to set the basis for an analysis of the constitutive entanglement of all the above control practices and these structural influences.

Structures that are instantiated in control practices involving R&D and Operations

According to the interpretation of the concepts of structures and agency provided by Orlikowski (p 409, 2000), structures represent rules and resources that are repeatedly enacted by agents. In their control practices, participants would knowledgeably mobilize or reinterpret modalities of the structural realm and in doing so they would constitute and reconstitute the structural properties of their environment. In order to deepen our understanding of how the package of control practices operates, we move on to the identification of the modalities that

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14 Like parts list (nomenclature), tests reports, product specifications, marking specifications, security information, users’instructions….
is the main facilities\textsuperscript{15}, norms and interpretive schemes (Englund et Gerdin 2008, Orlikowski 2000) that PD participants draw on in their control practices. We then try to describe what type of TIP has emerged for R&D participants through Neo-related practices and to what extent it now sits among the modalities that they can draw on.

Collaboration between the two groups is influenced at first by the stage-gate model of the PD process, what people refer to as the « PAC » when in fact initially it is the name of the committee that approves stages progression (PAC actually means Product Approval Committee). The PAC and the PROC procedure are fused in people’s mind. This constitutes a template (Kamoche and Cunha, 2001) that embraces the temporal aspects of PD processes, the accountabilities, the informational objects that have to be exchanged. The PAC meeting also seems to be in people’s mind a kind of touchstone that they enact by developing other governance practices (project meetings, R&D weekly meetings, design reviews) that are anchored to it. On top of this generic template, PD participants collectively elaborate contextualised images of the ongoing projects (projects reports) and of the activity as a whole (gating map, the resources follow-up file, R&D income statement) that capture as many dimensions of these activities as possible. These images have certain but not all characteristics of a structural determinant when the repertoire of informational objects that help constitute these images and that are described in the PROC definitely represent one such structural facility. Participants also draw on a repertoire of labels that can be associated with these objects (project code, product code, validation status, version number). Participants acknowledge that despite their being Zeltron’s own PD process and own repertoires, they also correspond to typical PD process models. Young technicians tell us that it matches what they have just learnt at school and senior technicians say that it is now the state of the art and that norms as well as customers pressure through their audits have induced a certain convergence of Zeltron’s processes and repertoires with external norms conveyed through consultants, customers, audits and recruits. However, observed specificities (like Zeltron’s choice to monitor product costs based on their own definition of a direct cost) prove a certain degree of interpretation of these external norms. Spatial arrangements of PD activities also seem to influence participants collaborative behaviours. They know they can count on relatively low spatial and cultural distances since a majority of products are manufactured in France and Tunisia. For French projects, there is just one floor that separate R&D and Operations. For Tunisian projects, there is a minimal time lag and business trips are not too costly. Another fundamental influence is that relationships with Operations are marked by the existence within the R&D team of manufacturing experts. These are –generally senior – technicians and engineers that are mobilized by R&D on each project to work on interfaces with Operations (like the development of specific manufacturing tools). R&D participants openly state that they are big enough to take care of manufacturing issues upfront and that Operations have to trust them to deliver all what is needed by Operations. Operations should not poke their nose in R&D’s business. More generally, R&D sees Operations as their supplier whereas they see themselves as a key component of the firm’s value offer (institutional ads praise indeed Zeltron’s R&D capabilities) that is deemed to serve marketing and sales before any other group. In their actions and discourses, they demonstrate that data management is not within their mission. The yearly appraisal criteria and system (in practice, R&D managers appraise collaborative skills within R&D, not outside) is not at all supportive of collaboration with Operations. Overall, structures that underpin R&D’s actions towards Operations outline a relationship that is unbalanced. Operations appear to be dependant on R&D’s discretion to

\textsuperscript{15} The term facilities is used by Orlikowski rather than resources.
have access to information. Table 1 synthetizes the main modalities that PD participants draw on as described above.

