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Sociomaterial regulation in organizations: The case of information technology

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Abstract

Information technology (IT) is used to regulate organizational processes both to allow and to prevent specific behaviour. Recent scandals in the financial industry exposed overconfidence in IT based regulation and, as scholars of regulation have long known, the games people play increase with the number of rules in place. To explore the practices in organizations with a broad perspective we define sociomaterial regulation as the relationships between the rules, the IT artifacts, and the practices. A new theoretical terminology around the three relationships (materialization of rules in IT artifacts, interdependency between IT artifacts and practices, and coupling in time between rules and practices) helps to explore a large case study of the implementation of an e-learning system in a French university over a five years period. The study reveals five modalities of sociomaterial regulation which can be understood using the three relationships: functionality-, tool-, role-, procedure-, and social process-orientation play out very differently for the organization in terms of the change in practices, the sources of control (hierarchical versus emergent), and innovation activity. We discuss implications for management and policy.

Keywords: Information Technology; rules; regulation; practices; sociomaterial regulation; sociomaterial coupling.

1. Introduction

In summer 2007, Jérôme Kerviel, a trader in a large French bank Société Générale (SG), was fired. He was accused of exposing SG to a significant financial risk resulting in a €5 billion loss. Jérôme managed to conceal his excessive trading positions through clever violations and smart (mis)use of SG's control procedures most of which were Information Technology (IT) basedⁱ. Though the trading system imposed a maximum ceiling at €125 million for tradesⁱⁱ, Kerviel succeeded to leverage new positions in the order of €600 million. At the same time he concealed his real positions by 'transferring' them to his computer from which he either erased them or maintained them as fake positions. This involved a series of violations to trading regulations: theft of user names and passwords, faking of e-mails, engaging in inverse operations, among others. By doing so Kerviel "created" his own (more or less shared with his colleagues) 'regulated' world of high risk-bearing operations and demonstrated how control systems could be misused beyond their intended designs. In fall 2011 we learned that the SG case is not an isolated phenomenon: similar IT-based trading systems had also been circumvented by a UBS trader faced now €1.5 billion lossⁱⁱⁱ.

The SG and related cases illustrate a peculiar and a new important relationship between materiality and traditional rule based regulation. Had a single man deprived of €5 billion from the bank in the beginning of the 20th century, it would have featured quite alternative forms of materiality such as guns, an explosive combination of vaults and dynamite, and a truckload of cash. After the introduction of IT-based control systems in banks and digitizing money to bits the material and the social elements and their interactions relevant to the story have become increasingly complex. The ultimate idol of materiality – money – has lost its true materiality and become virtual numbers blinking on a trader's screen. The power of the material to protect the wealth – the steel-and-concrete walls of a vault – has been transformed

into millions lines of code with embedded rules of authorization, access and controls to allocate money. During this transformation the “gangster” robbing the bank on a gun point has been transmogrified into a handsome gentleman in an Armani suit-and-tie- whose (accepted) social role is to make the bank richer.

The reason why SG and UBS stories are so interesting is the lesson they teach about regulation and its new sociomaterial foundations. In the world where money at hand is a sum of daily transactions displayed on a computer screen, and the vault’s walls are now a combination of access and authorization passwords, screen interfaces and software-inscribed trading limits, a new understanding of the relationship between social and material is needed in how regulation works and is related to its material foundation. Instantiating material constraints into IT do not always result in the desired social compliance. Adding more rules, constraints and controls *inside* the IT system will not automatically be as effective in shaping practices as making presence of powerful materials including concrete walls and armed guards felt. In addition, students of regulation have known for some time that as more rules are introduced, the more games actors can play and the more unexpected outcomes will result (Crozier and Friedberg 1977).

Despite the pervasive presence and richness of IT based regulation, there is a paucity of studies of IT use *as a form of materially based organizational regulation*. On one hand, organizational studies on regulation remain primarily footed in the idea of *pure social regulation* and largely ignore its underlying material elements- in particular the growing presence and role of IT (Latour 1994, 2005). The bulk of management and organization studies view the relationship between the rule-making and the rule following through a pure social lens (Latour 1994 2005; Denis 2007). Jackson and Adam’s (1979) investigation of rule life cycles in organizations, Jabs’ (2005) work on communicative rules involved in launching of the space shuttle Challenger, or Oberfield’s (2010) study on rule following within a

government organization are illustrative of this approach. On the other hand, IT based regulation remains a significant research challenge for students of IS and organization theory. A few studies available focus on the material dimension of organizational regulations founded on true material elements of control such as walls, police, or asylums (Hook, 2001; Latour2005). Whenever IT is introduced as material element of social life (Orlikowski and Scott 2008, Orlikowski 2008, Leonardi 2011) there is some recognition of rules and their entanglement in IT artifacts as scripts (Orlikowski 2005) but how these scripts emerge or how they influence regulation remains clouded. In contrast, the epicenter of these discussions focuses on the constraining features of the material artifacts and agent's genius to overcome these by appropriating material features for her purposes often in ways that harbor conflict or include illegitimate behaviour (Markus and Silver 2008, Barley and Leonardi 2008).

To understand how organizational rules underlying regulation, material artifacts (in particular information technologies) and practices interact, our interest here in is to explore how uses of IT based artifacts enable and support the regulation of various practices. We adopt a sociomaterial lens in that we take the intertwining of social and material seriously in enabling and modifying regulatory processes. In this context, we denote *IT based regulation* those sociomaterial regulatory processes, which create, combine and embed rules within IT artifacts and by doing so maintain and enforce rules that govern the organizational use of those IT artifacts and their effects. By exploring how the sociomaterial couplings of IT artifacts, rules and practices sustain organizational regulation we address the following two questions:

- 1) *How to describe IT-based sociomaterial regulations in organizations?* We posit that the extant IS literature does not offer a systematic vocabulary and conceptual tools to make sense of IT based sociomaterial regulation.

2) *What are the possible relationships between rules, IT artifacts and practices in organizations?* Through empirically tracing the links between rules, artifacts and practices during the implementation of a large e-learning system by analyzing the changing source of regulation and the coupling in time between IT embedded rules and practices we formulate inductively a taxonomy of modalities of IT based sociomaterial regulation. The study also identifies the presence of temporal conflicts in rules and their implementation which affect the overall dynamics of regulation. We posit that regulation evolves through tense and reflexive engagements where organizational participants re-negotiate and re-design the links between rules, practices and IT artifacts.

The remainder of the paper is organized as follows. First, we review the literature on rules, organizational regulation and related sociomaterial practices in order to develop a terminology and framework of sociomaterial regulation. Then, we report on the case study and theorize the dynamic relationships between IT artifacts, rules and practices by applying the framework to understand patterns in the case. We conclude by discussing theoretical and practical implications of our findings, by noting limitations, and by identifying vistas for future research.

2. Sociomaterial regulation in organizations

We discuss the origin of rules in organizations and describe conceptual dimensions to make sense of sociomaterial regulation in organizations as defined as the relationships between, rule, IT artifact, and practice.

2.1 Rules and rule based regulation

Since Max Weber's conceptualization of organizations as rational rule systems – i.e., bureaucracies – *regulation as a form of rule-making and following has been the prima donna*

of classic organization theory (Weber 1968, Merton 1957, Crozier 1964, Crozier and Friedberg 1977, Cyert and March 1999, Beck and Kieser 2003). Indeed, “scholars have long argued that rules as well as rule-following behaviors are key features of modern organizations” (Sullivan 2010,p. 433). However, to understand why rule making and rule following are so central to organizational regulation we need to first examine the nature of rules and their following.

Rules are not mere factual descriptions of behaviors, but state *what ought* or *ought not to happen* given a set of conditions (von Wright 1963). Rules are therefore not to be mixed with empirical regularities (facts) in that all observed social regularities are not determined by rules. Consequently, factual observations cannot refute the rules as they will refute generalized facts (Bach and Harnish 1979). We can detect rules underlying social regularities by searching for accounts why people behaved given the situation in a certain way (von Wright 1963). Hence rules are expressed in descriptions like: “if we face situation Y then we are expected to do Z” (Twining and Myers 1983). Rules thereby refer to and establish mutual beliefs of both conditions and behaviors (Wittgenstein 1958) through controlling, guiding and/or defining (Mills & Murgatroyd 1991), which determine how a group, organization or society are expected to behave. Rules are anticipatory (but not similar to predictions!) in that they cover new cases and define ‘stable’ future conduct (Bach and Harnisch 1979). By conveying such deontic recipes rules create a common ground that permits predictability within social interactions and constitute the foundation to build repeatable, low variation, and shareable “concrete action systems” (Crozier and Friedberg 1977).

