

7-1-2013

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THE EVOLUTIVITY OF ORGANIZATIONAL ROUTINES: A NEW CONCEPTUALIZATION OF THEIR PERFORMATIVITY AND THEIR RELATION TO INFORMATION TECHNOLOGIES

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Abstract

The ability to adapt to a changing environment is necessary for the survival of organizations. The evolutivity of organizational routines is therefore a fundamental issue for both theorists and practitioners. In this "theory building" paper, we adopt a variance perspective and a process perspective to meet this issue. In a variance perspective, by analyzing the contingency of results of the literature to characteristics of the different routines studied, we propose four dimensions to characterize the routines and estimate their evolution potential (interdependence, reflexivity, temporality and regulations). In a process perspective, we seek to better theorize the immediate causes of action in order to describe and understand the evolutivity of routines. To do this, we propose a reinterpretation of the Pentland and Feldman (2003; 2005) model by the paradigm of critical realism. Our investigations lead us to recognize the threefold nature of routines (behavioral, cognitive and material) and to better appreciate the role of information technologies in organizational routines: IT are a source of recurring agencies on this triple ontology. More than ever, the organization and information technologies must be thought together.

Key words: Organizational Routine, Critical Realism, Agency, Evolutivity.

1 Introduction

The ability to adapt to a changing environment is necessary for the survival of organizations nonetheless characterized by routine. The evolutivity of organizational routines (their propensity to adapt and evolve) is a fundamental issue.

The concept of organizational routine has been widely used and developed in economics and social science (Cohen et al., 1996). Nonetheless, its areas of application are defined on very different temporalities and levels of analysis, forming distinct streams: economic, psycho-cognitive and managerial. These streams examine specific problems and use the concept consistently with their domain. According to the different works, organizational routines have the effect of either inertia or continuous adaptation, or both at once. The managerial stream, who is ours, is particularly interested in empirically describing and understanding these antagonistic phenomena of the evolution or the stability of organizational routines. The organizational routine model of Pentland and Feldman (2003; 2005; 2008), has become an important reference for this managerial stream. This model posits permanent interaction between two realities with different levels of abstraction: the ostensive aspect (or structure) and performative aspect (or interaction) of the organizational routine. Their model therefore suffers from the same shortcomings as the theory of social structuration concerning the apprehension of the present moment and materiality (Archer, 1982; Jones and Karsten, 2008). However, firstly, to describe and understand these antagonistic phenomena, we must adopt an appropriate level of temporal analysis: the instantaneous. Here and now, why does a particular individual execute an action in one way rather than another? Secondly, the integration of a material dimension is required for this model to be fully appropriate for the field of information systems (Volkoff et al. 2007).

In this paper, we address the issue of the evolutivity of the routine from two perspectives (Sabherwal and Robey, 1995): the variance perspective (identification of variables influencing the evolutivity of routines) and process perspective (description of sequence of events that explain why a routine evolves or remains stable).

In a variance perspective, the first objective of this paper is to attempt an explanation for the antagonistic results of the literature concerning the evolutivity of the routine. To do this, in the next section of this paper, we analyze the contingency of these results to the different characteristics of the different routines studied by the different streams. We propose four dimensions to characterize the routines and explain their evolutivity (interdependence, reflexivity, temporality and regulations). Firstly, this model allows us to discriminate, without rejecting, the respective contributions of different works, whatever their areas of application. Secondly, these dimensions can also be mobilized empirically by theorists and practitioners to estimate the evolutivity of organizational routines. However, these dimensions do not allow us to describe and understand how a routine evolves or remains stable.

In a process perspective, the second objective of this communication is to better theorize the immediate causes of action in order to describe and understand the evolutivity of routines. To do this, in the third section, we propose a reinterpretation of the Pentland and Feldman model by the paradigm of critical realism (Mingers, 2004). By focusing specifically on the performative aspect of routines, we propose a more comprehensive definition of organizational routines. A routine is a *recurrence of a behavioral, cognitive and material nature* that is perpetually constructed and reconstructed as the realization of a collective process of interrelated tasks with an organizational finality (for argumentation on the other points of this definition, see Becker (2004)). In the fourth section, the recognition of the threefold nature allows us to better appreciate the role of information technologies in organizational routines: IT are a source of recurring agencies on this triple ontology. The study of IT is useful to the understanding of organizational routines. Reciprocally, the IS discipline needs to appropriate this modeling of the immediate causes of routine recurrence to develop, select and govern IT and their routine uses. The last section discusses the contribution of various theoretical propositions

formulated in this article relative to two debates: that concerning evolutivity of routines and that, raging in the domain of information systems, regarding whether sociomateriality exists or not.

2 Contingency of routine evolutivity: perspectives in the literature

The concept of evolutivity is central to the conceptual ambivalence of organizational routines: it is both a source of inertia and a means of permanent adaptation (Howard-Grenville, 2005). The endogenous or exogenous character of the factors of the variation of routine is a persistent question (Pentland et al., 2010). Endogenous evolutivity is the propensity of a routine to evolve over time. Exogenous evolutivity is the capacity to adjust easily to its environment. Characterizing these two forms of evolutivity is an important aspect of process governance.