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Norms and interpretative schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Main template: with the Product Development procedure (PROC) and the « PAC » stage-gate model of the product development process</td>
<td>1. Operations as a supplier of R&amp;D</td>
</tr>
<tr>
<td>2. Common repertoire of formal interfaces and tasks</td>
<td>2. R&amp;D serves Marketing interests (« our client ») and R&amp;D interests first</td>
</tr>
<tr>
<td>3. All the available accounts of Projects progresses: projects reports, COPIL reports and Design Control File</td>
<td>3. Operations information depends on PMs (at their discretion or upon consultation)</td>
</tr>
<tr>
<td>4. Available information repositories: Design control file and its mirror electronic directory; CAD files. Electronic files with no access at a distance (simple client-server technology and no web access)</td>
<td>4. R&amp;D has all the competencies to anticipate Operations’ needs</td>
</tr>
<tr>
<td>5. Technical competencies of PD participants</td>
<td>5. Data management is out of R&amp;D scope as well as qualification work (on the product, on the process)</td>
</tr>
<tr>
<td>6. Governance meetings as places of information sharing and as occasion for synchronizing project information</td>
<td>6. Main decisions are taken at the gates, formalization takes place at the gates</td>
</tr>
<tr>
<td>7. R&amp;D manufacturing experts</td>
<td>7. Individual collaboration capabilities are appraised at R&amp;D level</td>
</tr>
<tr>
<td>8. Spatial arrangements of the different groups (relative proximity)</td>
<td>8. Collegiality inside R&amp;D enable troubleshooting (including for what regards manufacturing problems)</td>
</tr>
<tr>
<td>9. Repertoire of categories, language, roles</td>
<td>9. R&amp;D as a key function and a core competence at Zeltron’s</td>
</tr>
<tr>
<td>10. Product codification system and rules in Oldsoft as well as documents codification rules</td>
<td>10. Accountability is transferred to Operations when PAC approves progression at gate 4</td>
</tr>
</tbody>
</table>

Table 1: Structures that are instantiated by R&D in control practices

The material and technological aspects of collaboration between the two groups contribute to this situation. PD participants have evolved from a room dedicated to two-dimensions products drawings storage to a storage of 3D-product drawings and data on local servers accessible upon PMs or CAD technician’s agreement. Storage of the same data now goes through both local servers and Neo. The description of practices associated with the cPDM provided in prior section show that Neo is enacted in practice in a very limited way. A more careful look at resources, norms and interpretive schemes associated with Neo (from R&D’s point of view, see table 2) enable us to see that the introduction of Neo in Zeltron’s PDA, thanks to how it is enacted by both sides reshuffles the cards of collaboration. The structure that R&D participants draw on can be characterized for the time being as a safe-conduct technology-in-practice. As was seen earlier, what is of interest for R&D is that Operations approve electronically the change in status from Approved to Release, that they give them a safe-conduct. They know that manufacturing cannot start without this change in status. Room for maneuver offered by the paper validation workflow no longer exists. To have the safe-conduct, they now know that they have to demonstrate an increased attention to Operations informational needs throughout the development process even if these information exchange do not go through Neo yet. The limited safe-conduct use of Neo should not foreshadow the
potentiality that is now in everyone’s mind of a comprehensive product information database. It is under construction and far from being complete but it is instilled in the modalities of action. Along with it can be found the increased possibilities of information retrieval that derives from the attribute dimension of the database. Thanks to internet, everyone knows that algorithms exceed human search capabilities. As described in the background information, the need for a dedicated data management function emerged from R&D uses of Neo. Now, Doc control stands out as a group that performs the data management function within the PD community, a role that R&D has never accepted to endorse. Within the safe-conduct technology-in-practice, Doc Control appears as a go-between resource. Overall, the enactment of the safe-conduct technology-in-practice corresponds to Operations being less dependent on R&D discretion as far as collaboration is concerned. It seems interesting to note that some evolutions of the structures that were regularly instanciated by R&D in their collaboration with Operations parallels the introduction of Neo and the safe-conduct TIP. Among these evolutions can be found increased spatial and cultural distances (new manufacturing sites in India and China) and the retirement of manufacturing experts in R&D (see the structures that have evolved underlined in table 1). These evolutions legitimate even more the idea of a database that would be accessible anywhere in the group. The enactment of increased distance and decreasing in-house manufacturing competences could be a foundation for an evolution in the type of technology-in-practice that is enacted by participants and renewed forms of collaboration.

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Norms and interpretative schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Neo (to replace Oldsoft for product code creation)</td>
<td>1. R&amp;D should not go further than product creation and upload of final drawings.</td>
</tr>
<tr>
<td>2. The Product Database under construction with many dimensions of information retrieval</td>
<td>2. Neo requires specific data management competences</td>
</tr>
<tr>
<td>3. The Lifecycle Electronic validation workflow, decreased room for manoeuvre</td>
<td>3. A database will never substitute PMs to get insight in product information</td>
</tr>
<tr>
<td>4. Persistence of all existing resources except Oldsoft</td>
<td>4. Neo does not address R&amp;D’s needs</td>
</tr>
<tr>
<td>5. Product information becomes accessible at a distance without the intermediation of PMs</td>
<td>5. Accountability is now transferred to Operations when Operations approve the Release status in Neo. This change in status is a like « a safe-conduct » for R&amp;D</td>
</tr>
<tr>
<td>6. The Doc Control team</td>
<td>6. If R&amp;D wants to get the safe-conduct, they have to provide Operations with all the information they need.</td>
</tr>
</tbody>
</table>

