The instrumental genesis of collective activity

The case of an ERP implementation in a large electricity producer

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Collective activity at the core of organization dynamics

Imagine a bunch of cars stopped on a road because a tree was blown down by a storm and blocks the way. 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 in organization dynamics, since we argue that collective activity is always mediated by

instruments (Vygotsky). 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 (ERPs[1], 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 a longitudinal case study (SAP implementation at EDF, a large electricity company). We shall synthetize the main results of this case study: the dialogical construction of collective activity requires community building, integration of instrument design and utilization in a continuum, and competence hybridization. In the conclusion, we explore what managerial action and future research can draw from the theoretical frame of collective activity and instrumental genesis.

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, and 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 professional groups such as management accountants (Granlund & Malmi) or what motives guide their adoption (Hyvönen). Other research based upon case studies refers to theories such as the structuration theory (Caglio), the theory of actor networks and boundary objects (Dechow & Mouritsen; Lodh & Gaffikin; Quattrone & Hopper 2001, 2005a, 2005b), the evolutionist theory of the firm (Scapens & Jazayeri), new institutionalism (Gosain). These contributions bring new insights on organizational changes. Though often criticizing the structural approaches which conceptualize information technologies (IT) as causal drivers of

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change, they often attribute some autonomous agency to I. T. tools, for instance as vectors of intrinsic knowledge, “frozen” experience, institutional determinants or interpretive schemes.

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. In this pragmaticist view, organization itself will be characterized as the social enactment of collective activities: designing products, producing and selling them, 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 additions of individual activities. Interactions between actors are assured through coordination and cooperation mechanisms, so that individual activities can 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 (“relation with other people”: different actors interact) and transactional (“relate to nature”: collective activity achieves some type of transaction with the world to transform it).

This is particularly the case for organizational dynamics related with the implementation of technological or managerial instruments. The actual impact of instruments in 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 such as ERP must be apprehended through actors’ practices (Caglio, 135). This is not simply a methodological issue: “how to study the implementation of management information systems?”. It is also a theoretical issue: what theory of *collective activity* do we use to study *actors’ practices* beyond a mere empirical description? Actually, 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 it 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) in a permanent conversational elaboration.

Collective activity cannot either be described as the execution of pre-existing formal plans. It is rather built in an on-going flow of living experience, in contextual situations. Actors mix improvisation and the use of schemes and plans as resources to rebuild collective activity in front of circumstances. The transformation of organizations must 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. It is difficult to act upon the organizational utilization of instruments if attention is not given to the way collective activity is disturbed or rebuilt *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" the collective activity, as one of the components of collective activity, by asking questions such as "how shall we redesign our collective activity with SAP?". Unfortunately collective activity is not a strong point of management research and managerial practices, though the theory of activity (Vygotsky, Luria, Leont'ev, Clot, Engeström) meets a growing interest in organization sciences with an increasing number of researchers who look for "an account of the interactional work, the particular embodied practices" (Button, quoted by Orlikowski & Barley).

Collective activity is a dialogical construction of sense

In the frame of a research about the organizational genesis of work danger in building industries, in which we cooperate with researchers in the psychology of activity, we recently heard a short dialogue between two 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 to work there. He asked his colleague:

"Are you doing something?

- Oh yes, I have to check concrete overthere, 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 had rather come with you, 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 can 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 must interact to permanently rebuild their activity and keep on making sense of it.

Each individual activity is continously addressed to others. 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, Bakhtine), individual acts make sense only in the frame of interactions and 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) 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), we mean here that any act is a speech, an “act speech”.

Collective activity is situated

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 “off screen” and definitely contributes to sense: what is “out of the activity”, what was not done and could have been done (what level of cost the factory might have reached).

Collective activity is reflexive

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”, “in this type of situation, I would not do that”.

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 the immediate activity. 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 interpret their collective activity, they design its social configuration. The answer to the question "what are we doing? directly influences 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 an early association of the architect with the building company which can trigger new interpretive schemes.

Collective activity is mediated

Reflexivity and cooperativeness are ensured by the permanent "inscription" (Latour, Quattrone & Hopper 2005b, Robson) of collective activity in systems of signs[2]: speeches or texts in natural or technical languages, gestures, instruments (accounting, performance measurements, standards, 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, labels or attributes. As soon as human

[2] 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.

activity goes beyond reflexes to enter awareness, it is thought by human actors through semiotic mediations (Vygotsky), languages and tools, to which the semiotic theory is applicable (Eco):

- They 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 activity attributes and provides an impoverished image of concrete activity; when a worker says “I am drilling a part”, he gives an account of his activity which ignores an infinite richness of gestures, emotions, conversation with a colleague, feelings about the machine.
- 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 technical 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 reduction action. The signs impoverish the image of concrete activity, but they also enrich it by opening repertories 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 meanings[3] which assures a common understanding basis. This does not mean that signs are not 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. In the continous flow of experience, actors enact new facts and new acts into arguable traces.