Becker (2005) tried to identify antecedents of the stability of routines. He offers the following factors: complexity and uncertainty (here represented by their consequence: actor's reflexivity), interdependence, time pressure (here, temporality). We also analyze a fourth variable: regulation. Indeed, Nelson and Winter (1982) have always considered that discussing the implicit or explicit rules or conventions related to the routine is like opening Pandora's box. In this vein, D'Adderio (2011) analyzes the importance of prescribed regulation. We propose a model of contingency of routine evolutivity that includes these four dimensions (Figure 1). The research streams can be differentiated based on their positions relative to these dimensions (Table 1). The concept of organizational routines is multilevel (Vromen 2011); these research streams are primarily differentiated by the level of analysis adopted for the study of organizational routines.

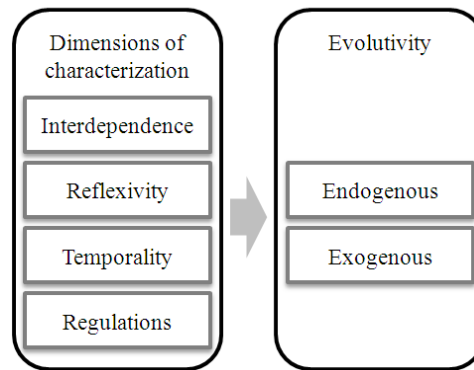


Figure 1. Model of contingency of routine evolutivity

LITERATURE	Level of analysis	Individual <-----> Group		Group <-----> Organization			Organization <-----> Society	
	Streams	Psycho-cognitivist		Managerial			Evolutionist economy	
Approaches	Experiential	Artificialist, computation	Task-centered		Actor-centered		Micro	Macro
Research subject	Routinization of decision making	Decision by routine	Conscious application of rule	Interpretation of rule	Interpretation of action situation	Interpretation of constraint action situation	Acquisition of distinctive skill	Evolution of economic equilibriums
Representative reference	(Cohen and bacdayan 1994)	(March and Simon 1958)	(Hutchins 1995)	(Reynaud 2001)	(Rerup and Feldman 2011)	(Turner and Rindova 2012)	(Levitt and March 1988)	(Nelson and Winter 1982)
DIMENSIONS	Interdependence							
	Reflexivity							
	Temporality							
	Regulations							

Table 1. Literature on routines according to four dimensions

2.1 Interdependence dimension

The structure of an organization is designed to manage interdependencies. The routine is a permanent social construct that improves coordination between tasks (Nelson and Winter, 1982). The interdependence of tasks is stronger within a single routine than between two routines in the same organization (Becker, 2004). Task interdependence should be evaluated in terms of the interrelationship between a task and others tasks of the same routine (Becker, 2004), as well as between a task and others tasks of others routines (Novak et al., 2012). Moreover, interdependence between the behavioral, cognitive and material aspects of the routine should be analyzed (section 4).

The evolutionist economic stream suggests interdependence of the routine--construed as a technology in the sense of the contingency school--with the industrial or societal environment. It therefore ignores inter- and intra-routine interdependence. The psycho-cognitive stream addresses this interdependence only minimally because of its goals and the laboratory situated experiential methodology through which it isolates external variables. The managerial stream distinguishes the interdependence dimension using two approaches: task-centered and actor-centered. The task-centered approach restricts the perimeter of analysis and tends to remove the routine from its organizational context. Interdependence is thus measured solely at the intra-routine level. In the actor-centered approach, the context of the routine is considered because the individual is both a member of an organization and an executory force for a specific task (Feldman, 2000; Pentland and Feldman, 2008). A recent article foregrounds the importance of "intersections of routines" in the understanding of the unintentional consequences of projects and noncompliance with work procedures on other interdependent routines (Novak et al., 2012).

A routine with strong internal cognitive, behavioral and material interdependence is presumably less likely to evolve endogenously or as a result of a weak disturbance of the environment. Each element of this interdependent routine context is a stimulus for the same conditioned response. In contrast, a routine with strong interdependence with an element of the environment subject to variation would have greater exogenous evolutivity. Indeed, Howard-Grenville (2005) has established that interdependence of the routine with its environment was a source of frequent variations in the tasks (named lexical variability by Pentland (2003)) or in the sequence of tasks (named sequential variability by Pentland (2003)). Nonetheless, Howard-Grenville exposes that such variations of a routine reflect the ability of the routine to adapt to its environment, and therefore its ability to reinforce its overall stability.

2.2 Reflexive dimension

The reflexive dimension is the degree of reflection needed to the individual to perform the routine task (Becker, 2004). The routine tends to lead to "mindlessness" (Ashforth and Fried 1988), but a routine task can require an "accomplishment effort" (Pentland and Reuter 1994). Variety is an important factor that determines individuals' need for reflexivity. It is useful to characterize the lexical and sequential variety of tasks to identify changes in the routine, and particularly to characterize the complexity of the action situation that may require strong reflexivity by individuals (Becker, 2005). This process entails characterizing natural reflexivity within the routine rather than reflexivity following a disturbance, created by an organizational change, for instance. We also examine the reduction in reflexivity induced by the routine itself (Ashforth and Fried 1988).