Though in many settings rules exist without being written down, they are often written down and ‘materialized’. This enables their systematization, convergence, and distribution over time and space. When written down, the rule sentences must include distinct components that clarify the scope and use of the rule and justifies its use. The components include: 1) the

character (is the rule expressing a permission / prohibition / guidance or else), 2) the subject (who should conform to it), 3) the condition (the circumstances under which the rule is applicable), 4) the content (the sort of behavior to which the rule applies), and 5) their authority (who has the status to promulgate the rule) (Von Wright 1963). As these five components specify critical parameters that will reduce variation in organizational behaviors written rule systems have become a pivotal element of modern regulation (Weber 1968, Merton 1957, Crozier 1964, Crozier and Friedberg, 1977, Cyert and March 1999, Beck and Kieser 2003).

Rules can originate from various sources (Reynaud, 1988). Typically the rule making is *endogenous* to the very group which will follow the rule, or *exogenous* whereby rules are promulgated by external sources or authorities to the group which must then follow the rule. We call the former *emergent* control and the latter *hierarchical* organizational control. Clegg, for example, (1981) emphasizes the tight connection between exogenous rules and hierarchical control, while Reynaud's theory emphasizes dynamic shifts between forms of control depending on how the source of rule making changes over time.

Because of the rule's anticipatory and inter-subjective nature the rule following that comes after rule-making - either endogenous or exogenous- is not mechanistic and automatic. It is a process of structuration- recursive and embedded in practical consciousness (Crozier and Friedberg 1977: Giddens 1984). Agency makes rule making and following possible, but it also makes rule violation and change possible. As Mills (2003, p. 194) notes, actors engage not only in establishing, enacting, or enforcing, but also in misunderstanding, and/or resisting rules. An organization's *modus operandi* as a regulatory system is thus more akin to an open system with emergent features than to a deterministic, closed, mechanism of a Swiss watch. Consequently variations and shifts in, rule-making and following often become a boiling pot, an opening in an organizational arena in which tensions between power, structure and agency

are played and rewritten. If and when IT becomes part of this game as a powerful means to enforce or enable rule following it cannot avoid such tensions. How this happens will be examined next.

2.2 Materialization of rules in IT artifacts

Regulation can now be defined more accurately as the *rule-making, maintenance, following and enforcement practices achieved in and by an organization* (Hage & Aiken 1969, Leblebici & Salancik 1982, Suddaby et al. 2007;Reynaud 1981, 1997). For example, the SG's trading systems and administrative processes were designed to decrease variation by guiding and constraining trader's behaviors through enforcing 'trading' rules hierarchically agreed upon and promulgated by SG's management. But how was this enforcement achieved? It does not just rely on an assumption that somehow magically trader's mutual beliefs will be aligned resulting in benign following of the SG's written code-books and other rules. This is a too weak protection against the whims of the trader's agency. In contrast, the enforcement has to be accomplished by relying on specific material features that are designed and embedded in trading systems, which maintain and enforce the rules now expressed as dedicated behavioral scripts which the traders must to enact during their trading business (and thereby follow the rules). These embedded material scripts define e.g. who has access to specific resources- for example to create positions - and what one can do or not do with those resources- for example, by imposing trading limits; the features also covered scripts that defined monitoring processes which tracked to what extent traders comply to trading rules established by management by e.g. reporting traders' positions and trades. Such systems can be implemented by specific socio-technical designs including ways to track down trades, logging them and distributing control in the organizational system with controls. This sociomaterial foundation of regulation will be the focus of this section.

From a sociomaterial perspective organizational regulation is a situation where social elements (rules) and material elements (constraints as rule expressions) meet *practice* as to decrease the variation in actors's behaviors. Basically, both rule-setting and the rule-following take place in the presence of some *resources*, which constitute "media through which power is exercised" (Giddens 1984, p.16). At the backdrop looms a wider variety of alternatives how such resources can be configured with regard to any rule set (Giddens 1984). Regulation is thus by definition always *sociomaterial* in the sense that the practices of regulation integrate social and material aspects and these two go always together either in parallel or sequentially. IT as a material element pervades all walks of organizational life it has offered unprecedented capabilities to implement and enforce various inscriptions and thereby to penetrate and relay social structures and behaviors (Mutch 2010; Orlikowski and Iacono, 2001). The benefit of IT is that it is also extremely flexible in its features that can amplify the range and forms of organizational regulation. Indeed, IT offers a myriad of ways of relating its material agency with social agency associated with rule making and following: it can record and maintain large numbers of complex rules and permits myriads of rule combinations to be applied to different situations; it can track and record events triggered for and by rule following; it can infer new facts and conclusions of the ways in which rule following unfolds as to determine whether new rules will be needed or new rules to apply; it can be also used to create and apply meta-rules i.e. which rules to apply and when to change them. Finally, the cost (effort) of changing and enforcing rules across organization as a response to new contingencies is relatively low rendering adjustments to IT based regulation almost real time and reducing related inertia and cost. The presence of these powers is easily vindicated by examining the complex maze of IT based rules and their enforcement in any large organizations. Such IT based features now generate complex, penetrating and pervasive regulatory processes, which are difficult to understand and manage with or without IT.

Thereby they also create an illusory confidence in the omnipotent power of IT based regulation thereby creating a space for unpleasant surprises as experienced by SG's and UBS' management.

2.3 Coupling in time between rules and practices

Another aspect in studying material foundation of regulation is its temporality (Alter 1985, 2000). Regulatory processes enabled by artifacts will often share a temporal asynchrony with the intended organizational regulations- i.e. the rules are not temporally valid for the given situation¹. Siding with critics of organizational conflict as a static phenomenon (March 1981; Sztompka 1991) Alter (2000) introduces therefore the concept of 'dyschrony' (from the Greek *δυσ* "difficulty" or "lack" of synchrony): organizational rules "do not submit easily to the will of transformation of actors. Rules only imperfectly settle managerial problems raised by dynamic contingencies – often they have a life of their own. One reason for this is that they fail to obey the same action rhythm." In other words, the attention on coupling in time problematizes the relationship between rule and practice.

Due to dyschrony: 1) "All elements in organizations do not transform at the same rhythm. Some retain rules while others do not [i.e. rules applied to a given artifact can be forgotten]; and 2) all rules do not necessarily contribute to organizational coherency. Some *may* follow an independent logic and do not settle anything [i.e. even if acknowledged as such, rules, because of their multiplicity in organizations, are heterogenous and potentially conflicting] ” (Alter 2003, p.506). A simple example here would be drivers' attitude towards a speed bump on the road. Some would take it as an expression of a statutory mandate to lower speed.

¹ This is nothing new. Sociologists have for some time remarked the possibility of decoupling rules, artifacts and practices in time. For example, Simmel (1917) emphasized the temporal autonomy of rules with regard to action.

Others view it simply as an obstacle to be reckoned with. Yet, others will just try to bypass or drive over it and take their chances. Viewing such flexible couplings between rules and actions allows scholars to focus on the dynamics of sociomaterial regulation.

Because of this flexibility the regulation embodied in the artifact (e.g. in the form of a speed bump) may be not perceived *anymore* as regulation, when the initial authority and intention disappears and rules associated with their material expression are not known anymore. In such cases, one can speak of a “misfit” within concrete situations between present sociomaterial constraints and underlying rules. What once was intended to be hierarchical control (a speed bump mandating lower speed) implementing a socially recognized rule (thou shall not increase speed x in a specific situation) is not (anymore) perceived as such. The rule is not anymore reproduced and reinforced through agency. Complying with the constraint is not anymore a rule-following pattern, which will structure behaviors beyond the encounter of the speed-bump (i.e. the speed-bump constrain me but also reminds me the rule for future behaviors). Thus, timing matters for the encounter with the material constraint embedding a rule. Because of this an artifact^{iv}, such as IT may regulate by itself, when e.g., the meaning of rules behind it are ‘forgotten’ whereby the artifact becomes simply a constraint (Alter 2003). Therefore, the materiality of the artifact (its capability to constrain or enable social action) and its possible temporal coupling with the underlying rule and its justification needs to be one critical element of theorization of IT enabled regulation. In this regard Alter’s concept of “dyschrony” extends analyses of regulation to better accommodate its sociomaterial dynamic features. Both social and material features of regulation within an organization can be dyschronic- i.e. not temporally synchronized with each other, opening a second, temporal dimension for the sociomaterial analysis of regulation.

