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THE INSTRUMENTAL GENESIS OF COLLECTIVE ACTIVITY. THE CASE OF AN ERP IMPLEMENTATION IN A LARGE ELECTRICITY PRODUCER

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Abstract:

Collective activity should be a focal subject to study organizational dynamics, particularly in relation with the implementation of management systems such as ERPs. Collective activity is analyzed here as an ongoing dialogical construction by actors. It is always mediated by signs and particularly by instruments. To design and adapt collective activity, a reflexive dialogical exchange between actors, a “collective activity about collective activity”, mediated by instruments, is necessary: we call it “the instrumental genesis of collective activity”. We analyze the case of an ERP implementation at EDF, a large electricity company, in the purchase and procurement area of the production division. The design and implementation of the new system was not clearly viewed as the instrumental genesis of collective activity. Difficulties appeared particularly for cross-functional cooperation and for the construction of new professional profiles of competence. In the light of this case, we suggest that key conditions for the intelligibility and the actionability of collective activity are the establishment of communities and the hybridization of professional competences.

Keywords: Collective Activity, Collective Sensemaking, Community, Dialogical, ERP, Instruments, Instrumental Genesis of Activity, Interpretation, Sign

Résumé :

L'activité collective devrait être un sujet majeur pour l'étude des dynamiques organisationnelles, par exemple dans le cas de la mise en place de systèmes d'information de gestion intégrés (ERP). L'activité collective est analysée ici comme une construction dialogique continue par les acteurs. Elle est toujours médiatisée par des systèmes de signes et en particulier par des instruments. Pour concevoir et adapter l'activité collective, il faut qu'ait lieu un échange dialogique réflexif entre les acteurs, une « activité collective sur l'activité collective », médiatisée par des instruments, que nous dénommons « la genèse instrumentale de l'activité collective ». Nous analysons le cas de la mise en œuvre d'un ERP à EDF, grand opérateur du secteur de l'énergie électrique, dans le domaine des achats et des approvisionnements de la division « production ». La conception et la mise en œuvre du nouveau système n'a pas été clairement identifiée comme genèse instrumentale de l'activité collective. Des difficultés sont apparues, notamment pour ce qui concerne les coopérations transversales (inter-métiers) et pour la construction de nouveaux profils de compétence professionnels. À la lumière de ce cas, nous suggérons que l'établissement de communautés (de métiers et de processus) et l'hybridation des compétences professionnelles sont des conditions clés pour l'intelligibilité et l'actionnabilité de l'activité collective.

Mots-clés : Activité collective, Communauté, Dialogisme, ERP, Genèse instrumentale de l'activité, Instruments, Interprétation, « Sensemaking » collectif, Signe

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Collective activity at the core of organization dynamics

Imagine a few cars stopped on a road because a tree was blown down by a storm. Six drivers try to lift it up to remove it from the road. But their efforts are unsuccessful: the tree is too heavy. One of the drivers then says: “if we synchronized our effort better, maybe we could make it”. Another one proposes: “I count up to three, and at three we all try to lift it together”. The four other drivers agree. He counts, they attempt to lift the tree at “three”, they succeed and move it out of the way. The six drivers have just simultaneously invented a collective activity, which is more than the addition of individual activities, a management instrument: the very simple synchronization count “1-2-3”, and an organization, which appears as an *instrumented collective activity*. This collective activity is obviously interactional – the six drivers spoke to each other and coordinated their actions – but it has also a transactional dimension, in the sense of “trans-action, global action crossing the actors and directed towards the world to transform it” – here, they did not interact for the sake of interaction, they had to remove the tree and they removed it.

We will focus this paper on the central role of collective activity in organization dynamics, or more precisely: the central role of *instrumented* collective activity, since we argue that collective activity is always mediated by instruments (Vygotsky, 1986). To our mind, collective activity should be a focal issue in organization research to meet two objectives:

- intelligibility –to build the theoretical tools required to understand organizational dynamics, particularly in relation with the implementation of management instruments,
- actionability – to improve the actors’ capacity to orientate organizational dynamics.

We shall first propose a theoretical analysis of the organizational transformations triggered by changes in management instrumentation, for instance when integrated management systems (ERP¹, i.e. software which integrates management functions around a common relational data base) are implemented. Our theoretical approach is focused upon the instrumental genesis of collective activity. Then we shall present an in depth case study (SAP implementation in a large electricity company) and its main results: the dialogical construction of collective activity requires community building, the integration of instrument design and utilization in a continuum, and competence hybridization. In the conclusion, we explore some implications for managerial action and for future research.

Part One: Instrumented collective activity as a dialogical sensemaking process

Collective activity as a focal issue in organization dynamics studies

There was already much research about organization dynamics linked to management instruments, particularly ERPs. Some of this research is descriptive and tries to observe what happens when ERPs are implemented, for instance how they impact the practices of management accountants (Granlund & Malmi, 2002) or what motives guide their adoption

¹ Enterprise Resource Planning

(Hyvönen, 2003). Research based upon case studies refers to theories such as the structuration theory (Caglio, 2003), actor networks and boundary objects (Dechow & Mouritsen, 2005; Lodh & Gaffikin, 2003; Quattrone & Hopper 2001, 2005a, 2005b), the evolutionist theory of the firm (Scapens & Jazayeri, 2003), new institutionalism (Gosain, 2004). These contributions bring new insights on organizational changes. Though often criticizing the structural approaches which conceptualize information technologies (IT) as causal drivers of change, they often attribute some autonomous agency to I. T. tools, as vectors of knowledge, “frozen” experience, institutional determinants or interpretive schemes embedded in software.