The evolutionist and psycho-cognitive approaches consider routines as lacking reflexivity. From a microeconomic perspective, a routine is "learning by doing," and is therefore non-reflexive (Levitt and March, 1988). From a macroeconomic perspective, the routine is a dehumanized behavioral continuity that undergirds an economic theory. Reflexivity cannot be grasped at this level of analysis. In contrast, the experiential psycho-cognitive approach does not capture reflexivity either because it is contextual enough (Cohen and Bacdayan, 1994). Action situations are much simpler than a management situation where reflexivity is deemed necessary to interpret, adapt and even supplement normative rules

governing task execution (Reynaud, 2001). If a routine is characterized by reduced reflexivity, reflexivity is nonetheless necessary to ensure the flexibility of the routine in a disruptive or complex environment (Turner and Rindova, 2012; Rerup and Feldman, 2011).

Heightened reflexivity can lead to an indefinite evolution of the routine. The reflexivity is imposed by complexity. Complexity makes the final status of an organizational change more difficult to anticipate and reflexivity recognizes the immanent power of individuals. A routine whose members are engaged in strong reflexivity is more likely to evolve, with or without a disturbance (Howard-Grenville, 2005). The mechanisms of reduction of cognitive dissonance (Vaast and Walsham, 2005), hence of adaptive learning, are stronger in this case. Nonetheless, this evolution may have its own logic and deviate from its initially intended process.

2.3 Temporal dimension

The routine must be characterized according to temporal variables (Becker, 2005). Accordingly, one can distinguish three temporalities related to both tasks and their sequence: seniority of the sequence/task, duration of latency between occurrences and duration of the occurrence. Central to the concept of routine is the gradual construction of its identity (Nelson and Winter, 1982). The routine can be compared to a rut that is increasingly difficult to exit. There is thus an increase in the potentiality of routine recurrence following each occurrence of the routine. The routine is a gain in cognitive resources, and changing it incurs a psychological, even economic, cost that must be justified (Becker, 2004). This trend can lead to “competency traps” (Levitt and March, 1988).

The temporal dimension is the object of study of the psycho-cognitive experiential approach. It entails modulating the frequency and duration of tasks to observe the mnemonic consequences. In contrast, the evolutionist macroeconomic approach pays less attention to the temporal modalities of the iterations of a routine. Paradoxically, by overstressing human intentionality or organizational engineering, the managerial stream largely ignores the effect of time on routines.

Nonetheless, the shorter the time frame, that is when tasks are brief and very repetitive, the lesser the endogenous evolutivity. In contrast, intense exposure to disturbance triggers rapid changes in behavior. Conversely, the longer the time frame, the higher the probability of endogenous evolutivity and the lower the probability of exogenous evolutivity.

2.4 Regulations dimension

Lastly, the concept of routine intrinsically contains the idea of emergent regulation (Nelson and Winter, 1982; Feldman et Rafraeli, 2002). Nonetheless, we cannot ignore prescriptive pressures from management (D’Adderio 2011; Miner 1994), or even leadership by a member of the routine with strong prescriptive power. The task sequences may be prescribed to varying degrees, and deviation from these prescriptions may be tolerated to varying degrees. In addition to managerial pressure, pressure from the community must also be considered.

Similar to the temporal dimension, this dimension is an instrument of analysis of the experiential approach. For the economic approach, the environment acts as a selective pressure. This dimension differentiates two perspectives within the task-based managerial approach regarding the normative perspective of an imperative rule (for example, ISO standards (Lazaric and Denis, 2005)) versus a rule that must be transcended to be applicable/that inspires an innovative solution (Reynaud, 2001). In the actor-centered approach, cognition is certainly reflexive, but is also distributed and even negotiated (Feldman and Rafraeli, 2002), and the formalism of the rule gives way to a broader and therefore more nuanced perimeter of constraints.

D’Adderio (2011) argues that regulatory artifacts have varying degrees of influence on action. Regulation is certainly indispensable to characterize the endogenous or exogenous evolutivity of the organizational routine. Regulation pressure arguably leads to reduced endogenous evolutivity. By implication, it also reduces the autonomous adaptive capacity in organizational change projects.

Managers exert internal selective pressure (Miner, 1994). The emergent character attributed to a routine by some scholars should not be left to chance. If the evolution of the routine cannot be totally determined, it can nonetheless be influenced by managers engaged in establishing material and procedural constraints, along with negotiation of shared cognition. A better understanding of the mechanisms of construction of routines could give rise to solutions that could help managers improve their performance. Cohendet and Llerena (2008, p257) argue that these aspects of routine governance, together with their consequences and managerial opportunities, have received very little attention, which would explain some conceptual weaknesses of organizational routines. The four dimensions discussed above, particularly the latter, can correct this conceptual omission. Therefore, beyond simply distinguishing the literature, the four dimensions of our model represent a chart that managers can use to characterize their routines and their potential evolution. In a process perspective, we will now attempt to grasp the opposing phenomena that underlie the evolutivity of routines from an academic standpoint.