2.4 Interdependence between IT artifacts and practices

The IT artifacts and organizational practices are linked through material as well as social agency and their interplay, which Leonardi (2011; 2012) calls imbrication. On the one hand, practice makes use of IT artifacts in a myriad of ways during everyday life in the organization. This social agency defines the use of the IT artifact as it makes meaning of the features and affordances of the IT artifact for a specific purpose. This social agency is what is commonly thought of as (human) agency. On the other hand, the IT artifact allows for specific uses and constrains the practice in certain ways, forcing users to adopt specific ways of coping or changing their practices. This form of material agency is frequently overlooked but characterizes organizational life and is well documented (Pickering, 1995; Orlikowski, 2000; Suchman, 2006). Agency appears as a pivot of our model because it is a locus of a social foundation of regulations as the two forms of agency create interdependencies between practices and IT artifacts.

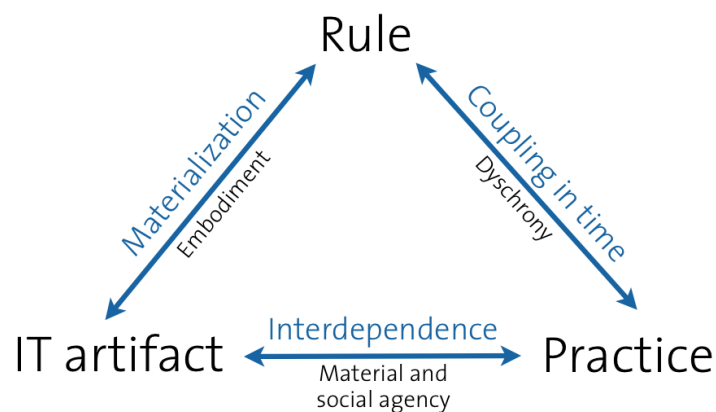


Figure 1: Relationships between rule, IT artifact, and practice and their possible expressions

Figure 1 summarizes the three relationships and their most common expressions in organizations. The following example illustrates our terminology in sociomaterial regulation. Take the organization of public transportation. A law requires part of the public costs to be recovered by ticket sales and the ticket to be the entitlement for transportation. As of the first relationship, the rule that every passenger needs a ticket is materialized in tickets, issuing and

validation machines, as well as the occasional control by conductors. The threat of legal prosecution and fines is likely to induce passengers to buy tickets while some passengers continue to ride illegally with the risk of getting caught. Depending on the type or predictability of controls and the level of fines the practice of fare evasion may increase or decrease, putting the practice out of synch with the rule, which represents the second relationship. Thirdly, passengers choose to buy tickets and the material presence of gates, validation machines, and conductors further encourage ticket purchasing, that is a certain type of practice. It is important to note that agency can be attributed to both the passenger and the material setup of tickets and machines. To understand the scope of sociomaterial regulation, consider the introduction of electronic tickets that can be displayed on mobile devices rather than printed on paper or validated through near field communication. Purchasing behaviour changes, possibly being automated, validation machines and gates need to be updated, and electronic rule enforcement may render the conductor's job obsolete. The triad of relationships displayed in figure 1 mobilizes a terminology to address and explore multiple issues surrounding sociomaterial regulation and we next introduce a case study to refine the theory of sociomaterial regulation.

3. Research Design

Our research design is inductive, grounded in a case study, and incorporating the technology (Glaser and Strauss, 1967; Walsham, 1993). Based on the theoretical perspective outlined above we explore the nature and dynamics of sociomaterial regulation in a large multi-stakeholder IT system – an e-learning system adopted in a major French university. While building our narrative, we seek to identify events, which affect and/or are affected by organizational regulation, and which shift the grip of hierarchical control to emergent control, or vice versa. We strive to understand how the regulatory practices unfold, in particular, how

the rules emerge, are perceived and invested; how these processes relate to changes in the IT system use, and where in the end dyschronies emerge.

3.1 Study site

The study took place between 2002 and 2007 in a large French university. We chose this setting for three reasons. First, a university is a bureaucratic environment, i.e., a setting in which rules and regulations are visible and formal. Second, during the study phase, the university was undergoing a major organizational change (the deployment of new study programs), which was likely to bring about major changes in regulations. This involved the plan to re-frame all degrees to comply with the Bologna Process, which aims to create Pan-European university degree standards. Finally, the university was implementing new IT systems, including an e-learning system. We focus, in particular, on the regulatory process involved in using an e-learning environment called “Virtual Office” (‘the VO’) at the university’s Management department^v. The VO was an open source package designed to manage course content and student registrations. The adoption of the system was motivated by the need to improve educational effectiveness and to increase the faculty ‘visibility’ and ‘accessibility’. Another reason was increased mimetic pressure, as competitors had already adopted such technologies.

The VO software was intended to supplement co-located education by offering a personalized and virtual “learning environment”. The system included several capabilities like: personalized lists of registered courses; a shared study plan; discussion forums; automatic reviews and corrections of exercises, indexing for PowerPoint or Word files and so on. The system was expected to significantly influence learning and teaching among faculty, students and administrative staff. The implementation was mandated by a committee at the university level called “ICTT” (“Information, Communication, and Teaching Technologies”).

The committee comprised VO delegates from each faculty. Three categories of staff were involved: 1) IT technicians, 2) administrators (teachers in charge of the content of a site devoted to their teachings), and 3) super administrators. Super administrators could access and modify all sites within their department.

3.2 Data Collection

Multiple genres of data were collected for triangulation. A first data set was a log of e-mails sent by all system stakeholders (i.e., students, administrative staff and teachers). The e-mails were received by one of the authors who acted as a VO delegate of his department from 2004 to 2007. The e-mails dealt with the introduction of the e-learning system and the inauguration of educational regulations. In total, 2000 e-mails were extracted and 1,200 were selected for analysis. 800 e-mails appeared as incomplete or too short for being the subject to coding. The analysis helped locate major events in the VO appropriation process and regulation.

This corpus of e-mail complemented observational diary notes from the participating author. Participating and reflexive observations (through direct and ex post discussions with co-authors) were at the core of the study (Yanow, 1995). The diary was used to identify critical events. Additional participant observation gave access to actors' motivations, beliefs and shifting interpretations. To establish "multiple perspectives" (Pentland 1999; Rimmon-Kenan 1983), the e-mails and diary were complemented with five semi-structured interviews (average duration: 1 hour) with key personnel, including developers (1), IT managers of the university (2), and members of the management department (2). Finally, we also collected documents from internal sources including memos, minutes of the department meetings, managerial directives, internal correspondence, and external sources including leaflets, websites of the faculties, departments or university, press releases, etc. from late 2002 to early 2007. Overall, the use of observations, interviews and document analysis (in particular

emails and log-in files of the VO system) allowed us to gain distance, to triangulate data, and to identify and describe the key events that shaped the evolution of the system.

3.3 Data Analysis

We systematically analyzed two materials: e-mails sent by the various stakeholders to the IT projects (more precisely, a sample of 2000 emails), and the diary containing everyday observations by the participant co-author.

The e-mail corpus was analyzed by searching for categories and sub-categories using through the Sphinx Lexica™ software to build a thematic dictionary of interpretations, discourses and behaviors related to IT regulation (Bardin 1998; Weber 1990). Appendix A.1 presents final thematic dictionary. We carried a two-level analysis: a meta-coding and a coding. The meta-coding aimed to identify the general purpose of each message and the profile of the sender. The coding focused on the content of individual e-mails, and the meaning of each segment of text. By counting the meta-codes for each year we sought to identify trends in IT artifact interaction (see appendix A.1). Among the meta-codes we used, EXCH-RULES tagged all emails containing discussions of rules and procedures relating to the VO system. The bulk of these emails illustrated instances of *hierarchical control where implemented*. Instances of *emergent control* were mostly found in the various *bricolages* mentioned in e-mails (tagged with such meta-codes as EXCH-USE or EXCH-MAN). By tallying the codes for each year, we were able to trace the dynamics of the VO use and associated changes in regulatory practices^{vi}. The descriptive base-line provided a foundation for interpreting the nature and dynamics of regulations.

The diary was analyzed by means of a simple descriptive coding, a set of codes used to identify observations likely to be interesting for the research. A first code thus focused on a descriptions dealing with the project and its history [PROJ-HIST]. A second code focused on

the description of problems and solutions met by IT managers and VO delegates in the post-implementation phase [PB-SOL]. A third code covered all descriptions about the social and political context of the technology and its use [SOC-CONT]. And a last code helped to identify all practices and discourses related to rules and attempts to regulate interactions through or in the technology.

Interviews were not recorded but were the object of a systematic summary. The aim of the interviews was to establish the history of the system, the IT organization, IS/IT strategy, training, and communication between key stakeholders. All interviews were conducted during the early phases of the project.