Our starting point here will be different. We observe that organization dynamics appears in the form of transformations of collective activity, of what actors do and how they do it. That is why an increasing number of researchers look for “an account of the interactional work, the particular embodied practices” (Button, 1993; quoted by Orlikowski & Barley, 2001). In our pragmatist view, organization is characterized as a system of collective activities: designing, producing and selling products, making material or information flows circulate. Those collective transactions roughly correspond to what management literature calls “business processes”. Those collective activities are not the simple addition of individual activities. Coordination and cooperation mechanisms must enable actors to accomplish together some global sensemaking transactions with the world (selling to customers, getting purchased goods delivered...). Work is always "performed in conditions of joint, collective activity (...) Only through a relation with other people does man relate to nature itself, which means that labour appears from the very beginning as a process mediated by tools (in the broad sense) and at the same time mediated socially" (Leont'ev, 1981). Collective activity is interactional (different actors interact) and transactional (it achieves some transaction with the world to transform it).

This is particularly the case for organizational dynamics related with the implementation of managerial instruments. Their actual impact on organizational transformations can hardly be understood or influenced if they are not studied in the context of the collective activities in which they are engaged. Many researchers have already observed that organizational changes linked to management information systems must be apprehended through actors’ practices (Caglio, 2003). This is not only a methodological issue (how to study the implementation of management information systems), but also a theoretical issue: what theory of collective activity should we use to study actors’ practices beyond a mere empirical description? The notion of “individual activity” is questionable, if by “individual activity” we understand some “pre-collective” state of activity. From the very start of acting and thinking, activity is social, since each actor’s activity responds to others’ activities, it calls for others’ activities, it anticipates others’ activities. The global articulation of collective activity is not mere coordination of individual acts, it is collective sensemaking (Weick, 2001) in a permanent conversational elaboration. To view collective activity as a coordination of individual activities would be somehow the same error as viewing conversation as a coordination of monologues.

Collective activity cannot either be described as the execution of pre-existing formal plans. It is rather built in the on-going flow of living and situated experience. Actors mix improvisation and the use of schemes and plans as resources to adapt collective activity in front of circumstances. The transformation of organizations can often be explained through the difficulties met by collective activity. It is not only a matter of intelligibility, it is also a matter of actionability. To act on the organizational utilization of instruments, attention must be given to the way collective activity is transformed *through* instruments. What is proposed here is a kind of upside down turn: instead of looking at collective activity “from” the

instruments, for instance by asking the question “how should we accompany SAP implementation?”, we suggest to look at the instrument “from” collective activity, as one of the components of collective activity, by asking questions such as “how shall we redesign our collective activity with SAP?”.

Collective activity is a dialogical construction of sense

We cooperate with researchers in psychology² to study the organizational factors of work danger in building industries. We recently heard a short dialogue between two workers on a building yard, at the foot of a prefabricated wall which stood three meters from a fixed wall and was maintained by cables. The first operator had to climb to the top of the prefabricated wall. He asked his colleague:

“Are you doing something?”

- Oh yes, I have to check concrete over there, if it is dry I shall work there.
- All right then, I put my ladder on the inner side of the prefabricated wall, between the two walls, so it cannot slide.
- Yes, but if the prefab wall slides, you can be crushed between the two walls, you should not do that!
- I do not think the prefab can slide.
- In that case, I’ll check the concrete later, I’ll maintain your ladder, you put it on the external side of the prefab”.

In the short time of this dialogue, changes take place in the operating modes (position of the ladder), in the cooperation schemes, in the sequence of tasks (“I’ll check later”), in the level and nature of risks. For a while the collective activity takes the form of a conversation between two actors, with an emerging sense which cannot be separated from their discursive interaction in the context and directly modifies subsequent actions. In achieving an organizational transaction which makes sense for them (building a wall in reasonable conditions of time and safety), actors interact to rebuild their activity and keep on making sense of it.

Each individual activity is continuously addressed to others, whether they may be physically present or not. Any actor acts *with* other actors, acts *for* other actors, acts *by* getting their support, acts *by anticipating* their future actions. Other actors are at the same time sources and resources for the subject’s activity: sources, because the subject acts to respond to their action; resources, because the subject needs others to meet his/her own personal objectives. In the same way as speeches make sense only in the pragmatic context of locutors’ interactions (Grice, 1967; Bakhtine, 1929-1973), individual acts make sense only in the frame of collective activity. By acting, actors interpret the situation: the spatial, time and social settings and other actors’ actual or potential acts. To summarize, collective activity is an ongoing and situated *dialogical* (Bakhtine, 1929-1973) construction (in the sense of a dialogue, a conversation in acts) and neither a monological construction nor the simple execution of an abstract representation. In the same way as some philosophers of language observe that any speech is an act, in the theory of “speech acts” (Searle, 1969 & 1979; Grice, 1967), we mean here that any act is a speech, an “act speech”.

Collective activity is situated and reflexive

Collective activity makes sense in a context, or rather it makes sense *with* a context. For instance, when the management accountant presents cost information to the executive committee, the level of cost will be interpreted according to the cost level reached by other factories, the cost level in previous periods, the reputation of the factory manager... The context provides what is “out of the activity”, what was not done but could have been done, what is “off the screen” and definitely contributes to sense.

² This situation was observed and analyzed by Yves Clot, director of the “Clinique de l’activité” research center (Paris) and Julie Dubosc, researcher at the same research center.

While acting together, actors analyze and comment their collective activity, not as isolated subjects, but in a dialogical exchange. In the building yard situation mentioned before, one operator says “you should not do that”, the other one answers “I do not think it can slide”. Actors interpret their activity, by connecting the concrete, singular, “here and now” experience to generic schemes of interpretation, generic meanings: “in this type of situation, the prefabricated wall should not slide”.

Reflexive sensemaking is not only cognitive, it is also emotional (the second operator tacitly means: “you might be right, but still I am frightened, I do not wish to let you try”) and evaluative (“if you do so, is the general objective of safety respected? but if I postpone my other task, can we finish the building in time?”) So the immediate transformative level of collective activity (“we build a wall”) is duplicated by a reflexive level (“how should we build this wall together?) which permanently challenges the first level and interprets it. Both levels are dialogical: acts “speak to” acts, act interpretation “speaks to” act interpretation.