3 Pentland and Feldman's model revisited

Pentland and Feldman's model (2003; 2005) is used widely in administration sciences. Their article "Reconceptualizing Organizational Routines as a Source of Flexibility and Change," published in the *Administrative Science Quarterly* in 2003, has received over 1000 citations in Google Scholar. Their model posits permanent interaction between two very different realities and previously a source of confusion. The interaction is a "generative system" of the recurrence of the routine (Feldman and Pentland, 2005). The ostensive aspect "is the abstract, generalized idea of the routine, or the routine in principle," a general cognitive consideration of the series of iterations of the routine (Feldman and Pentland, 2003 p. 101). The performative aspect "embodies the specific actions, by specific people, at specific times and places, which bring the routine to life." It is a concrete behavioral iteration situated in space and time (Feldman and Pentland, 2003 p. 101). Pentland and Feldman (2005) introduced an artifact aspect in their model that influences both the ostensive and performative aspects of the routine. This model becomes a tool to analyze the consequences of managerial artifacts. The concept of cognitive dissonance (Vaast and Walsham, 2005) is the need felt by an individual to change its representation (ostensive aspect) of the routine when it is inconsistent with actual performative execution of the routine, or inconsistent with the representations that have other members of the routine (Feldman and Rafaeli 2002). The same trend in search of cognitive consonance explains the performative recurrence depending on the actual ostensive aspect of the routine. In this model, the ostensive aspect is both the structure and the outcome of the performative aspect. This co-constitutive duality is pointed out by critical realism as a gap in the structuration theory (Archer 1982).

3.1 The critical realism's argument

In the critical realism paradigm, structural elements generate various events and objects, and inhibit others, thus constituting the actual reality. This actual reality is only in part offered to human experience (Mingers, 2004). IT artifacts and organizational routines can be examined at three reality levels: the empirical, the actual and the structural. Structural elements are not observable directly; only the present reality is. The structural reality is only inferred from our description of empirical reality.

The structurationist paradigm undervalues the importance of temporal sequencing (Archer, 1982), which is nonetheless crucial to understand routine evolutivity. Regarding temporal sequencing, critical realism reinstates the concept of agency. Within structuration theory, human agency is the individual's capacity to act during social interaction. This agency produces and is reproduced by the individual mental structure (the "structural"). Within critical realism, agency does not constitute the structure; rather, it constitutes action. This action constitutes the structure of the following iteration of action. Material or human agency is therefore the mechanism through which persistent structural properties contribute to the generation or inhibition of a present event. Agency is no longer a simple theoretical

liaison between the structural and social interaction (as it is in social structuration theory), but rather the preferred instrument of analysis of the antecedents of action (in the sense of critical realism).

This refocusing of the antecedents of the organizational routine allows us to reconcile the two definitions of a routine: 1) a routine as an expression, that is as an observable recurrence (Pentland and al., 2010); 2) a routine as a propensity, that is as a density of a probability of action (Hodgson, 2008; Knusden, 2008). The sum of enacting agencies generated by different structures constitutes a potential, a propensity (definition 2). This potential engenders a sequence of situated actions, whose recurrent nature eventually allows them to be perceived empirically as a routine (definition 1). These two visions of the routine, which were previously irreconcilable, are therefore necessary to unite the three strata of the routine's reality in the critical realism paradigm (Mingers 2004): real (structural), actual and empirical. We will now examine the consequences on Pentland and Feldman's model (Figure 2).

3.2 Modifications

We make two main changes to the Pentland and Feldman's model (Figure 3). By taking into account the three strata of reality, we distinguish the structure of action and the ostensive aspect of the routine. The issue of structural causes of performance of the action remains therefore intact: what are the structures that determine action (Section 4)? Secondly, we confer to the performative aspect a triple ontology: behavioral, cognitive and material. The material acts and the cognitive flows of the action are therefore located within the performative aspect of the routine.

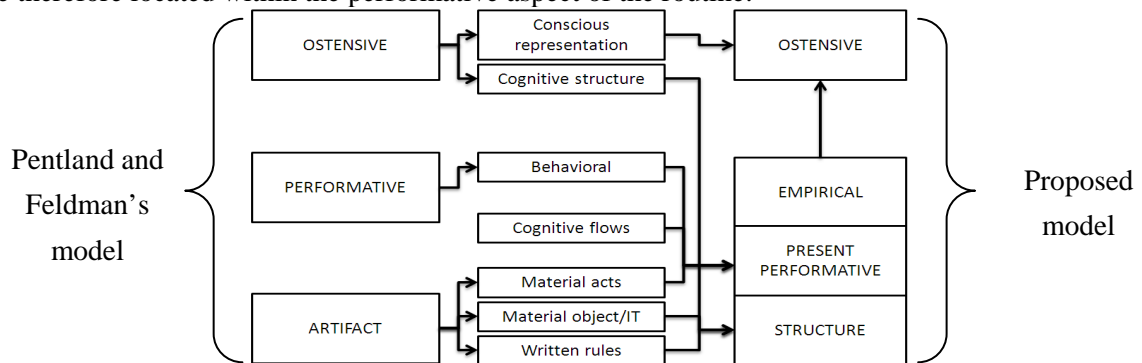


Figure 2. Changes to Pentland and Feldman's model

3.2.1 Modification of the ostensive aspect

Within Pentland and Feldman's model (2003), the ostensive aspect amalgamates two distinct concepts: the cognitive structure and the conscious representation of the routine. The cognitive structure cannot be summarized in the way individuals decide to answer the question: "how would you describe, routine X?" In our proposed model, based on critical realism, the ostensive aspect is only the individuals' conscious representation of the routine resulting from their empirical experiences of the routine. The objectivization of this representation through discussions among members of the routine is an issue that has been discussed in the literature (Feldman and Rafaeli, 2002).