All the materials and their treatment were condensed and organized by means of broad chronological matrices (Miles and Huberman, 2002). Covering the main features of sociomaterial regulations, the presence of conflict or dyschronies in sociomaterial regulation and most of all, critical events related to technology design and use, they helped us to describe the broad sociomaterial dynamic of organization in the case. More finely, they also helped us to question and discuss the modalities of IT, rules, practices entanglement for each phase.

In particular at the stage of the chronological matrix elaboration, data analysis involved a reconciliation and plausibility analysis of emerging interpretations. Here, the co-authors challenged proposed accounts and interpretations “by asking questions and suggesting alternative explanations” (Vaast and Levina 2006, p.191). These interactions helped address the classic challenge of an intense field study: the need to be detached from the organizational setting.

4. Findings

4.1 Case narrative

Based on the analysis the VO implementation could be divided into five phases (from 2002 to 2007) where each phase was characterized by a significant change in VO's use and associated form of regulation (**Error! Reference source not found.**). The third row in Table 1 identifies conflicts and dyschronies in sociomaterial regulation as they appeared in the case and that informed our theorizing.

<i>Phase</i>	<i>I</i> (<i>Early 2002- November 2003</i>)	<i>II</i> (<i>September 2003-November 2004</i>)	<i>III</i> (<i>November 2004- December 2005</i>)	<i>IV</i> (<i>January 2006- March 2006</i>)	<i>V</i> (<i>April 2006- September 2007</i>)
<i>Presence of rules</i>	From the medicine faculty to the economics and management faculty: a discrete implementation. Hierarchical control (the presidency) puts forward a new way of teaching.	Let's make it work! Emergent control dominates in practice. Students and teachers improvise with technology.	The VO becomes an everyday tool. Emergent control is more and more explicit. Local adaptations are reflexive and fed by each other. No real top-down control present.	The clash: a conflict between two emergent rules; clash between emergent and top-down control.	Towards a controlled VO. A top-down control is taking the lead.
<i>Presence of conflict</i>	No.	Some conflict due to incoherent sources of control among faculty.	Incoherent sources of control lead to coordination problems, conflict across departments, and first instances of reinforced hierarchical control.	Escalating conflict between regulations. "Competition between two procedures", i.e. procedures clash.	Decreasing conflict and dyschronies.
<i>Critical events</i>	Implementation of the VO.	First usage by students and teachers.	Rules are discussed among teachers of the management department.	Conflict about the recruitment of students to management administrative staff.	First official decisions about VO uses and VO strategy.

Table 1: Implementation phases of the virtual office (VO)

We next discuss the state of regulation and its evolution within each phase. In particular, we review how forms of emergent and hierarchical control oscillated due the way in which IT artifacts, rules and practices were coupled differently during each phase. We also analyze how forms of control were synchronized over time.

Phase I (early 2002-November 2003): Initial implementation in a regulatory vacuum

The implementation of the VO system began with the decision to launch the system by the head of the Economics and Management faculty. The decision was inspired by the quick uptake of the system at the university's Medicine faculty in 2002^{vii} and by the dean's fear of 'missing the boat'. There was no desire to regulate anything related to teaching or learning through the VO. After a very short development phase, the system was installed in fall 2002. But it was only after a presentation of the system to faculty members in May 2003 that the dean decided to offer the tool also to students. At the same time, the ICTT committee was tasked to manage the project. Shortly after this dozen sites were launched in September 2003: one administrative portal and eleven teaching-oriented sites.

Phase II (September 2003-November 2004): Emergent control and the infringement of unknown rules

After September 2003, the software's take-up was slow. Faculty made mistakes during registration and the list of students included in the course-rosters was never accurate. As a result, many students did not find their log-in information. Furthermore, some teachers did not adopt the new system, because of lack of motivation. Initially, the VO remained unknown and unused and the number of students using the software was low (around 10% in late 2003 according to the login-file of the VO).

From January 2004 onwards log-ins and system use sky-rocketed. For all administrative sites, the number of log-ins increased to 30-40 a day and the administrative site alone accounted for half of the online activity. Faculty increasingly promoted the use of VO. The usage of VO involved mostly basic functionality like distribution of documents, registering useful hyperlinks, or distribution of course presentations. Nonetheless, the tool gradually gained

new supporters among the faculty. The ICTT committee members were promoting the tool in their own courses. Their idea was to foster students' interest in using the VO through teasers such as illustrations of funny discussions on the VO forums.

The students' feedback was also positive. In fact, the number of registered users was not a true representation of the real number of users. Students frequently shared the same password and log-in. On the whole, students appreciated having online information concerning schedules, grades, addresses, internal rules, etc. The discussion forums received also a growing number of contributions. On the whole, the VO had soon become a means for students to achieve increased autonomy in conducting their studies, which offered a real benefit also for most of the faculty. Students were expected to learn more independently and inform themselves more about teaching programs.^{viii} The development of an administrative portal relieved part of the isolation students had felt previously.

Administrative staff was also satisfied, as the system made their job easier. Students called less frequently to ask simple questions concerning schedule changes etc. Multiple administrative innovations also took place. Increasingly the system became an administrative tool, a research support environment, and an environment offering courses by the Management department. An e-mail received by VO delegates^{ix} illustrates the new central role acquired by the system: "*My best wishes for 2004. I cannot connect to the VO. Can you help me?*" Thematic analysis of the corpus of emails reveals the absence of hierarchical control, or rather, its enactment by VO users.

The emergence of local control can be traced to the intense and loose interactions among several technical administrators of VO who controlled the access rights to the system. In fact, new administrator accounts were created to help the existing super-user to interact with students despite the official (but relatively unknown or unacknowledged) rule that "*there*

must be only one administrator per department. It is possible to give her the login and password of the superadmin” (February 2004). This emergent regulation stemmed from the absence of identified rules to regulate the status of super-users who had full and free access to all functionalities of the VO. As a result several people gained this status among faculty and students. This freedom fostered improvisation and new ways of using the system.

Other forms of emergent regulation stemmed from the improvisation. While the status of administrator was reserved for teachers, the system itself did not prevent the possibility of assigning to a student or a group of students the role of administrator. For some teachers, this functionality afforded a convenient work-around as they did not have the time or the competence to maintain their course sites. In one case, students asked for super-administrator privileges, because their program director asked them to do a group project on the VO and its management. Such an assignment contradicted an existing formal rule (unacknowledged at this stage).

An important aspect of the form of regulation during 2004 was the emergence of new roles to support the user-IT artifact interactions. Who is in charge of what? What is the role of technical administrator? What is the role of the VO delegates? Technical management had to be established to replace the former administrative tasks of managing courses. It took time before the role assignments became well defined and more uniform. In fact, even VO delegates provided conflicting answers of their role, sustaining an unstable emergent regulation. This is an example of temporal decoupling. At this stage, the lack of means to evaluate and clarify different forms of control was obvious. The department had no appropriate forums to discuss when forms of bottom-up regulation would be appropriate or how to balance the emergent and an absent hierarchical control. The ICTT committee was only moderately involved in the VO management as VO delegates did not participate in its meetings; the dean did not integrate the VO into his management practice.

Phase III (November 2004-December 2005): The VO becomes a common platform regulated by hierarchical control

As of late 2004, the system had become an essential part of everyday life of the department and represented an institutionalized form of regulating studies. Usage of the tools continued to grow. The system grew from ten sites in December 2003 to 65 in late June 2004. The first engagement of the upper management took place. The head of the department signaled a strong commitment to the use of the system by participating in forums that discussed new course features. The administrative officer, the dean of the faculty and even the president's office of the university began to be involved in using the system. Delegates – the members of the IT committee – received their first premium at the end of year 2004 for their work as a “delegate.”^x Finally, a “permanent work group” was established responsible for regulating VO and e-learning.

The students' course evaluations were amended to include a section on the quality of the VO sites maintained by the faculty. A new procedure to collect feedback through the VO was implemented. The remainder of non-users established their sites. Official information about the Management department was regularly conveyed online. More advanced functions of VO were more extensively used such as the group tool and online exercises. At the same time the functionality of the system was gradually directed towards governing student-administration interactions- a perhaps surprising outcome for a system initially adopted for managing course content.

Several evaluations of the VO were carried out during the steering committee meetings. The entire faculty and the system analysts responsible for the software held their first official meeting. A general evaluation of the VO was also conducted for the annual meeting of the Management department, and the institute's council. Yet, from a managerial perspective, the

project was not an obvious success. Several regular users – especially students – became increasingly vocal in their criticisms. They were frustrated that too many teachers used their site as a “PowerPoint garage”. They wanted advanced functions for resource management, and up-to-date information, especially regarding classroom assignments.