Reflexivity and dialogism are closely interconnected. According to the way actors exchange about their collective activity, they design its social configuration. The answer to the question “what are we doing?” is directly connected with the answer to the question “who is ‘we’? who should be involved in the reflexive discussion?”. For instance, in the building company, we established a cross-functional group to study the drivers of danger linked to design options in the first phases of a project. Most members of the group consider the architectural design of the building as a given circumstance which they cannot influence. There is no architect in the group. In their minds their collective activity does not include architectural design and architects do not belong to the community in charge of improving safety. This may change: in some projects, there is now an early association of the architect with the building company.

Collective activity is mediated

Reflexivity and cooperativeness are ensured by the permanent “inscription” (Latour, 1999; Quattrone & Hopper 2005b, Robson, 1992) of collective activity in systems of signs³: speeches or texts in natural or technical languages, gestures, instruments (accounting, performance measurements, procedures...). Actors permanently interpret their collective activity with and through signs, including the formal stylizations of activity itself: prescribed tasks, definition of missions. The concrete activity, always unique, is conceptualized, discussed and interpreted by actors through generic descriptions and labels. Conscious human activity is thought by human actors through semiotic mediations (Vygotsky, 1986), languages and tools, to which the semiotic theory (Eco, 1983) can be applied:

- Signs provide a partial and simplified image of the concrete activity, by attaching it to generic classes of activity, in the same way as a word (“table”) links a singular object (this wooden table) to a generic class of objects (the tables); this semiotic translation sacrifices many of the concrete activity attributes, providing an impoverished image of it; when a worker says “I am drilling a part”, he gives a limited account of his activity which ignores an infinite richness of gestures and feelings.
- But this semiotic translation is not neutral and purposeless: the choice of the signs refers to specific directions in sensemaking, justified by intended actions; for instance, “part drilling” attaches the present singular activity to a professional category, with generic knowledge, rules and values. If the controller refers to an activity by its cost structure, he/she reduces the concrete activity to an economic signification but opens the way to cost analysis and action. The signs impoverish the image of concrete activity, but they also enrich it by opening repertoires of significations and action potentials that would not exist otherwise.
- The signs of the activity create a distance between the subjects and their own activity and abstract activity from the singular experience. They allow reflexivity: to think about their activity, actors must represent it in thinkable and workable ways.
- The signs are socially embedded. They refer to some shared glossary of meanings⁴ which assures a common understanding basis. This does not preclude that signs may be ambiguous or interpreted in personal ways. But there is a certain level of socially agreed limits to interpretive schemes within the community of “sign users”. This common “area of acceptable meanings” is the basis which allows collective activity to develop as a dialogical exchange.

The instrumental genesis of collective activity

Amongst systems of signs engaged in collective activity, instruments play a major role, because of their dual nature (Rabardel, 1999) as artefacts and schemes of utilization:

- they belong to the world of things, because they are objective *artefacts* such as computer code, drawings, texts, material objects which oppose their inertia to actors,
- they belong to the subjective world of actors’ thought: actors interpret them as potential or actual activity, through their design (potential activity) and utilization

³ By « signs » we mean any interpretive triad (Peirce): 1 object / 2 significans or symbol / 3 signification or interpretive scheme. Instruments are signs (their structure and shape are interpreted), the measurements they produce are signs, actors’ acts are signs.

⁴ We use here « sense » and « meaning » in the following way: « meaning » is the generic scheme of interpretation – what a dictionary or a common professional culture can give ; « sense » is the situated understanding that actors can build in a concrete experience to determine the course of action; meanings are resources for sensemaking.

(actual activity); instruments are present in mental processes of interpretation, as *schemes of utilization*⁵. Without schemes of utilization, artefacts are not instruments, they remain meaningless “things”. The schemes of utilization mix individual and organizational norms of utilization (rules of coordination, structure of roles in the utilization of the instrument).

This double nature allows instruments to be fundamental mediators of collective activity, as analyzed by activity psychologists (Vygotsky, 1986; Rabardel, 1999). This dual nature is mentioned by management researchers in studies about IS implementation: “we distinguish between ERP as a technology of database module and ERP as a system, the latter only becoming “system” through both design and use” (Dechow & Mouritsen, 2005).

As any type of sign, instruments simultaneously constrain and enable activity by attaching it to a generic class of meaning, here a generic “utilization of the instrument”. Constraints derive from both their physical and structural characteristics and the social habits which prevail in their utilization scheme. Instruments also enable collective activity: they allow to do things which would have been impossible otherwise. For instance, the cost of the activity allows to compare it with other activities, to cumulate activities in the budget forecast, to assign cost objectives. Potential constraints and affordances⁶ (Gibson, 1977) are infinite and human agency plays a key role in enacting some of them, “shaping either the design or the use of technologies” (Orlikowski & Barley, 2001).

By using instruments, actors translate objective artefacts into collective activity. By designing instruments, they translate imagined future collective activity into artefacts. In this correspondence between objective artefacts and collective activity, instruments may appear as a kind of social memory, as if they froze collective activity and interpretive schemes. But the reproduction of similar schemes of action throughout periods of time is not the automatic power of artefacts, it is the permanent product of human interpretation, in the same way as language is not the static depository of culture, but permanently evolves through uses.

On the background of the generic utilization of instruments, individual actors express their own experience and creativity in their particular way to adapt instruments to their needs, in their *style* of utilization, which is similar to the style of writers in using language (Bakhtine, 1929-1973; Barthes, 1953). At times actors can deviate from generic prescriptions, achieving a stylistic innovation. This stylistic innovation can provide a critical view of generic practices. If it is convincing and effective, it can be imitated and it can transform the *genre* of activity. This iteration between *genre* and style is one of the key mechanisms of organization dynamics. “Genres” dynamize personal activities, styles dynamize generic practices (Clot, 1999).