3.2.2 Modification of the performative aspect

In Pentland and Feldman's model (2003), the performative aspect is construed as an improvisation, a permanent adaptation (Pentland and Feldman, 2003), and an effort of accomplishment (Pentland and Reuter, 1994). Other structural elements must therefore support human agency at the heart of the specific performance. In our proposed model, the performative aspect of the organizational routine lies in the actual reality and occurs as resulting from tensions between agencies of structural origin (according to critical realism). The performative aspect has three distinct ontologies: behavioral, cognitive and material. Indeed, action is equipped and thought out simultaneously with its physical

execution. The performative aspect thus possesses three distinct ontologies: behavioral (actual execution of the task), cognitive (cognitive activity before and during the execution of the task) and material (physical supports of the execution of the task). We use the term ontology to describe the incommensurable nature and differing temporalities of these three aspects. They are positioned on a continuum regarding their propensity to persist. Material structure is essentially what remains in the world. The cognitive structure is central to what is commonly known as memory, largely unconscious, which we know to be selective and imperfect. Behavior is inherently evanescent. Behavioral recurrence therefore requires structural persistence of another ontology: cognitive or material.

3.2.3 Modification of the artefact aspect

Pentland and Feldman’s model (2003) dissociate the technological artefact from the performative aspect ontologically. The performative aspect stripped of its material dimension led the proponents of the “artefact turn” (D’Adderio, 2011) to seek this dimension elsewhere: between the ostensive and the performative aspects (Pentland and Feldman, 2005; Volkoff et al., 2007). In our proposed model, we resituate the material dimension in the performative aspect. Indeed, the technological artifact acts at times like a member of the routine. For critical realism, the actual reality of the technological artifact situates it within the performative, and its active role in the execution of the routine makes it an actor of performativity.

In structuration theory, which posits human agency, materiality is structural (of human agency) when it is integrated with its spirit (Jones and Karsten, 2008). Accordingly, concrete confrontation of the human subject with materiality occurs during the interaction (performative). Through this temporal perspective, it is not materiality that mediates the relation between the ostensive and performative (Volkoff et al., 2007; D’Adderio, 2011), but rather the practical performative experiences that allow materiality to be integrated in the human mind and to integrate with the ostensive representation of the routine (and of the technology) (Leonardi, 2011). Similar to procedures, representational and prescriptive artifacts are not easily integrated in Pentland and Feldman’s model, because they are sometimes confused with the ostensive aspect of the routine. We consider that the artifact has structural elements when it generates enacting agency.

3.2.4 Modification of the relation between the three aspects

In Pentland and Feldman’s model, the ostensive and the performative reciprocally build each other (A); the artefact influences and is influenced by this construction (B) (Figure 3). Accordingly, the ostensive is simply the representation of a series of empirical experiences of the performative identified empirically as a routine (C). The performative aspect is the product of the confrontation of the agencies generated by the structures (D). The structures persist but are actualized by the performance of the action and the individual’s consecutive experience (E) (Figure 4)