Table 2: Neo as a technology-in-practice for R&D participants

5 Discussions and conclusion

Based on the above findings, we are able to present our nascent reflections on how control operates within Zeltron’s PDA. This section comprise different dimensions that have been organized as follows. We first report on the structural elements that participants draw on in their control practices and as to the role of control practices in shaping these structural elements. The main idea is that control practices interoperate in as much as they contribute to shaping converging or complementary sets of modalities. Then, we put forth that Neo acts like an additional structural element, a technology-in-practice, that is constituted through its use by PD participants and that – along with other structural elements – influences patterns of collaboration between PD participants. Finally we discuss a vision of control practices as
enablers for the elaboration and the exchange of multiple types of accounts of product development.

Control practices role shaped by and shaping structures

Analyses of control or accounting at a practice level constitute a potentially fruitful way of taking management accounting research further (Whittington 2011, Ahrens and Chapman 2007a). Our contribution to this effort lays in the provision of a rich comprehensive description of control practices in PDA. Through this description, one can see that collaborative behaviours do not solely depend on impulses from formal control mechanisms (like the PAC meetings, budget reviews, the PROC development procedure or the status progression workflow in Neo) that PD participants engage in. They also depend on less formal practices in which PD participants engage that are coupled or not with the more formal mechanisms (like discussions prior to PAC meetings or lunch time talks on projects progresses or all the interactions led by PMs to ensure that information circulates)(Pitkänen and Lukka, 2011). It is also apparent that on top of their direct influence, the administrative, cultural and social control practices that have been investigated play an indirect role in fostering collaboration. The awareness of available resources that they create as well as the norms and interpretive schemes that they convey tend to be internalized by PD participants. It confirms that control practices for that matter are vehicles that act as an interface for spreading these norms and schemes (Alvesson and Kärreman 2004). As such they become part of participants’ wider set of references that is also made of participants “core” values as well as of the values of the group(s) they belong to (Carlsson-wall and al, 2011). It is noticeable in the latter respect that the current way of organizing activities at Zeltron – with organizing as a control practice - brings with it, for each participants, multiple ties to different groups and therefore multiple sets of references. The sometime-referred-to intertwinning of social controls, administrative controls and self-control (Carlsson-Wall and al, 2011, Dambrin, 2007, Robson, 1992) could reside in this evolving blend of structural elements that control practices contribute to forge. In carefully scrutinizing all the different types of control practices, it has been possible to identify relatively stable elements of language, of experience, values, hierarchies of loyalty, categories (like the relevant groups involved in projects, current composition of the PAC), resources (like the design control file, spatial distances between participants, Neo) that are generally mobilized at Zeltron. By generally, we mean that some of these structural elements are repeatedly mobilized in the control practices but we also mean that a certain degree of selection of these elements is also enforced by PD participants (like when a PM decide not to follow all the steps of the PROC because the project he is dealing with is a “small” project). This confirms that practices have the potential to reconstitute structures as well as bringing change within them through a process of selection, reinterpretation and hierarchization in the hands of agents (Englund and Gerdin 2011, 2008) like when participants decided to convene everymonth to make collegial decisions on projects progresses and it became the PAC. Looking at the relationship between some of the main control practices, we see that those who draw on the same modalities reinforce one another and also reinforce the modalities that are drawn on whereas practices that are grounded on norms that are not in the existing array of frequently mobilized modalities run the risk to never become routinized (like it was the case for the weekly COPIL meeting that implied that the R&D manager would endorse an increased degree of accountability on projects which was in contradiction with the generally accepted norm according to which project’s accountability resides in PMs’ hands which explains that it was eventually aborted). Our paper abides by the idea that oppositions exist among the available structural elements and confirms the existence of a kind of contest between these elements (Ahrens and Chapman, 2007b) especially with
elements emerging from new types of practices. R&D technology-in-practice for instance is a new structure within the social ordering of PDA. It is out there now and at the time being it is still conflicting with the routinely mobilized structures of R&D participants. It is also clear that it is conflicting with Doc Control technology-in-practice even if we have not described it.

In supporting all these ideas, it is contended that structures do not simply underpin practices (Van-der-Meer-Kooistra and Scapens, 2008) but it is also contended that a better understanding of the constitutive entanglements of structures and practices can help make progresses on management accounting change (Burns and Scapens, 2000) or the appropriation processes of new accounting mechanisms which are two subjects that should still be researched further.