As Quattrone and Hopper observe, through the design and utilization of instruments, actors can define the spatial, time and social settings of collective activity (Quattrone & Hopper, 2005a). Instruments have the semiotic power to make what is far away in space or time (persons and things) present here and now. They provide some freedom to configure collective activity. For instance, a supply chain management system can integrate salesmen based in regional agencies, who made sales forecasts last month, manufacturing planners in factories, logistic planners at corporate headquarters, in the same collective activity. This configuring power can be used to “control at a distance” (Robson, 1992).

⁵ we use the words « utilization » and “use” in the following way: « utilization » is the « generic interpretive scheme », distinct from the concrete “here and now” use.

⁶ by “affordance” we mean some specific utilization that the structural characteristics of an artefact make possible.

Instruments bring generic meanings to the situation, but the actual sense is situated, since sensemaking is particularly related with “off the screen” elements. There is “much instrument” out of the activity: the instrument opens the way to a wide range of utilizations, of which a small part is actually activated. Through the instrument the actor “speaks of” what is done but also of what is not done. Instruments can point at potential and impeded activity, one source for innovation. Symmetrically, to make instrument utilization effective, actors do a lot of things which are not formally represented in the instrument. There is “much activity” out of the instrument.

Instruments impose different levels of constraint upon organizational norms of collective activity. For instance, a hammer is more constraining for the individual work than for collective activities, whereas some instruments like the fordian assembly chain or ERPs internalize organizational norms which strongly constrain collective activity.

Part Two: EDF case study

The context: EDF

EDF (Electricité de France) is a state-owned company which produces electricity in nuclear, hydraulic and thermal plants, transports, sells and delivers it to customers, designs and engineers electricity infrastructure. It has 42 million clients. Sales amounted to 46,9 MM€ in 2004. It employs 161 300 employees. It is the first producer in Europe (74% nuclear). Most nuclear reactors are based upon the same technology (Pressurized Water), with a high level of standardization.

EDF faces major strategic changes. Till 2004, it was a regulated public service, 100% owned by the French state. In 2004, it was transformed into a public incorporated company. The majority of shares are still owned by the French state, but a minority was sold on the financial market. Traditionally, EDF culture was based upon the notion of general interest; technical and economic rationality, the social dialogue with powerful trade unions. On deregulated markets, it is necessary to achieve sufficient profits to fund the international development of the company, the expensive dismantling of old nuclear stations and the development of new types of reactors. Due to the fairly high cost level of the company, cost-cutting becomes an important issue.

The Production and Engineering Branch (PEB) controls core nuclear technologies; it is the dominant investor within the group, and it faces the delicate challenge of nuclear dismantling and safety. PEB defined its own priorities: nuclear safety; cost-cutting in support functions (accounting, human resources, information systems) and in procurements (spare parts, equipments, subcontracted maintenance work); reinforcement of economic values in the predominantly technical culture; more flexible management practices.

SAP at EDF

In 2001, EDF decided to implement SAP/R/3 in the whole company, in 6 years, from 2001 to 2007, under the name of “PGI”. A strong project team was constituted. It was decided to impose an 80% standardised version, with some additional customerized tools (20%) to make SAP more accessible to a wide population of non-expert users. This orientation logically entailed the decision to reengineer business processes in a significant way, to adapt them to SAP architecture. SAP was seen as a major vector of change. A management master plan was defined and imposed to all branches.

PGI is an ambitious project: with several thousands of users, it is one of the biggest SAP platforms in Europe. PGI is implemented as an integrated solution, covering accounting, control, purchasing and procurements, inventory management, time and activity management

and sales. It is implemented branch by branch. It was decided to start with PEB, because this branch has a strong culture of rigour and control, due to nuclear safety requirements. PEB followed a division by division schedule: first (2002), PGI was implemented in the thermal and hydraulic division, which appeared as a convenient testing pilot, since it is much smaller and less sensitive than the nuclear division. Then the Nuclear Power Division and the Support Services Division (central accounting, human resource management, communication, finance, engineering support) followed, from December 2002 to February 2004.

Research methodology

At the end of 2004, EDF managers accepted that we analyze the organizational impact of SAP implementation. Due to the size of the company, we limited the research to the purchasing and procurement process in PEB. PGI had already been working for one year in that branch. We started our study in January 2005 and reported results in September 2005. This research could benefit from our previous in-depth knowledge of the purchasing processes at EDF, since we had observed the transformation of management systems and practices at the corporate purchasing department for three years.

Our study was participant observation. We had no operational mission, but the company expected some feedback to adjust future PGI implementation methods. PGI was globally considered as a success, since the system supplied the expected information with no major delay nor overspending. But EDF managers were aware that the new system generated difficulties which might prove to be serious on the longer run: there were less productivity gains than expected and some psychological and social tensions could be noted.

We followed an abductive process of research: semi-structured interviews of approximately 70 persons (PGI designers, PGI users, senior managers), some of them twice; access to all the Lotus Note documents related to the PGI project: we selected and analyzed some 100 documents (minutes of meetings, reports, instructions, procedures, training supports, methodological tools, action plans...); gradual adjustment of the theoretical frame.

The research project involved two entities:

- a project team in which we cooperated with two EDF managers (one representative of the corporate purchasing department, one representative of PEB); we made all the interviews with at least one of them;
- a steering committee, in which we reported the progress of our study to two senior managers: PEB N°2 manager and the controller of the corporate purchasing department; the steering committee met three times.

To further limit the scope of our study, it was decided to focus upon the Rhône-Alpes region, which has an important concentration of engineering, production (nuclear power plants in the Rhône valley and hydraulic plants in the Alps) and service units (Lyon regional headquarters). We alternately interviewed EDF employees on their working sites (nuclear plant, hydraulic units, offices in Lyon) and central managers at Paris corporate headquarters. We met maintenance technicians, maintenance managers, regional and corporate accountants, local procurement managers, regional and national purchasers, PGI project team members.

PGI at PEB: the purchasing and procurement process

Purchase and procurement is one of the most important PGI functions at PEB. EDF procurements, excluding fuel (oil, gas, uranium), amount to some 7 MM€ A PGI subproject team was established for this process, with purchasing and IS specialists. In the purchasing area, PGI was expected to allow economies of scale by centralizing the management of

suppliers and purchased articles repertoires, by diminishing the number of suppliers and by reducing the diversity of articles.