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) 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 and utilization; instruments are present in mental processes of interpretation, as *schemes of utilization*[4]. Without schemes of utilization, artefacts are not instruments, they remain meaningless "things".

This double nature, which allows instruments to be fundamental mediators of collective activity, is analyzed by the "theory of activity" psychologists (Vygotsky, Rabardel). It is also 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); "technologies are simultaneously social and physical artefacts" (Orlikowski & Barley). The schemes of utilization mix individual and local utilization (how one actor can use the instrument) and

[3] We use « sense » and « meaning » in the same way as some linguists : « meaning » is the generic scheme of interpretation – what a dictiornary 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.

[4] we use the word « utilization » with the precesie meaning of « generic interpretive scheme », distinct from the concrete "here and now" use.

organizational norms of utilization (rules of coordination, structure of roles in the utilization of the instrument).

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 affordances (Gibson) and the social habits which prevail in their use. For instance, if the cost accounting system was designed in such a way that it does not identify "non quality cost", it will constrain quality management: the cost of non quality will not be given by accounting systems. It can also happen that guarantee, rework, customer return costs are identified as specific cost centers, but actors never use them to analyze "non quality cost", because they have a cultural trend to consider the costing system as exclusively oritend towards productivity analysis. Instruments also enable collective activity: they allow to do things which would have been impossible otherwise. The cost of the activity allows to compare it with others, to cumulate activities in the budget forecast, to assign cost objectives… Potential constraints and affordances 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).

When being used, instrument translate objective artefacts into collective activity. When being designed, they translate imagined future collective activity (future uses) 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. The reproduction of similar habits 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 can derive smaller or bigger deviations from their own experience and creativity to better adapt utilization to their needs. They do what linguists call "a stylistic innovation" (Bakhtine, Clot). This stylistic innovation provides a critical view of generic practices. If it is convincing and effective, the stylistic change can be imitated and 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.

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, 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, logistics planners at corporate headquarters, in the same collective activity. This configuring power can be used to "control at a distance" (Robson).

Instruments bring generic meanings to the situation, but the actual sense is situated. 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. Only a fairly small part of them is actually activated. Through the instrument the actor "speaks of" what is done but of what is not done too – of "non activity". Symetrically, to make instrument utilization feasible and effective, actors do a lot of things which are not formally represented in the instrument. There is "much activity" out of the instrument. As a consequence, instruments play a major role in stylistic innovations: they point at potential and impeded activity.

According to the level of constraints they impose upon organizational norms of collective activity, instruments can be classified in different classes. For instance, a hammer is more constraining for the individual work than for collective activities, whereas some instruments internalize organizational norms which strongly constrain collective activity. Let us mention two examples: the fordian assembly line and ERPs.

Fordian assembly line	ERPs
Manufacturing operations	Operations of administrative business processes
Technological equipment	Management information system
Internalization of the sequential organization and the cadence/productivity of manufacturing operations	Internalization of the cross-functional coordination of operations of a specific business process

Dualist theories miss the focal position of collective activity

Dualist theories are based upon the separation between thought and action. They assume that thought can be abstracted from the situated action and that action can be determined by representations. Amongst many streams of dualist theories, cognitivism (Simon 1981, 1982) views human intelligence and human organizations as information processors. Dualist theories do not focus upon activity but upon representations. They do not take into account the dialogical and situated dimension of sense. Instruments are often supposed to "freeze" sense, abstracting it from the context of action, and therefore to "store" activity in a repeatable form: taylorian standards (Taylor), problem-solving procedures, artificial routines of action. Artificial instruments can apparently "store" activity when the whole "off screen" surrounding is so familiar that it can be forgotten. But when something important changes in the surrounding, sense is lost. In similar ways, if we accept that "as actor networks theory posits, the world is neither purely social nor purely technical, but always a mix of both" (Dechow & Mouritsen), we admit that techniques and social interactions are separate categories, even if they are interconnected in networks. It can then seem logical to separate design and utilization. As a consequence of this separation, for instance, design experts can underestimate the importance of design reversibility and flexibility to leave redesign autonomy to future users.

We rather posit that subjects are intrinsically social and build techniques and instruments *because* they are social and they need to interact in order to act. "Boundary objects" (Star & Griesemer) do not have the intrinsic power of supporting dialogical exchanges. Human interpretation makes them meaningful signs: a sign is a sign only if it is interpreted (Eco).