Despite first forms of hierarchical control, the new regulatory practice did not trigger any counter-regulations. The form of hierarchical control mostly legitimized top-down the existing process and justified the use of VO towards external stakeholders- in particular visitors from the ICTT committee or “conseil régional” - a public organization involved in the management of IT in French universities. By in 2005, the VO had constituted a set of norm governing its use: an a formal regime of regulating VO use had emerged i.e. faculty and staff had to use the system as an expected a norm (Alter 2003). Besides the student administration function, the VO supported debates in various forums – e.g., about plagiarism and way to regulate it – between students and teachers and students and students. The VO became a « victim of own success” and was deployed in a growing number of ways, which made its regulation increasingly challenging. In January 2005, the IT director of the university invited administrators to use the term “platform” to designate the critical role of teaching websites on the VO.

At the same time new forms of regulation emerged with increasing pace and scope. All involved a tight coupling in time i.e. practices of local use, local regulations and the shape of IT artifact were enacted synchronously. Some former students of the department asked, if they could maintain their registrations with the platform after their graduation. Some administrators accepted this request, and developed a work-around: the alumni were now registered as “temporary teachers” – an instance of emergent control. Other workarounds popped up. For example, a procedure to register external teachers, which required a teacher to first be registered in the university database, was not used by all departments. To simplify the

task, administrators preferred to use the ad hoc procedure that had been designed initially to register manually students, if they encountered a problem while logging into the system. The administrator gave the newly registered teachers an administrator status which, perhaps surprisingly, was technically possible. Some of these work-arounds generated unanticipated problems in VO use. Whereas initially some VO functionality was devoted exclusively to students or teachers, they were now increasingly mixed. Serious misunderstandings arose when the VO mailing lists were used to distribute information meant only for specific groups: students received information that was circulated only for teachers, and vice versa. From late October 2005, conflicts occurred between hierarchical and emergent controls. Therefore, in November of 2005, members of the ICTT committee started to reinforce hierarchical control of VO use by reminding administrators of an IT code of conduct. A member of the committee (the vice director of the IS department) explained:

“As a teacher myself, I use the pedagogic platform by creating the courses I want and registering the students I want. I do not allow any third party the possibility of modifying the accesses and contents. The documents I put on line are my own production....I also would like to suggest that the economics and management faculty change the way in which it manages access to the platform. Tenured teachers should from now on not be registered after the go ahead of VO delegates (and a meeting with them). Registration to the VO should solely depend on registration in the central database. Such is the case in every other faculties of the university. A VO delegate should only be a correspondent, not a censor. (...)”

This statement delivered a reminder that the registration to the platform should only be given by central services. But the informal procedure^{xi} and the use of the official register of log-ins clearly contradicted this view.

Phase IV (January 2006-March 2006): Escalating conflict between emergent and hierarchical control

During this phase, the VO use continued to spread. By now, all study programs had their administrative portals. Some portals were co-managed by teachers and students (which was not conforming to hierarchical control), and administrators. Increasingly, faculty heads used

the system to inform about department rules and broader administrative issues. In this phase, three sub-communities of VO co-existed with loose interactions: managerial, finance and accounting, and economics. By the end of this phase, more than 185 sites had been set up within the Virtual Office (101 for the Management department alone). From the students' and teachers' perspective, this led to lack of coherence and visibility. A new version of the software (launched in 2005), with a better user-interface, only partially solved the problem. Some students had to deal with more than 20 sites at any point of time.

In March 2006, the enforcement of registration procedures for teachers are discussed explicitly. The debate is launched by a technical expert, who tries to make 'official' the informal procedure used by the administrators:

“Today, the registration of a colleague on the platform involves a registration by the superadministrator in the central database. Otherwise, a message appears informing the colleague that he or she should get in touch with the superadmin to be registered. Would you agree on the following procedure: if a colleague agrees to register another colleague on the platform, it is automatically registered on the central database. Then, this person will be allowed to create his/her own platforms without being registered by the superadmin? Is it coherent with the policy of your faculty? “

This question was never followed up. Functionalities and procedures remained unchanged. During 2006, the dean sent his first messages about the VO use where he urged the faculty to elaborate a coherent IT policy and called a shift towards hierarchical control.

A VO delegate of the management department also invented new forms of emergent control. A 'joker account' was created. It was a quick way to manage problems of student access. Teachers could 'give it' to students. They could then have access to all platforms without a right to change/modify anything. In September, the first serious conflict arose between the dominant form of regulation (emergent control) and the growing prominence of hierarchical control. The Vice President of IS in the university decided to purge all lists of users related to the VO. All 'bricolage' was purged at once: students with administrator rights, the joker

account, temporary teachers registered as administrator or co-administrator without a central registration. Many user roles and related routines that had emerged over the last two years disappeared with a single technological fix. As a result, many temporary teachers were now not recognized by the system. All VO users were informed of the action by the IS director in a straightforward way: *“There are connection problems since this morning. The list of external users has been purged. For the time being, only users registered on the central database can connect. The platform will probably be reinitiated on Monday by a technician^{xii}.”*

Even VO delegates and superadministrators could not connect to the system. This provoked a tense exchange between superadmin/administrators and the ICTT committee with a copy of all e-mails going to the dean and other university managers. An e-mail was sent to one superadmin by the IS vice president on Sunday:

“Two problems: 1) Connections to the platform: It seems that the problem started on Saturday morning. I’ve just checked your status on the platform and it seems you can still administer the sites where you appear as an administrator. With regards to your other colleagues removed from the system (in particular X and X), I’ve re-introduced them into the system. Forthcoming registration should then be done through the central database and the official procedure...2) Students administrators. We cannot grant an administrator’s status to students. This enables them to enter into hot zones of the system (with exam subjects^{xiii}). I do not remember the professor involved asking anything about this. And this is the problem. We never agreed to offer the right to administer to any third party. Ultimately, the dean should handle this problem. “

The recipient asked for the dean’s position on the issue: could these emerging forms of control become official? Several tense exchanges ensued involving teachers exasperated by the central IT administration’s lack of flexibility. Finally, after a new meeting the ICTT committee put official pressure on administrators and super-administrators by sending an e-mail about the conflict:

”XX has kept us abreast of the emails you have exchanged about the platform. We have debated this during the commission. It is true that until now, there was no specific code of conduct for the VO. The commission agrees on the following points:

- *In no way can a student be administrator of a platform*
- *The administrator of a platform can only be a teacher using his/her own login and password*
- *It is not recommended to ask a student to be in charge of a course. This responsibility should always be given to a teacher.*

Indeed, the rights given to an administrator make it possible to send emails to all the university (by means of mailing lists) and this should be controlled. The ICTT committee approves all the restrictions which can be applied by the IS department in accordance with this logic. “

Despite the presence of earlier e-mails mentioning procedures to be followed, there was no official VO ‘code of conduct’ and related hierarchical forms of control. During this phase, one can even ask, whether this was a conflict between alternative forms of emergent control or between emergent and hierarchical control. The presence of a formal rule is not the main feature of hierarchical control; it is its *externality* (Reynaud 1979, 1988, 1997). Thus, we see that the year 2006 the stage for a conflict around heterogeneous regulatory orientation.

During this phase, we observe an active re-orientation towards hierarchical control. The IT committee and the head of the faculty become involved in managing the use of the VO. The IT code of conduct is now widely publicized and emphasized in the administrative portal as the ‘official’, legitimate view. The administration of the university insists on the need to bar students from being system administrators. A conflict ensued within the ICTT committee between teachers who tolerated the assignment of administration of a site to students and those who did not. During this phase, hierarchical control becomes visible and its legitimacy is also confronted. With the support of the university leadership, managers of the system succeed to bar students from becoming system administrators. However, no real ‘inscription’ in the artifact could be identified and the level of restrictiveness in the system did not change. The IT artifact still reflects a heterogeneous regulatory orientation. During phase IV, the locus of regulation has now shifted increasingly to the level of the ICCT committee and its enactment of rules related to other IT technologies create disconnect between IT artifacts and

rules associated with VO. At the same time dyschronies emerge due to the lack of inscription of new rules within the IT artifacts as the regulatory orientation shifts towards hierarchical control.

Phase V (April 2006-September 2007): Establishment of hierarchical control

From March 2006 to early 2007, the regulatory regime changed again. Students were no longer involved in the management of the VO. Several teachers were also no longer involved. More rules governing the website were defined. No external links were permitted. The dean and the president of the university stated that it was not the right way to distribute university information. Therefore, degree programs, departments and research centers started now develop external websites. The scope left for the VO use was highly restricted. An official leaflet was sent to students, asking them to sign an IT code of conduct^{xiv} detailing rules covering the VO^{xv}. Restrictions to registration processes were introduced to prevent students, or external people becoming site administrators. The economics and management faculty VO sites were now administered by the vice-president of the IS department. Many students and teachers were disappointed by this trend. The new implemented restrictions (rules of access) in the IT artifacts led to a tighter coupling in time and fewer dyschronies. Regulation became univocally an expression of hierarchical control.