Important changes affected the purchase and procurement process:

- in some units, there was a strong decrease in the number of employees who can make a purchase request (PR); for instance, in the engineering department the number decreased from 140 to 60;
- at the same time, there was a strong increase in the number of the direct users of the information system; traditionally, technicians communicated with controllers, accountants and purchasers through paper documents; they must now make their transactions in PGI;
- the PR, which was a merely technical document, now involves budget imputation, accounting imputation and tax regime;
- since the management of the repertoires of suppliers, articles and contracts is centralized, technicians lose all direct contacts with suppliers;
- the acceptance of deliveries, which was before a purely technical event, has now become an important financial event, since it automatically gives the authorization for supplier's payment; if the delivery is not formally accepted by the technician in PGI, the supplier cannot be paid.

One of the most difficult issues for the project team was data reliability. So far, the role of maintenance technicians had been limited to define technical requirements for purchases, but accounting and budget data were captured by accountants and controllers. With PGI, the majority of data would be captured by employees with a low management culture. To make it easier and safer, the project team developed an ergonomic intranet interface for maintenance technicians.

Change management

PEB management realized PGI required a lot of change management, which was entrusted to a small team of three, supported by consultants. They adopted a method based upon “impact studies” made for each unit in a standard format (format of impact studies in annex 2). For each professional profile, a local team built a matrix to weigh the importance of professional changes on four axes: Culture, Organization, Professional competence, Tool. Actions were defined: training, documenting, communication, peer-to-peer assistance, hot line, job redefinition, recruitments.

It is noteworthy to observe some limitations in this change management methodology:

- change is only managed on a unit by unit basis, and, within units, on a job by job basis; there is neither cross-functional, business process-oriented studies, nor impact studies for entire professional groups, across units;
- change actions are focused upon training, peer-to-peer, i. e. upon individuals; little is done in the collective dimension, for instance by establishing communities of practice;
- training itself is focused upon the transactional use of the software; for instance in a nuclear plant, the impact study recommended: “the purchasing requester (maintenance technician) must attend a one day training session to master the tool transactions necessary to establish and capture the request”;
- there was a strong discontinuity between the design and the utilization phases: little was said about the ongoing design adjustments during utilization.

These remarks are not only an “ex post “ observation; there were alarms before, notably because some units had already experimented previous versions of SAP. In 1999 a consultant was asked to audit 1997-1998 SAP implementations. He concluded that “business process reengineering efforts have been insufficient; changes have been underestimated and change management was not sufficient; training was too focused upon the tool itself, and not enough on professional transformations; it did not either take into account the cross-functional business process dimension”. In 2003, on several production sites, local purchasers recommended to extend the training of maintenance technicians to basic accounting and management, warning in one nuclear site: “technicians will not only capture their purchase request, they will participate in the whole process: in negotiating contracts, in following up orders. They will need to see the whole business process in the training, not only their own transactions”.

We do not mean that the PGI project was mismanaged, but that the cultural tendency to see tool, on one side, and collective activity, on the other side, as two separate elements, is strong. In 2004, an international consulting firm was asked to audit the situation of the accounting function after PGI implementation. The productivity gains expected in the accounting function had not been obtained. The consultants limited their study to accountants. They concluded that “it is necessary to reduce the number of suppliers’ bills which miss technicians’ acceptance by 50%; for that purpose, it is recommended to implement an automatic workflow system which will emit automatic reminders to technicians for deliveries without acceptance”. Neither the consultants nor the accounting managers seemed to give attention to the effects of “automatic reminders” upon collective activity: workload of technicians, potential tensions, cooperativeness.

The emergence of communities in the process of research itself

The interviews were partly individual and partly collective. In the visited units, we met small homogeneous groups of 3 to 5 PGI users belonging to the same professional profile. For instance, in the nuclear plant, we met groups of 4 maintenance managers (in charge of

validating purchasing requests), 5 maintenance technicians (purchase requesters), 4 local procurement managers (in charge of ordering). An interesting phenomenon took place during most of those collective interviews: the ephemeral emergence of “users’ communities”. Typically, one of the interviewed persons mentioned a difficulty he/she met to accomplish the job with PGI. One of the other interviewees, who was also one of his/her professional peers, then responded to him to present some solution he/she had found. A dialogue – or more often a multilocutor conversation – started between our interviewees. For a while, we silently listened to them (see annex 3 for an example of such a conversation). Our status temporarily evolved from interviewers to observers of a dialogical exchange between actors, first about PGI use, but it often moved to a more general debate about collective activity. The conversation became a reflexive collective activity about the collective activity of their daily operations. However, since collective interviews were always achieved with professionally homogeneous groups of people, never with heterogeneous business process groups gathering the different actors of the procurement process (more complex to organize), the collective interviews were often “haunted by ghosts”: there were strong calls from present actors towards absent ones, in a dialogical but truncated exchange.

Variety in the local design of collective activity instrumented by PGI

The architecture of SAP, based upon a business process model, imposes structural constraints to collective activity: unique data capture, cross-locked transactions. Nevertheless, we could verify that the actual design of collective activity could significantly vary from one unit to another (three examples in annex 4). Several parameters may have influenced the local design of collective activity: geographic dispersion, structure of supplies (more or less concentrated and standardized), nature of supplies (parts and equipments, subcontracted work, studies). But variations also seem to proceed from local history, culture and sensemaking vision of the future. For instance, the sentence: “we must move towards a project-based organization” could be heard in some units, not in others. It appears that SAP constrained but did not determine collective activity.

The technicians-purchasers relation

Collective activity varies, but it is always highly cross-functional, whereas, as we saw before, in the preparation phase, it seems that the business process dimension was not really anticipated. In the present use of PGI, cross-functionality remains a sensitive point, particularly in the relations between three groups of actors: maintenance technicians, purchasers and accountants.