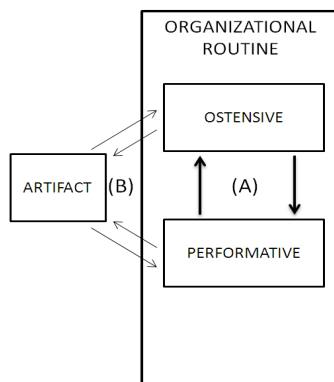


Figure 3. *Pentland and Feldman’s model (2005)*

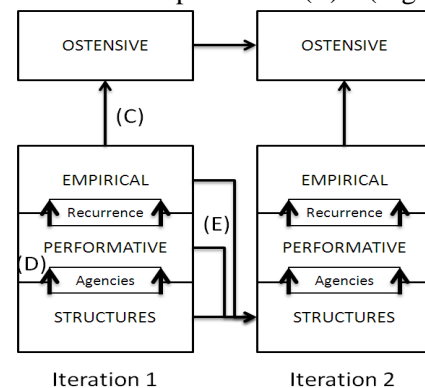


Figure 4. *Proposed structural dynamism of the routine*

4 The central role of IT in the stabilization of routines

Using Pentland and Feldman's model, Volkoff, Strong and Elmes (2007) emphasize the structuring role of the IT artifacts. Artifacts are developed to match to the ostensive representation of the routine defended by the project promoters and considered the performative target of the project. These authors consider that materiality plays a mediating role in organizational change. How is this role realized in practice? To answer this, we will go further by opening the black box of the performative aspect of routines. Performativity has a behavioral, cognitive and material ontology (see previous section). We will describe the structural role of the technological artifact in the generation of agencies in recurrence of routines according to the three ontologies (Figure 5). We can thus determine the potential influence of the artifact on the evolutivity of organizational routines. To illustrate our arguments, a large number of routine tasks and technologies could be mobilized. We focus on PLM (Product Lifecycle Management) technology, which is probably as structuring as ERP, but which has been studied very little (Merminod and Rowe, 2012). However, some works on routines have studied this technology or similar technology (D'Adderio, 2008; Becker and Zirpoli, 2005). The task chosen must match the four dimensions presented in the second section: this task must be interdependent to other tasks, recurrent, regulated, and require some reflexivity. We chose the creation of the metadata record in a CAD file saved in a technical data management system, namely PLM.

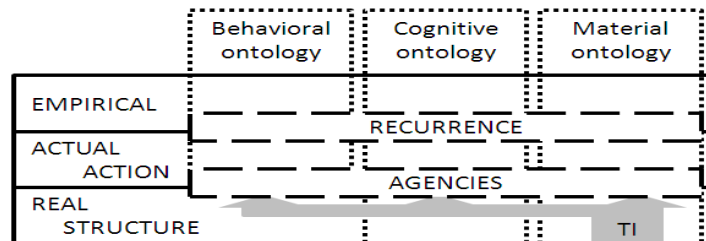


Figure 5. Agentic role of IT on the three ontologies of reality

4.1 Behavioral ontology

The behavioral ontology represents the observable execution of various task sequences of the organizational routine. The technological artifact acts, executing interrelated tasks with an organizational outcome. When designers want to create a CAD record, the tool automatically opens a form to enter a meta-data record to characterize the file, creating enacting agency: metadata entry. The behavioral agencies, which are stimuli of action, are the consequences of the behaviors of other members of the routine, in this case the technology. Beyond this entry task, the artifact also acts when it generates standard synthesis documents based on information contained in the metadata records. Without technology, the origin of behavioral agencies is merely social. Agencies are generated only by the present behavior of other members of the routine. However, because of its structural properties IT can generate persistent behavioral agency. This behavioral agency can either determine an individual's behavior (the literature has used the term functional affordance to designate this agency (Markus and Silver, 2008)), or the behavior of the IT itself.

4.2 Cognitive ontology

Action stimulates and necessitates a flow of sensory and mnesic informations. This informational activity reflects the cognitive ontology of action. This cognitive ontology is the result of the perception of the action situation, along with the concomitant behavioral project. The PLM artefact plays a triple role in the cognitive ontology. First, it is an information storage tool, that is, an external memory for the individual. The PLM contains all the previous metadata records. The designer can thus refer to it to fill in the data creation record. Second, it is the receptacle of a cognitive structure, i.e. a way of considering information. The tool foresees some fields and not others. It can also specify a list of

choices for each field. Third, the tool is active in the cognitive plane because it creates information. The "authoring" functionality characterizes the fact that the tool directly associates the name of the digital profile of the designer with the record created; the information generated is: "X is the creator of Y." Nonetheless, the technological artifact is not the only source of cognitive agency. Other structures come into play, especially the individual's cognitive structure. The human cognitive structure corresponds to mental associative rules, some of which are in unconscious memory, which support cognitive activity during the execution of the routine (Iannacci and Hatzaras, 2012). In our example, the documentary research habits within the tool are important aspects of the individual's attitude toward the entry field. Someone who has not mastered the attribute-based search keys may prefer to search for documents in the document tree visually. They will have a lower propensity to see the value in entering attributes. The cognitive structure may evolve without performance of the routine. An individual who usually solicits a specific person to execute a task of the routine may suddenly decide to turn to another person because he became better acquainted with that person over the weekend. Therefore, the structure of the routine on this ontology is divisible and independent. This is notably what Rerup and Feldman (2011) demonstrate when they discuss the relation between the cognitive structure of the routine and the more global structure of the organization.

4.3 Material ontology

The material ontology of the performative corresponds to the physical environment of the routine: places, tools, forms, objects of production, boundary objects, etc. The routine is thus situated in and inextricable from its physical environment (Hutchins, 1995). This materiality is both the support and the tool of the performance of the action. IT therefore has a rightful place within the material ontology. The structural elements of the IT artifact generate material agencies that favor or inhibit the persistence of both the hardware and software characteristics of the artifact. Therefore, a breakdown or slowdown in the system results from a change in the power relations between the material agents. If the material structure of the IT generates material agencies, they also generate, as we have seen, behavioral and cognitive agencies. PLM thus confers on cognitive and behavioral ontologies the structural solidity of materiality. In doing so, it becomes an important contributor to routinization by making recurrence more probable.