4.2 Discussion: The nature and modalities of sociomaterial regulation

Our case reveals discrete modalities in the nature of sociomaterial regulation and can be analysed in terms of the three relationships outlined in the theory section: the embodiment or dependency between the rule and the IT artefact, the agency that links the IT artefact with the practice, and the coupling of time between the rule and the practice. Table 2 summarizes the

findings from the case and we describe the five modalities of sociomaterial regulation in the following. Logic in this section follows the rows in Table 2 and elaborates with further detail when we apply the terms from the theoretical framework to explore the implications from the case.

<i>Orientation</i>	<i>Functionality</i>	<i>Tool</i>	<i>Role</i>	<i>Procedure</i>	<i>Social process</i>
<i>Materialization:</i> <i>Relationship between rule and IT artifact</i>	Embedded /materialized: functions of the IT artifact are designed to work as rules	Encompassing: the IT artifact embodies the rule and is nothing but the rule	Detached: assignment of rules independent of the IT artifact	Encompassing: the IT artifact embodies the rule and the associated collective action	Contradictory: co-existence of multiple rules and interpretations
<i>Interdependence:</i> <i>relationship between IT artifact and practice</i>	Material agency is expected to determine practice	Material agency is expected to determine practice	Social agency is expected to determine practice	Social agency (collective action) is expected to determine practice	No form of agency dominant, low predictability of practice changes
<i>Coupling in time:</i> <i>relationship between the rule and the practice</i>	Granular: a reassignment of functionality leads to dyschrony	Binary: re-interpretation of the tool leads to dyschrony	Trigger: change in rules followed by new uses of the IT artifact	Binary: collective action leads to new use of IT artifact	Granular: new use leads to reassignment of functionality

*** Table 1: Modalities of sociomaterial regulation and the links between rule, IT artifact and practice**

i) Functionality-oriented. This modality consists in the elaboration and enforcement of rules related to functionalities of the technology where functions are designed to work as rules. For example, VO managers sought to create restrictions in the parameter setting of a system's functionality or developed specific rules concerning how the function is enacted. This was

typically the case in the use of registration facilities for students (see phases 2, 3 and 4) and the use of a ‘joker account’ (where the functionality of account setting is used to re-introduce a flexibility in the registration of students in phase 4). Functionalities of the IT artifact materialize rules, and the rule can be said to be embedded in the IT artifact.

ii) Tool-oriented. In this case, the tool as a whole, its finality and meaning, is made a subject of regulation. In our case this occurred when a specific navigator had been imposed for security reasons or a new label created to name the IT artifact (to position it with regard to other artifacts and their use, see phase 3). The reminder issued by the ICTT committee during phase 3 about the code of conduct targeted the use of the system as a whole and implied specific ideas about its finality and meaning, which had been made a subject of regulation. Here, the IT artifact is the rule and embodies it.

iii) Role-oriented. Rules elaborate the expected rights, duties and skills of IT users, IT managers or other organizational stakeholders. In our case, rules defined the scope and variations in the missions and privileges associated with a specific function, status, or log-in access, as for example in phase 2 with the status of the super-admin. Phase 3 shows the new role and status of alumni who remained part of the community thanks to the role definitions of the VO. This was also the case in phase 4 with students’ involvement as administrators of some portals. Rules and IT artifacts are detached in the sense that the rules apply to roles attributed to stakeholders who are implicated in the use of the IT artifact.

iv) Procedure-oriented. The rule defines new administrative, pedagogic or research collective procedure related to the IT artifact. This is the case when the VO itself, from phase 3 onwards, starts to embody a new way of learning and diffusing knowledge for the management department and for the students and teachers. The IT artifact becomes a means for collective action and encompasses the rules that characterize the procedures.

v) *Social-processes oriented*. In this last situation, beyond a simple procedure, social life is modified through the IT artifact, its use, design or management. This is clearly the case from phase 3 onward for the management department. The VO becomes parts of the daily life of the department and the students and is at the core of a broad redefinition of many pedagogic, administrative and scientific activities. The relationship between rules and the IT artifact becomes contradictory and multiple uses co-exist and enter into conflict as users question the interpretations of rules and the perceived usefulness of functions of the IT artifact.

In terms of agency, the IT artifact can be both the object (for situations i and ii) and the medium (for situations iii, iv) of regulation which implies a distinction between material or social agency.

	<i>Regulation of practice through material agency</i>	<i>Regulation of practice through social agency</i>
<i>Relationship between rules, practices and IT artifacts</i>	Rules tend to be materialized, that is embodied in the IT artifact. The material artifact is used to constrain practices.	Rules tend to be expressed in social terms. The material artifact is expected to have flexibility in practice to accommodate variations in rules.
<i>Corresponding modalities of sociomaterial regulation</i>	Functionality-oriented (to make the system work, to make it more flexible...). The focus is on the IT artifact.	Role-oriented (to re-affirm or change roles within departments or university). The focus is on people and their use behavior.
	Tool-oriented (to change the expected uses of IT, to give it more visibility, to position it with regards to other competing technologies...). The focus is on the IT artifact.	Procedure-oriented (to change, discuss or reinforce a pedagogic, scientific or administrative procedure). The focus is on collective action.
	Social processes oriented (to reproduce or change more	

	<p>general social dynamics of the departments or university). The focus is on use cases, technology adoption, and evolving practices. Mixed agency, multiple sources of regulation, and thriving innovation characterizes this modality.</p>
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*** Table 2: The five modalities in terms of agency and the impact on practice**

Lastly, the coupling in time describes the relationship between the rule and the practice. Tight coupling refers to the ideal situation where a practice adheres to a rule as it is embedded and enacted through an IT artifact. We observed this only at the beginning and towards the end of our case. Similarly, the coupling can loosen as with the example of the speed bump and in the example of banks where traders enact their own risk strategies. We identify abroad trajectory of regulatory change throughout our case. Initially, the choice of the VO was driven by local mimetic forces and related logics of adopting technology. From Phase1 to Phase 3, the case illustrates the growth of emergent control mediated and enabled by the VO. From phase 4, different forms of hierarchical control began to emerge generating a conflict with institutionalized local adaptations of rule systems that govern the use of VO. If we apply the idea of coupling in time to our case we observe a pattern in sociomaterial regulation, as shown in Table 4. The phases in our case exhibit varying combinations of dyschrony and coherence in the sources of regulation.

<i>Sources of control (emergent versus hierarchical control)</i>		<i>Coupling in time (dyschrony)</i>	
		<i>Loose coupling</i>	<i>Tight coupling</i>
		<i>Practices are disjoint from or out of synchrony with rules (e.g. initial intention is lost) and enacted rules are no longer reflected in formal documents and artifacts.</i>	<i>Rules and their incorporation into formal documents or artifacts are timely and in line with practice. Practices, rules and artifacts are conflated. Rules and the material constraint conveyed by the artifact have symbiotic forms.</i>
<i>Conflicting or incoherent sources of control</i>	<i>Diverse regulations co-exist within the organization and are in conflict (emergent versus emergent or emergent versus top-down control)</i>	<i>Phase IV: Actors interact reflexively with rules. Procedures are frozen into the artifact, and a (forgotten?) IT code of conduct conflicts with some practices.</i>	<i>Phase II and III: New non-formal regulations emerge outside the artifact. The situation is moderately dyschronic as manifold rule applications are possible. Result of high innovation in the use of VO.</i>
<i>Coherent source of control</i>	<i>A type of control dominates (control or hierarchical)</i>	<i>Phase I: The VO design and use is not contributing to regulation within the faculty. Only limited uses recorded.</i>	<i>Phase V: Hierarchical control homogenizes VO use. This is dependent upon the ICTT committee's pressure and technical fix within the system. The practices become constrained and less variable.</i>

Table 3: Coupling in time and the sources of regulation

The case shows conflicting regulatory orientation due to emergent control that is not coordinated and is in tension with hierarchical control (at Phases II, III and IV). This results in the emergence of new practices that are not synchronized with the IT artifacts (e.g. in Phase IV a code of conduct developed at another time for another context) or functionality (e.g. access management by super-administrators), which has no meaning for the users at that time. Emergent control proliferates until Phase IV and then becomes homogenized through a conflict-driven engagement after Phase IV. A technical fix in the IT artifact and the clash between the procedure followed by faculty and by the ICTT committee signify procedure-oriented dyschronies (Alter 2003). There were no legitimate and visible forums through which to establish a reflexive joint regulation. Meetings organized by the ICTT commission involved only hierarchical control. Our case also shows a tight coupling in time for phases II, and III and a decoupling at the end of phase IV (with rules enacting a different temporality than the practices observed).