Both technicians and purchasers complain about the lack of cooperation. The technicians regret the insufficient purchasers’ knowledge of technical operations. For instance, hydraulic technicians suffer from specific constraints related with the geographical peculiarities of their activity: small dams in the mountains, some of them very far from towns down in the valley. The corporate purchasing policy (centralizing the management of the suppliers’ panel and reducing the number of suppliers) is a frequent source of problems for them, because they need access to small local suppliers. The policy was applied in a fairly rigid way to avoid permanent renegotiation, but hydraulic technicians conclude that their colleagues in the purchasing function do not understand their job. Engineers in the engineering center for the dismantling of nuclear units have the same type of complaint: from Lyon they must coordinate six or seven dismantling sites all over France, and they face geographic limitations in the use of suppliers which do not always take into account this specificity.

On their side, purchasers regret that technicians often make mistakes in their purchase requests: they do not choose the right article code, they do not refer to the right frame contract; those mistakes entail a heavy work of “undoing” and “redoing”.

Both groups seem to lack the global vision of the business process and behave in contradictory ways. For instance, when a purchasing contract covers several successive years, to limit their administrative workload, technical line managers tend to establish a single order for the whole period, with monthly deliveries triggered by simple mails. This choice entails budget overcommitment: the whole sum is charged to the first year budget. On the other side, purchasers, who are in charge of the economic performance of purchases, tend to recommend a month by month ordering, which involves 12 orders per article and per year and a heavy clerical work. Tensions result from those partial visions.

The accountants-technicians relation

Technicians impact accounting directly through the choice of an article-code in the purchase request; the article code automatically determines the account code and the tax regime. Accountants complain about the frequent mistakes, which oblige them to cancel and reconstruct the whole process at the end, through complex PGI transactions. But technicians complain that accountants are not available enough to coach them. They observe that the textual definition of accounts is not always clear and that the link between article and account is not always logical (for instance, some articles which they often need for current maintenance happen to be linked with investment accounts).

The other delicate point in the process is the acceptance of delivery by technicians: the acceptance automatically involves authorization to pay. It is a new responsibility for technicians. They often hesitate to give this agreement. If they take too long, the accountants receive the bill before the delivery is formally accepted, and they cannot pay it. The accountants face suppliers' claims, but the technicians feel overloaded with accountants' systematic reminders.

The accountants-purchasers relation

Those two groups also have mutual understanding problems, particularly as regards the modelling of frame contracts. Purchasers design frame contracts in which they define the generic decomposition of an outsourced maintenance service in lots and partial deliveries, which strongly constrain the way the service will be concretely achieved for technicians and will be billed to accountants. Purchasers also specify the article codes which must be used for a certain type of supply. Article codes determine accounts and tax rules: accountants complain that purchasers do not really know tax and accounting constraints when they design contracts.

Problems often appear as bilateral difficulties between two categories of actors, but actually, when analyzed carefully, they prove to be more complex multilateral conversational problems. “One to one” dialogues just seem to be an endless process of unsuccessful attempts to coordinate, because the third actor is always a “ghost” whose ignored constraints (and capacities) will later oppose their inertia to apparent solutions (example of “the steam valve story” in annex 5).

The importance of redefining professional roles in collective activity: the case of technicians

As the collective interviews showed, professional profiles incur deep redefinitions. For instance, the job of the maintenance technicians was traditionally seen as an exclusively technical craft: officially titled *preparators*, they had to prepare the maintenance intervention

of subcontractors. In the new activity model introduced into PEB with PGI, technicians are assigned a broader role: they accomplish accounting gestures, authorize suppliers' payment, check budget availability, define their requirements from a technical but also from a managerial (delivery and bill scheduling) point of view. To summarize, they are supposed to become project managers. Their title changes, from *preparator* to *intervention manager*. By writing the specifications of the purchase, they constrain future tenders, contract negotiation, billing and bill control. So it is of the utmost importance that the technician has a global understanding of the whole process and of his colleagues' functions.

How many of the technicians are able and willing to face such a conversion? What should be the target population of PGI users? In many units, the formal answer to this question was: "all the maintenance technicians should be PGI users". Actually it appears that the population of "preparators" splits in two groups: those who lack the aptitude or the will to widen their range of competences, those who are ready to acquire new managerial competences. This is not a consequence logically driven by PGI implementation, but rather the effect of the general redesign of collective activity. It was instrumented and not determined by SAP.

The case of purchasers and accountants

Similar questions are raised by the new roles of accountants and purchasers. Traditionally the purchaser had almost exclusively been a price negotiator. He/she is now asked to manage the economic performance of purchases, by following financial and non financial indicators. He/she must measure the economic effects of standardization, suppliers concentration and subcontracting. Purchasers are also asked to explain the new purchasing policy to line managers and technicians who do not understand and accept it easily. They must also ensure the "after sale service" of the frame contracts they negotiate, by coaching technicians when they use them. Above all, the design of frame contracts appears more and more as the purchasers' critical activity. The frame contract is a genuine model of its future utilization by technicians and accountants, through the decomposition of service into lots and the definition of articles. Purchasers must demonstrate a good knowledge of accountants' and technicians' jobs to design frame contracts which are easy to use. Here again the purchasers' population splits in two groups: those who believe their legitimate competence remains negotiation, those who wish to widen their range of competence and to become "purchase managers".

The same type of observation can be made with accountants, as many researchers have already observed (Scapens & Jazayeri, 2003; Caglio, 2003). They no longer produce primary data; they control them. They are expected to play a role of coaching and to cooperate with technicians in an ongoing way. To assure this role, they must acquire a basic understanding of technical operations.