5 Discussion

5.1 Contribution to the debate on routine evolutivity

In common terms, a routine is what does not change. Yet empirically, attempts to precisely describe the way work is done entail acknowledging the evolution in the performance of the tasks within what the actors call a routine. The routine thus evolves, but does not change! Cohen (2007) calls this paradox the "(n)ever-changing world." The performance of occurrences evolves, yet the routine "stays on track" (Schulz, 2008). The most important contribution of Pentland and Feldman's model is that it clearly distinguishes between the representational aspect and the concrete execution aspect of the routine. Their model thus provides an explanation for the weak exogenous evolutivity (or inertia) of the routine: change projects are never sufficiently interested in the actors' ostensive representation of the routine. The actors thus perpetuate actions that they represent as unchanged. Nonetheless, Pentland and Feldman's model cannot explain variation of performative origin. Why do instances of the routine evolve without an express will? To answer this question, we investigated the performative aspect in depth. We proposed a new conceptualization of their model as a model of agentic antecedents of action, foregrounding the propensity of action to recur, to be perceived empirically as a routine and to be ostensibly designated as such. The evolving and stable nature of routines is related to the tension, during the performative moment, between adversarial enacting agencies. In a process perspective, this model is only descriptive and explanatory. We thus propose a more predictive contingency framework of the evolutivity of routines in a variance perspective. These permanent agencies in stability or change seem associated with four variables characterizing organizational routines (interdependence,

reflexivity, temporality and regulations). For practitioners, these variables can be more easily mobilized to predict the evolutivity of their routines. For theorists, these variables allow to discriminate the respective contributions of different work on organizational routines to reduce the ambiguity on the routine concept and its organizational effects.

5.2 Contribution to the debate on sociomateriality

For Leonardi (2011), a routine and a technology are only two mental representations of the same imbrication of human and material agency. Within the performance of the action, the routine and technology are inseparable. We have gone further by examining how IT can generate not only material agencies, but also behavioral and cognitive agencies, making the individual and the machine more interdependent. Therefore, it is increasingly difficult to determine whether people use machines or machines use people. Many routines in organizations can be described as socio-material in this sense. However, people and machines are ontologically very different structurally, and regarding the agencies they generate. It is only collective action that can be called socio-material. Collective action is executed by people and machines simultaneously, but most importantly its agentic antecedents are of human/social and material origins. In his analysis of material agency and organizational routines, Leonardi (2011) did not draw on Pentland and Feldman's model, although it is a reference in IS. We investigated whether this model could accommodate the concept of agency (central to socio-material analysis), to advance this research agenda. This article proposes conceptual clarifications in this respect.

6 References

- Archer, M.S. (1982). "Morphogenesis Versus Structuration: On Combining Structure and Action" *The British Journal of Sociology* 33 (4): 455–483.
- Becker, M.C. (2004). "Organizational Routines: a Review of the Literature" *Industrial and Corporate Change* 13 (4): 643–678.
- Becker, M. C. (2005). "A framework for applying organizational routines in empirical research: linking antecedents, characteristics and performance outcomes of recurrent interaction patterns," *Industrial and Corporate Change* 14 (5): 817–846.
- Becker, M. C., and F. Zirpoli. (2008). "Applying organizational routines in analyzing the behavior of organizations," *Journal of Economic Behavior & Organization* 66 (1): 128–148.
- Cohen, M. D. (2007). "Reading Dewey: Reflections on the Study of Routine," *Organization Studies* 28 (5): 773–786.
- Cohen, M.D., and P. Bacdayan. (1994). "Organizational Routines Are Stored as Procedural Memory: Evidence from a Laboratory Study" *Organization Science* 5 (4): 554–568.
- Cohen, M.D, R. Burkhart, G. Dosi, M. Egidi, L. Marengo, M. Warglien, and S. Winter. (1996). "Routines and Other Recurring Action Patterns of Organizations: Contemporary Research Issues" *Industrial and Corporate Change* 5 (3): 653.
- Cohendet, P., and P. Llerena. (2008). "The Role of Teams and Communities in the Emergence of Organizational Routines" In *Handbook of Organizational Routines*, 256–280. Edward Elgar Publishing.
- D'Adderio, L. (2008). "The Performativity of Routines: Theorising the Influence of Artefacts and Distributed Agencies on Routines Dynamics" *Research Policy* 37 (5): 769–789.
- D'Adderio, L. (2011). "Artifacts at the Centre of Routines: Performing the Material Turn in Routines Theory" *Journal of Institutional Economics* 7 (Special Issue 02): 197–230.
- Feldman, M.S. (2000). "Organizational Routines as a Source of Continuous Change" *Organization* 11 (6): 611–629.
- Feldman, M.S., and B.T. Pentland. (2003). "Reconceptualizing Organizational Routines as a Source of Flexibility and Change" *Administrative Science Quarterly* 48: 94–118.
- Feldman, M.S., and A. Rafaeli. (2002). "Organizational Routines as Sources of Connections and Understandings" *Journal of Management Studies* 39 (3): 309–331.