*The role of technology for control practices*

Change is well represented at Zeltron by the introduction of the cPDM technology. As we could see, the cPDM seems at first to just bring with it a digitalization of product data management as opposed to paper flows or local electronic data storage. But it appears from our case study that the cPDM reaches further in terms of organizationnal consequences and that these consequences are not entailed in a deterministic way as was already shown (Decho and al, 2007, Robey and Boudreau, 1999, Orlikowski, 1992, ). Collaboration is just potentially enhanced by the cPDM. Informed by the structurationnist view of technologies as was put forth by Orlikowski (2000), we try to show that a technology’s outcomes depend on how it becomes repeatedly enacted by the different communities in the organization. It is important to note that even the strategies for circumventing or downplaying the technology are a way of enacting it. New and Zeltron-specific patterns of collaboration that come along with the technology are not the ideal patterns of collaboration put forth by cPDM editors but they participate in a structuration process. The degree of support to the development of collaborative behaviours therefore depends on these repeated enactments. Through the practices that involve the cPDM, several technologies-in-practice are constituted. They represent – depending on the groups involved – certain combinations of resources and norms (we illustrate what it represents for R&D participants only) that lead to effective changes (like the creation of a dedicated team) and the reinterpretation of pre-existing modalities of the social order (like from a Doc Control point of view: “R&D now depends on us to release their products”). The existing control practices seems to be put at stake by Neo and the TIPs it entails. Through these TIPs, we see the emergence of new norms and interpretive schemes as well as the revamping of resources brought about in the embedded process model of data management. More precisely, what is at stake here is the pivotal role of PMs on the four dimensions of information management and probably also the role of the design review and some social practices. With this focus on this compartment of collaboration within Zeltron’s PDA, we have been able to put together an interpretation of the role of technology for control practices. It would certainly be interesting to pursue this effort by reflecting on the other technologies-in-practice (for marketing, management etc.) as well as on the degree of alignment or opposition between the different modalities that are enacted (opposition being obvious here with an under-appropriation of the technology). Reconfiguration (Wagner and al, 2011) is underway and could be thought of through a deeper analysis and categorization of the wider set of structural elements especially the material ones that were just seen here through the concept of facilities. We observe that even in studies that refer to the material dimension of the technology it is often the case with accounting logics that unfortunately remain the focal point (Wagner and al, 2011).

16 With work-in-progress project information as well as final project information constantly available through the platform with pre-defined non discretionnary accesses configured in the system.
Control practices to produce images and accounts of project progresses

When they engage in control practices, PD participants actively seek to specify the type of information that has to be shared (the main example is the PROC) or the criteria for identifying relevant information. They become knowledgeable of these criteria because they engage in practices conveying the different types of accountability (customer accountability with product specifications, time accountability with planning, cost accountability with target costs and project budget). In enacting the corresponding systems in practice, they enable the constitution and the update of references against which they can appraise uncertainties. Control practices are also orientated towards the formalization of a growing part of this information. Explicit knowledge of project progresses seems to become the norm. It is easier to share it at a distance and it is relatively stable (Dambrin, 2007). It triggers both informal and formal exchanges (Pitkänen and Lukka, 2011). Collaboration depends on an information that is qualified. On this aspect, Zeltron’s control practices are at a crossroad. With growing distances, paper systems (like the Design Control file), paper validation workflow and direct consultation of PMs reach their limits. With growing project complexity (product variants, local norms), the « tandem » also reaches its limits. It just cannot maintain product codes and links between product codes and components’ codes and would spend too much time getting proper formal validation from all the parties involved. Eventually, through Zetron specific control practices, what participants do is that they contribute to the diffusion of project information. These four dimensions of the information processing role (Galbraith, 1974) of control practices (allowing the specification, the formalization, the qualification and the diffusion of project information) are essential in product development process. It has indeed been shown that synchronization and stabilisation of projects information is needed (Brown and Eisenhardt, 1997) at intervals. It is as if control practices would target at constituting images or accounts of project progresses that integrate as much as possible the multiple dimensions of the project, its heteromogeneity (Quattrone and Hopper, 2006) so that participants can ground their decisions. It corresponds to a process of accounting at the gates that scaffolds with references the looser accounting that is done during the stages of the projects (Jörgensen and Messner, 2010). The blend of control practices that supports the production of these accounts as was shown depends on how PD participants collectively and individually mobilize structural properties of their environment.

In this paper, we have attempted to provide additional insights into how control operate by looking at control practices in a context of product development processes. We could see the extent to which the package of control practices is guided by a specific and evolving blend of structural elements that participants hierarchize and (re)interpret constantly especially when a technology is implemented. In an age of digitalization, we saw that control is about crafting shared multidimensional accounts of activities underway.
### Appendix

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*Figure 1: the different modes of data collection*