The general aspiration for functional communities of practice and the need for process communities

In front of such radical transformations of their function, all interviewed actors expressed the aspiration to avoid solitude and to share experience with their peers. They repetitively suggested to establish communities of PGI users of the same professional profile, either on a given site, if the concerned population is large enough, or across different sites if the local concerned population is not sufficient. For instance, the maintenance technicians of the nuclear plant suggested to organize a community of technicians using PGI on this site (a population of around 150 persons). The managers of maintenance services (mechanics, control and command, boilers, etc.), a population of around 10 to 12 persons per unit, wished the establishment of a community of maintenance managers across the 5 or 6 nuclear plants of

the region. In a strikingly convergent way, all those interviewees seemed to define communities of practice (Wenger, 1998; Wenger & Snyder, 2000). PGI appeared as a trigger rather than as the real focal point of this requirement, since the discussion started with PGI problems of utilization, but quickly moved to more general collective activity characteristics. In such professional “genre” communities, formed by the actors who achieve the same generic activity and use the same generic transactions in PGI; actors wished to build generic professional practices and generic competence profiles.

But there was also a more implicit requirement for process communities, to be formed by the actors who achieve complementary activities and use complementary transactions in PGI, to adapt the structure of roles, the coordination modes and the role of managers, who “must learn to: identify shared goals, share information, reach consensus, promoting the trust necessary for developing and sustaining such relationships” (Scapens & Jazayeri, 2003).

Key competences in design activities

Today the debate about the improvement of the “purchase and procurement” process focuses upon three critical issues: the modelling of frame contracts; the design of suppliers, articles and accounts bases; the design of purchase specifications. All of those three activities are about instrument design, with a clear dialogical dimension. When modelling a frame contract, the purchaser addresses to technicians and accountants, whether they are present and identified or not. The purchaser’s aptitude to model contracts which are easy to use depends upon his competence, but it also depends upon technicians’ and accountants’ aptitude to express their constraints and needs in clear ways. Contract modelling designs an instrument, the contract, which will play an important role in later phases of the collective activity. In the same way, when the technician designs the purchase specifications, he addresses to the purchaser, who will order with those specifications, and to the accountant, who will control bills with it. Again, this is a dialogical activity: technicians, purchasers and accountants must build mutual understanding and cooperation.

Hybridization of competences

EDF generic trio “purchaser-technician-accountant” illustrates the dialogical nature of collective activity, and the need for some understanding of other actors’ specific roles. With ERPs “we are witnessing a phenomenon of *hybridization*” (Caglio, 2003), i.e. “the enlargement in the set of practices and legitimated competencies which make up the domain of a specific expertise” (Kurunmäki, 2001). This evolution can be observed whenever a company experiences the development of cross functional collective activities: business process management, total quality, just in time, project management. ERPs do not “carry” cross functional activity *per se*. If the organization cannot develop cross functional collective activities, ERPs can simply fail or be used in degraded modes.

The hybridization of competences is a dialogical requirement. When actors develop the cross-functional configurations of their collective activity, mutual understanding requires some “overlapping” of their domains of meaning. They face shared artefacts (PGI, frame contracts, purchase specifications, accounting models) which do not *per se* ensure that meanings are shared. They must make sense of the situation in such a way that they can go on acting together. In the same way, locutors engaged in a conversation must have some common linguistic material to communicate (for instance, the same natural language), but this is not sufficient. They must also have some shared interpretive background, history- and experience-based, to draw meanings from the same discourses which are compatible to act

together, even if it does not reach the point where “everyone of us knew the problem of everyone else, independently from the specific function” (Caglio).

Hybridization is not a mechanistic iteration between actors and instruments, by which accountants would “deposit” their knowledge in SAP and line managers would “collect” this knowledge in SAP. Hybridization is the source and the product of dialogical and situated interactions between actors who belong to different professional groups. Instruments can help this dialogical construction, as much as they can hamper it. For instance the tendency of the centralized accounting function at EDF-PEB to use the I.S. as a unilateral pressure (automatic reminders) against technicians might endanger the capacity to cooperate.

Conclusion: the instrumental genesis of collective activity

Instrumental design is more than the design of instruments: it is the instrumental genesis of collective activity. “Genesis” rather than “design”: “design” connotes some deliberate and predetermined construction, whereas we see the “genesis” of an instrument as exploratory trials leading to partially unpredictable practical consequences. The effectiveness of collective choices is not the static issue of “making options visible” in one precise moment, thanks to the “true” representations. It is rather a dialogical and ongoing issue: how do actors interact, to pragmatically make sense of their interactions? Articles, suppliers and accounts must continuously be adapted and redefined. Frame contracts are permanently renegotiated. The effective achievement of collective activity is a matter of permanent interactions, which must not only ensure the normal daily operation of the purchase and procurement process, but must also ensure its permanent reconstruction. What is at stake is a collective activity about collective activity.

The use of instruments does not guarantee this necessary reflexivity. Since the activity is collective and dialogical, reflexivity about it must also be collective and dialogical. Isolated actors do not have the means to (re)build the collective activity by themselves. They control only pieces of the puzzle. Only communities can reflexively build collective activity. This questions the separation between design and utilization. At EDF, PGI designers addressed the future PGI users, who were not actively involved but nevertheless were addressed. When adapting the utilization of PGI, the users responded to the designers, who were not involved in the field but nevertheless were addressed. Even if they did not modify the PGI artefact as a set of computer codes, users modified PGI as an instrument by transforming its scheme of utilization. There was a continuous reconstruction of instruments – and of instrument utilization, i.e. of collective activity. But, because of the different configurations of involved actors and addressed actors, absent players become problematic “ghosts”. For lack of “collective activity about collective activity”, collective activity becomes a difficult challenge. By making the relevant communities effective, the actors make collective activity arguable and actionable. The relation between activity building and community building appears as a key issue the intelligibility and the actionability of collective activity and to enhance the practical meaning of the sentence: “we act together”. Therefore it should also be a key issue for managers and researchers.