- Giddens, A. (1987). *La Constitution De La Société: Éléments de la Théorie de la Structuration*. Presses Universitaires de France, Paris.
- Hodgson, G.M. (2008). "The Concept of a Routine" In *Handbook of Organizational Routines*, 15-30. Edward Elgar Publishing.
- Howard-Grenville, J.A. (2005). "The Persistence of Flexible Organizational Routines: The Role of Agency and Organizational Context" *Organization Science*: 618–636.
- Hutchins, E. (1995). "How a Cockpit Remembers Its Speeds" *Cognitive Science* 288: 265–288.
- Iannacci, F., and K.S. Hatzaras. (2012). "Unpacking Ostensive and Performative Aspects of Organisational Routines in the Context of Monitoring Systems: A Critical Realist Approach" *Information and Organization* 22 (1): 1–22.
- Jones, M.R., and H. Karsten. (2008). "Giddens's Structuration Theory and Information Systems Research" *MIS Quarterly* 32 (1): 127–157.
- Knudsen, T. (2008). "Organizational Routines in Evolutionary Theory" In *Handbook of Organizational Routines*, 125–151. Edward Elgar Publishing.
- Lazaric, N., and B. Denis. (2005). "Routinization and Memorization of Tasks in a Workshop: The Case of the Introduction of ISO Norms" *Industrial & Corporate Change* 14 (5): 873–896.
- Leonardi, P.M. (2011). "When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies" *MIS Quarterly* 35 (1): 147–167.
- Levitt, B., and J.G. March. (1988). "Organizational Learning" *Annual Review of Sociology* 14: 319–340.
- March, J.G., and H. Simon. (1958). *Organizations*. New York: J. Wiley.
- Markus, M.L., et M.S. Silver. (2008). "A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole's Concepts of Structural Features and Spirit" *Journal of the Association for Information Systems* 9 (10): 609–632.
- Merminod, V., and F. Rowe. (2012). "How Does PLM Technology Support Knowledge Transfer and Translation in New Product Development? Transparency and Boundary Spanners in an International Context" *Information and Organization* 22 (4): 295–322.
- Miner, A.S. (1994). "Seeking Adaptive Advantage: Evolutionary Theory and Managerial Action" In *Evolutionary Dynamics of Organizations*. Oxford University Press.
- Mingers, J. (2004). "Real-izing Information Systems: Critical Realism as an Underpinning Philosophy for Information Systems" *Information and Organization* 14 (2): 87–103.
- Nelson, R.R., and S.G. Winter. (1982). *An Evolutionary Theory of Economic Change*. Cambridge (Mass.): The Belknap Press of Harvard University Press.
- Novak, L., J. Brooks, C. Gadd, S. Anders, and N. Lorenzi. (2012). "Mediating the Intersections of Organizational Routines During the Introduction of Health IT System" *European Journal of Information Systems* 21 (5): 552–569.
- Pentland, B.T., and M.S. Feldman. (2005). "Organizational Routines as Unit of Analysis" *Industrial and Corporate Change* 14 (5): 793–815.
- Pentland, B.T. (2003). "Conceptualizing and Measuring Variety in the Execution of Organizational Work Processes" *Management Science* 49 (7): 857–870.
- Pentland, B.T., and M.S. Feldman. (2008). "Designing Routines: On the Folly of Designing Artifacts, While Hoping for Patterns of Action" *Information and Organization* 18 (4): 235–250.
- Pentland, B.T., and H.H. Rueter. (1994). "Organizational Routines as Grammars of Action" *Administrative Science Quarterly* 39: 484–510.
- Pentland, B.T., T. Hærem, and D. Hillison. (2010). "Comparing Organizational Routines as Recurrent Patterns of Action" *Organization Studies* 31 (7): 917–940.
- Pentland, B.T., T. Haerem, and D. Hillison. (2011). "The (N)Ever-Changing World: Stability and Change in Organizational Routines" *Organization Science* 22 (6): 1369–1383.
- Rerup, C., and M.S. Feldman. (2011). "Routines as a Source of Change in Organizational Schemata: the Role of Trial-and-error learning" *Academy of Management Journal* 54 (3): 577–610.
- Reynaud, B. (2001). "'Suivre des règles' dans les Organisations." *Revue D'économie Industrielle* 97 (organisations et institutions : la centralité des règles): 53–68.

- Sabherwal, R., D. Robey. (1995). "Reconciling Variance and Process Strategies for Studying Information System Development" *Information Systems Research* 6 (4): 303–327.
- Schulz, M. (2008). "Staying on Track: a Voyage to the Internal Mechanisms of Routine Reproduction" In *Handbook of Organizational Routines*, 228-255. Edward Elgar Publishing.
- Turner, S.F., and V. Rindova. (2012). "A Balancing Act: How Organizations Pursue Consistency in Routine Functioning in the Face of Ongoing Change" *Organization Science* 23 (1): 24–46.
- Vaast, E., and G. Walsham. (2005). "Representations and Actions: the Transformation of Work Practices with IT Use" *Information and Organization* 15: 65–89.
- Volkoff, O., D.M. Strong, and M.B. Elmes. (2007). "Technological Embeddedness and Organizational Change" *Organization Science* 18 (5): 832–848.
- Vromen, J. J. (2011). "Routines as Multilevel Mechanisms," *Journal of Institutional Economics* 7 (Special Issue 02): 175–196.