Surprisingly, our analysis shows that the phase demonstrating the strongest innovation in use (and probably highest value creation from stakeholders' point of view) matches with phases of tight coupling in time and conflicting sources of control. Rules become synchronized with practices while IT artifacts are enacted to conflate with the local and emergent rules.

Two key explanations account for the observation that innovation appears to flourish when coupling in time is tight and the regulatory orientation heterogeneous. Firstly, a strong coupling in time can favor a better coordination and stronger conventions between actors involved in emergent control (Reynaud and Riechb e 2007). IT artifacts in synchrony with practice convey a sense of meaningful regulation (independent of emergent or top-down control) likely to strengthen the change in practice while it belabors innovative modes of using the technology. Second, heterogeneous regulatory orientation favors diversity in initiatives and plurality is the mother of innovation in practices.

With regard to our research questions as to the nature of IT-based sociomaterial regulation and the ways to characterize it, we offer a terminology to conceptualize the relationships between rules, IT artifacts, and practice with high granularity and we shed some light on the role of the IT artifacts in regulating practice. Our case confirms that regulation makes use of IT artifacts as both objects of regulation and a medium to influence practices through rules. Material and social agency combine in various ways across the modalities of sociomaterial regulation that we identify. They imbricate in differential ways to use Leonardi's terminology (2011).

5. Implications and limitations

The IT artifact, rules and practices ensemble has traditionally been conceptualized in IS studies only indirectly and with relatively weak conceptualizations. This study seeks to demonstrate how IT-based regulation can operate in multiple and rich ways as illustrated by our analysis of implementation and use of an e-learning system. The elaboration and application of the three relationships of sociomaterial regulation (materialization of rules, coupling in time, and interdependence) offered a way to explore the nature and dynamics of sociomaterial regulation surrounding the introduction and evolution of the system. Our contribution to regulation theory in this context is the elicitation of five modalities for employing IT during regulation. Contrary to prior studies of IS use (in particular causalist studies, see e.g. Huber, 1990), this study illustrates that there is no *a priori* association between an IT artifact and the type of regulation. The enactment of the same IT artifact in different contexts can result either in hierarchical or emergent control, and may change or may replicate practices. More specifically, our research leads us to solicit an initial taxonomy of relationships between rules, IT artifacts, and practices. The taxonomy and the emerging modalities address Orlikowski and Iacono's (2001) call to take the IT artifact seriously by

offering a way to reveal empirically the interpretive heterogeneity of IT mediated regulation (Kallinikos, 2011).

Our results also speak to a recent debate about the mediating role of IT artifacts for changing work practices and organizational control and the rare studies exploring it (Monteiro et al., 2012; Tilson et al., 2010; Ciborra et al., 2000; Orlikowski, 1996). In particular, we show how regulation occurs via extending the use of existing IT artifacts and creating new practices within the triad of IT artifacts, rules, and practices. Sorting the dynamics along five modalities we show exemplary movements and open up theorizing to a myriad of combinations how regulatory processes can unfold. Our observation of conflicting regulatory orientations as fruitful for generativity in user practices helps designers of IT artifacts when they serve as digital infrastructure. In fact, as long as the IT artifact is attuned to current practices conflicts in control may be tolerated. The observation also raises questions as to the power balance among organizational stakeholders and (outside) users as well as about the timeliness of design and openness of design (von Krogh and Haefliger, 2010).

Compared to studies on the social shaping of IT artifacts (in particular sociomaterial studies), we offer a richer vocabulary to analyze interactions between practices, rules and artifacts. In particular, we introduce Alter's (2000) notion of dyschrony (to describe the varying degree of coupling in time) and thereby complement and extend sociomaterial studies (e.g. Orlikowski, 2007, 2010; Leonardi, 2011). In his research, Leonardi (2011) suggests to explore the 'imbrication', i.e. the interplay between human and material agency which he sees as a sequence and overlapping patterns (Leonardi, 2011: 150). In continuation to this, our results show modalities of regulation where a specific focus implicates a dominant material or social (human) agency and its impact on practice. The two perspectives complement each other: our five modalities of sociomaterial regulation can be thought of qualifying the overlapping patterns described as imbrication and the dynamics substantiate the sequences that

imbrication may follow in that IT artifacts and related practices may be more or less synchronized in organizations.

From a practical perspective, the triad of IT artifacts, rules, and practices calls for theorizing around integrative mechanisms that can achieve a dynamic match and smooth synchronization. For large banks, such as UBS or SG, a sociomaterial perspective on regulation suggests that improving either IT artifacts or introducing stricter hierarchical control may re-create the very situation that caused the failures, namely dyschrony and practices out of touch with either the rules or the design intent of the IT artifact. Management needs to cultivate a deeper understanding of the practices in the organization, their guiding values and outlooks. Without such an understanding, designers of IT artifacts will be quickly outsmarted by their users, heterogeneous sources of control create local pockets of behavior, and central management loses traction when it comes to compliance and necessary, organization-wide adherence to standards.

While homogeneity in organizational practices may be beneficial for compliance, innovation requires exploration and organizational architectures that can cope with contradictions (Smith and Tushman, 2005). In line with this heterogeneous regulatory orientation was seen conducive to innovation. This suggests that dynamics of sociomaterial regulation forms one of the key elements of ambidexterity: how to balance exploration and exploitation in organizations. Management has always a choice of dynamically synchronizing the triad of IT artifacts, rules, and practices or, at times, permitting regulatory processes to emerge and creating (potentially) productive conflict. In line with this Alter (2003) calls for creating consensus about regulation's legitimacy and efficiency. Paralysis and decay of IT artifacts is a huge risk. Managers should not forget that emergent control can result in drift, muddling through, and bricolage (Ciborra et al. 2001) both for the potential benefit to innovation or detriment to the overall organizational goals and coherence necessary for collective action.

We see three limitations. First, our view of IT-related regulations is only one perspective of how behaviors change in organizations. For example, Giddens (1984) distinguishes three dimensions of social structuring (signification, domination and legitimation) corresponding to three modalities (interpretive scheme, facility and norms). Thus, regulations relate to only one of them (norms) and their interactions with facilities. For example, in our case we could also analyze in more detail mobilizations of interpretive schemes and power in the rule-based regulation. However, our goal was to make sense of sociomaterial regulations (with a focus on IT) as most existing studies on organizational change have looked at either power (i.e. facilities), language (i.e. interpretive schemes), agency and interactional relationships between these constructs (see Orlikowski and Scott, 2008).

Second, the nature of the studied IT system involving quite loose information distribution and communication facility introduces limitations. Some IT artifacts like the system we studied are “weakly rule-embedded”, whereas others can be strongly rule-embedded (Hanseth and Monteiro 1998). For example, Enterprise Resource Planning systems (ERP) are distinct from e-learning systems in that they convey embedded regulatory capabilities through long design and implementation phases (see Lemaire 2003). In addition, these systems structure strongly heterogeneous stakeholder processes with explicit institutional rules and logics (see Lemaire 2003). In the future, it will be necessary to distinguish more clearly between different types of IT artifacts and the ways of embedding rules. Further research should focus on highly rule-based technologies to highlight potential contrasts in sociomaterial regulation dynamics. Our work does not suggest a systematic comparison of IT-related sociomaterial regulations versus regulation conveyed by other material or symbolic artifacts. A speed bump is ‘met’, it is not ‘used’. Its power of constraint is physical and the embodied rule almost inevitable. In contrast, the process of sense-making related to a IT-based regulation may be more interactive and emergent (as the interface incorporates meaningful texts, images, sounds, and

symbols). Further research should explore the specificity of IT-related sociomaterial regulations.

Third, our work did not extend the inquiry into societal macro level regulation. While we recognize the importance of societal exogenous regulation in the use of IT artifacts, it is not directly incorporated in our theoretical perspective, and we therefore bypassed it in our analysis. Consequently, we did not analyze how powerful external actors in the institutional field, such as consultants, user groups, journalists, business school leaders, associations and vendors impacted the evolution of regulations. A possible way to overcome this limitation would be to apply the concept of “organizing vision” by analyzing how exogenous regulations give alternative roles to IT artifacts (see Swanson and Ramiller 1997).