ANNEX 1: DECISIONS AND DECISION LEVELS FOR THE NEW PURCHASE AND PROCUREMENT PROCESS ORGANIZATION

1. at the corporate level, it was decided that:
 - the bases of suppliers, articles, frame contracts would be centrally managed, to impose a purchasing policy oriented towards scale economies;
 - there would be no paper purchase requests;
 - there would be only one level of validation (simultaneously technical and budgetary) for PR;
 - the acceptance of purchased goods and services would be achieved 100% in PGI;
 - the supplier's bill would be 100% controlled in PGI;
 - above a certain amount, orders would be established in a centralized way by the corporate purchasing department.
2. at Production and Engineering Branch level, it was decided that:
 - whenever possible, purchasing would be achieved through centrally negotiated frame contracts;
 - there would be only one (technical and financial) acceptance of the deliveries,
 - the suppliers' bills would be controlled by the regional accounting services.

ANNEX 2: THE STANDARD FORMAT OF IMPACT STUDIES ACHIEVED IN EACH UNIT

- description of the local and human environment,
- main human and social impacts generated by PGI and consequences for the organization,
- description of the action plans required to manage those impacts:
- required changes for each professional profile (maintenance technician, first line manager, accountant, controller, purchase manager...) in each unit,
- actions of communication about PGI,
- optimization of the structure of roles and division of labor on the site,
- optimization of the list of PGI users,
- definition of support requirements.

ANNEX 3: A CONVERSATION HEARD DURING THE COLLECTIVE INTERVIEW OF MAINTENANCE TECHNICIANS IN A PRODUCTION UNIT

“(A) They (PGI project team) did not really want us to use PGI as such, apparently they thought it was too complex for us! Actually the intranet interface they gave us is a tool for illiterates!

(B) You exaggerate. Personally I am glad to have the intranet interface, when I listen to colleagues who use PGI I had better to escape it! For what I must do the frontal interface is quite sufficient.

(A) Not for me, really! I do not complain for the sake of complaining, but there are important things I could do before I cannot do now, and in spite of instructions, I must use paper again. This is reverse progress, backwards!

(C) What can't you do, for instance?

(A) For instance, when I write the purchase request, the screen I have on the intranet offers a very poor content capacity. There is a lot of important information in my technical specifications that I cannot include in the interface and however the procurement manager needs to know them to understand the context exactly, what kind of supplier I need, what precise conditions their intervention will have to respect, all kinds of information necessary to make a contract. So I have to print my specifications and to fax them to the procurement manager.

(C) This is not so frequent and it is not that tragic: I do it too from time to time.

(A) In my case, I must do it systematically.

(B) But you do not need to do so! You can send your documents in electronic form through PGI!

(A) No, I cannot. I asked the PGI project team: no way.

(B) But now you can! I do it every week! It has been feasible for more than 3 months! You have an electronic document function which allows you to post piles of technical documents as annexes to your purchase request, within the intranet interface system!

(A) Are you sure? But who knows that?

(B) I do! I can show you, if you want, it is very simple.

(C) Well, I am interested, too, though in many cases I think that the technical information for the procurement manager can be greatly simplified, we have bad habits, we overinform. But we should meet from time to time, technicians with technicians, about such issues, I am sure we could learn a lot and it would make life easier!”

ANNEX 4: THREE DIFFERENT MODELS OF BUSINESS PROCESS ACTUALLY MET IN DIFFERENT UNITS

Profile A (nuclear plant)

Transaction	Actor achieving the transaction
Purchase request in PGI	Technician (preparator)
Hard copy of complementary technical documents	Technician (preparator)
Consultation for the technical validation by mail, out of PGI	Maintenance service manager
Validation (unique: technical and financial) in PGI	Maintenance service manager
Order in PGI	Procurement manager on the site
Delivery acceptance (unique: technical and financial) in PGI	Technician (preparator)
Supplier's bill control	Regional accountant
Payment	Regional accountant

Profile B (hydraulic plant, one particular dam)

Transaction	Actor achieving the transaction
Purchase request paper definition	Technician (preparator)
Purchase request in PGI	One technician who knows PGI well makes purchase requests for his colleagues
Validation (unique: technical and financial) in PGI	Local supervisor (working on the same dam)
Consultation for the technical validation by mail, out of PGI and order in PGI	Centralized procurement managers team in the valley headquarter of a group of dams
Delivery acceptance (unique: technical and financial) in PGI	Technician (preparator)
Supplier's bill control	Regional accountant
Payment	Regional accountant

Profile C (amounts superior to 20 000 € engineering unit for old nuclear plants dismantling)

Transaction	Actor achieving the transaction
Purchase request, paper version, out of PGI	Technician prescriber (the technician who makes the engineering study for this operation)
Purchase request in PGI	Secretary
Validation (unique: technical and financial) in PGI	The manager of the concerned engineering project
Consultation and order in PGI	Regional purchaser
Technical acceptance out of PGI	Technician on the dismantling site
Financial acceptance in PGI	Project manager in Lyon
Supplier's bill control	Regional accountant
Payment	Regional accountant

ANNEX 5: THE STEAM VALVE STORY

A hydraulic plant technician decided to replace a steam valve. He perfectly knew who the supplier should be. He looked for an article code. He found “steam valves”, but the article was exclusively allowed for nuclear plants. He called a purchaser, who advised him to use another article code vaguely corresponding to “valves and other mechanical components”, instead of asking for the extension of the first article code to hydraulic plants: the purchaser thought it would be a short cut to avoid a heavy procedure (dialogue 1 technician-purchaser).

The technician wrote his purchasing request. The valve was ordered. It was delivered. The technician accepted the delivery. But when the accountant received the bill, he discovered that the account number was not correct (it was not the right tax and legal regime). He called the technician to tell him everything had to be cancelled and redone from the beginning (dialogue 2 accountant-technician).

Then the technician called the purchaser to protest and to ask for another article. Both the technician and the purchaser agreed to find accounting constraints disturbing (dialogue 3 technician-purchaser). The technician did not have any immediate solution. He promised to contact the accountant as soon as possible to explore what articles could simultaneously correspond to the technical requirement and the accounting rule, which he did (dialogue 4 purchaser-accountant). Two or three potential solutions were identified by the purchaser and the accountant, to be validated by the purchaser with the technician (dialogue 5 purchaser-technician).

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