The future research into IT based regulation should go beyond identifying modes of artifact-mediated regulation and practices. We should explain rather their contingencies and limitations. In addition, the proposed taxonomy should be refined and validated in different organizational settings and technologies, one of them certainly being a context of innovation. A deeper exploration of labour sociology (see e.g. Reynaud, 1988, 1997) could be useful to conceptualize sociomaterial regulation. Further research could go also a step further by studying regulation in situations like those found in the International Monetary Fund, the World Bank, the NATO, where multiple logics, regulatory environments, and national rule systems collide. The context of telework involving both social and organizational regulation may also present an interesting avenue.

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APPENDIX: MAIN CONCEPTS IN THE PERSPECTIVES ABOUT IT MEDIATED REGULATIONS

A.1 Thematic dictionary

i) Meta-coding (i.e. coding applied to the all email)

Profile of correspondents

CATEGORY	SUB-CATEGORY	DEFINITION AND CODE
Teacher	Assistant professor, Associate Professor, Professor, without responsibility (not in charge of a diploma or department)	TEACH-NO
	Assistant professor, Associate Professor, Professor in charge of a diploma	TEACH-DIP
	Assistant professor, Associate Professor, Professor in charge of a department	TEACH-DEP
Administrative Staff	Administrative management (B and C status in the French administration)	AD-MAN
	Technical management (B and C status in the French administration)	TECH-MAN
	Upper administrative management (A status)	UPP-MAN
	Upper technical management (CIO, manager in charge of another technical service, A status)	UPP-TECH-MAN
Students	Student at the BA level	STUD-BA
	Student at a Master level	STUD-MS
Management of university	President or vice-president of university	PRES-UNIV
	Dean of faculty	DEAN-FAC
	Member of a central committee (IT committee for instance)	MEMB-COM
	Other management	OTHER-MAN

General aim of the mail

CATEGORY	SUB-CATEGORY	DEFINITION AND CODE
Problem-solving	Problem-solving connection- oriented (not registered on the system, login or password lost, problem to settle the system...)	PB-SOLV-CON
	Problem-solving in the use of the IT artifact	PB-SOLV-USE
	Problem-solving of other things	PB-SOLV-OTHER
Ask for service	Diffusion of a message (mostly asked by colleagues) or document through the VO. The mailing lists on the VO were often solicited by users (who not use them directly).	DIFF-INF
Hierarchical instruction	Manager asks IT delegate to do something	INST
Exchange about the management of the VO	The way the IT artifact should be managed or set.	EXCH-MAN
	The way the IT artifact should be ruled. Discussion about rules or procedures.	EXCH-RULE
	The way the IT artifact should be used (best practices of use by students or teachers).	EXCH-USE
	A forthcoming meeting	EXCH-MEET
Evaluation or opinion about the VO, a managerial action on the VO or an event on the VO (for instance a message on a forum).		COMMENT-VO

ii) Direct coding (applied to sentences or groups of sentences in each email)

Elements related to users and uses of the VO

CATEGORY	SUB-CATEGORY	DEFINITION AND CODE
Presentation of a user by himself-herself (diploma, department, course attended, etc)		PRES-UT
Problematic situation encountered		PRO-ENC
Exploration of a solution by user	Successful exploration	SUCC-EXPLO
	Unsuccessful exploration	UNSUCC-EXPLO
Politeness formula		POLIT
Opinion/assessment about the VO	Positive	POS-OP
	Negative opinion	NEG-OP
Discussions about rules to follow	With students	RULES-WITHSTU
	Between students	<i>RULES-BETSTU</i>
Gratefulness following the solving of a problem		THANK
Asking for reformulation/precision about a message sent by delegate. Meaning unclear		MEANING-MESS

Elements related to colleagues, managers of the VO and management of the university

CATEGORY	SUB-CATEGORY	DEFINITION AND CODE
Following the search for help with a technician		HELP-TECH
Chat about pedagogy and the VO (with colleagues)		CHAT-PED
Chat about managerial rules of the VO (procedure to register students, unpolitically correct discussions, required vocabulary to name the VO and its sub-components...)		CHAT-RULES-VO
Discussion about a formalization	Of VO-related rules (design of an IT code of conducts, evolution of the internal rules of diploma, evolution of internal rules of university, etc...)	FORM-RULES
	Of VO-related standards	FORM-STAND
Discussions about the governance and strategy of the VO. Who should manage it? What are the roles? What are the resources? What are the long-term objectives?		CHAT-GOV-VO
Task to carry out (relaying a message on a VO mailing list, registration, parameter-setting of a site to complete...)	Information or document to relay	TASK-VO-INFO
	Change to do in the structure of a site	TASK-VO-STRUC
	Other	TASK-VO-OTHER
Congratulations or encouragements about the VO		CONG-VO

Elements not related to the VO

CATEGORY	SUB-CATEGORY	DEFINITION AND CODE
Discussion about pedagogy outside the VO		PED-OUTSIDE-VO
Exchange about management rules on the VO but not related to the VO (discussions between managers of the VO about pedagogic rules in general, discussions on forums between students or teachers about rules to respect within the group...)		RULES-NOT-VO
Other		OTHER

Results of meta-coding:

	2004	2005	2006	2007	Total	%
TEACH-NO	57	72	69	4	202	6,0%
TEACH-DIP	36	28	26	6	96	2,8%
TEACH-DEP	12	8	7	0	27	0,8%
AD-MAN	46	87	22	17	172	5,1%
TECH-MAN	24	72	7	1	104	3,1%
UPP-MAN	0	0	0	0	0	0,0%
UPP-TECH-MAN	6	1	6	1	14	0,4%
STUD-BA	44	29	5	0	78	2,3%
STUD-MS	51	61	20	6	138	4,1%
PRES-UNIV	0	0	0	0	0	0,0%
DEAN-UNIV	0	0	7	0	7	0,2%
MEMB-COM	7	4	21	0	32	0,9%
OTHER-MAN	4	1	1	0	6	0,2%
PB-SOLV-CON	55	54	28	3	140	4,1%
PB-SOLV-USE	15	7	11	0	33	1,0%
PB-SOLV-OTHER	12	34	13	0	59	1,7%
DIFF-INF	70	77	38	21	206	6,1%
INST	10	12	18	1	41	1,2%
EXCH-MAN	73	79	39	3	194	5,7%
EXCH-RULE	3	8	16 ⁵³	2	29	0,9%
EXCH-USE	4	4	4	0	12	0,4%

1. Endnotes

ⁱ For a comprehensive case report see Landier, Sraer and Thesmar (2009) or Udeh and Dhillon (2008).

ⁱⁱ A rule incorporated into the IT artifact used by traders.

ⁱⁱⁱ See in particular this article from the Telegraph:

<http://www.telegraph.co.uk/finance/financial-crime/8770947/Rogue-trader-losses-engulf-UBS.html>

^{iv} Alter (2003) does not use the term “artifact”. Nonetheless, he uses various terms in his writings which we find convenient carrying the same meaning as our “artifact” to summarize this way. In particular, he uses the terms: “computer systems” (p.496), “information systems” (pp. 500, 502 and 509), “managerial technology” (p. 505), “micro-computing” (p. 506) or “technical devices” (p. 509).

^v The economics and management faculty consisted of a management department, an economics department and an accounting department.

^{vi} Beyond a *descriptive analysis* (i.e., a counting of the codes), we also applied lexicometric analysis (Guilhaumou 1986; Bolden and Moscarola, 2000) to locate regulation-related discourse segments. Lexicometric analysis involves thus *quantitative analysis* of textual sequences. These results were not deployed further in the case analysis, because of the weak results in identifying regulatory dynamics. The main reason for this is that people rarely used

explicit words to enact a regulation (e.g. “you should”, “have to”, “rules”, “regulation”, “norm”).

^{vii} By June 2003, more than 300 sites (administration and/or teaching-oriented) were developed and in use! Many of them deployed advanced functions of the software.

^{viii} The management department also had a decentralized site in a small town 80 kilometers away from the main site. It included 40 students.

^{ix} There were 3 VO delegates within the economics and management department, each with a super admin status (giving them full access to the VO’s sites and, registration, and other functions).

^x Most of them were directly in charge of the IT artifact in their own department.

^{xi} Each VO delegate was expected to meet the new administrators (teachers) of sites. This was the procedure required by the IT department (and recalled in an email at stage 3).

^{xii} Which was a way to erase all improvisations on the plat-form, and to delete the status of administrators given to some students.

^{xiii} This was incorrect: no examination subjects had been put on line.

^{xiv} Surprisingly, an IT code of conduct had been elaborated a couple of years earlier, but it was completely absent from interactions and discussions. At this stage, it was re-introduced. This illustrates Alter’s (2003) idea of an autonomy of rules.

^{xv} Previously, only email was the subject of a (signed) IT code of conduct.