By ignoring the dialogical level of collective activity, research might be condemned to iterate between the material agency of instruments and the subjective psychism of human actors. Bakhtine (Bakhtine) showed that literary critique, when it ignores the dialogical nature of human discourse, falls into two symetric empirical impasses: subjective empirism – the subjective psychology of the writer isolated from the social interactions of his/her work, or technical empirism: the linguistic materiality of the text, ignoring that the text gets sense by interacting with other texts and discourses. Similarly, in the study of organizations, we can find ourselves locked in an iteration between some intrinsic power of artefacts per se ("SAP imposes… SAP transforms… SAP prevents…") and the subjectivity of isolated actors (cognition, motivation, ethics), without grasping the "in between" level of collective activity and dialogical interaction. To make the "design-utilization" of instruments actionable, we

thing that instrumented collective activity must be the focus of research and managerial practices.

Part Two: EDF case study

The context: EDF

EDF (Electricité de France) is a state-owned company which produces electricity in nuclear, hydraulic and thermical 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. The production capacity of 125 Gwe makes it the first producer in Europe: 74% nuclear, 17% thermical, 9% hydraulic. All nuclear reactors are based upon the same technology (Pressurized Water), with a high level of standardization.

The company is structured in 5 branches: Commerce, Production and Engineering, Distribution, International Participations and International Trade.

EDF faces major strategic changes. Till 2005, it was a regulated public service, 100% owned by the French state. In 2005, 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.

Traditionnally, EDF culture was based upon the notion of general interest; engineering and economic rationality, nuclear safety as a vital and conspicuous achievement, the social dialogue with powerful trade unions. The new strategic situation imposes a different agenda. 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 a priority, particularly in administrative functions.

The Production and Engineering Branch (PEB) plays a key role, since it 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: cost-cutting in support functions (accounting, human resources, information systems); cost-cutting in procurements (spare parts, equipments and subcontracted maintenance work); cultural changes, to move from a purely technical culture to a culture mixing economic and technical criteria; more flexible and reactive 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 a standardised version (80%), 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. Actually 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 (January 2002 to January 2003), PGI was implemented in the thermical and hydraulic division (THD), which appeared as a convenient testing pilot, since it is much smaller and less sensitive than the nuclear division. Then the Nuclear Power Division (NPD) and the Support Services Division (SSD: central accounting, central human resource management, communication, finance, engineering support) followed, from December 2002 to February 2004.

Research methodology

We studied the implementation of PGI in the purchase and procurement domain at EDF – PEB from January to September 2005. This research could benefit from a previous in-depth knowledge of the purchasing processes at EDF, since we had been allowed to observe the transformation of management systems and practices at the corporate purchasing department of EDF for more than three years, since 2001.

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 decided to limit the research to the purchasing and procurement process in the Production and Engineering Branch (PEB). PGI had already been working for one year in that area.

Our study was participative observation. We had no operational mission, but the company expected some feedback from us to adjust future PGI implementation methods. PGI was

globally considered as a success, since the system worked and supplied the expected information with no major delay nor overspending. But EDF managers were aware that the new system generated all sorts of difficulties which might prove to be serious on the longer run: there were few productivity gains and some psychological and social tensions could be observed.

We followed an abductive and iterative process of research: semi-structural 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…).

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 the Production and Engineering Branch); 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: the director of Support Services Division, one of the leading managers of PEB, and the controller of the corporate purchasing department; the steering committee met three times in six months.

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 (two of the most important engineering units are based in Lyon), production (nuclear power plants in the Rhône valley and hydraulic plants in the Alps) and service (Lyon has important regional headquarters, with accounting, purchasing, IS and technical services) units. Rhône-Alpes was seen as a representative “microcosm” of the whole company.

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, unit procurement managers, regional and national purchasers, PGI project team members.

In September 2005, we presented the final conclusions of our study to the steering committee.

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 the purchasing-procurement process. 65% of the team members were purchasing professionals, 35% IS specialists. Apart from the general goals assigned to PGI, in the purchasing area, PGI was expected to achieve economies of scale by centralizing the management of suppliers and purchased articles portfolios, diminishing the number of suppliers and reducing the diversity of articles.

Traditionnally, the main steps of the purchasing and procurement process at EDF PEB were as follows:

- the maintenance technician defined a paper purchase request; he often consulted some potential supplier to define the request;
- the technician's superviser validated the requirement from a technical point of view;
- a manager validated the requirement from a budget point of view;
- a local purchaser contacted suppliers and negociated a contract;
- the controller of the unit registered the procurement in budget control;
- the accountant of the unit captured the procurement in the accounting system;
- at the time of the delivery, the maintenance technician accepted the delivery from a technical point of view;
- the manager accepted the delivery from an economic point of view and gave the green light for payment, in agreement with the controller and the accountant;
- the local accountant received the bill, controlled it and paid.

With PGI, it was decided to simplify the process. Organizational norms for the new process with PGI utilization were defined at three levels: corporate, PEB branch, local units (see annex 1 for the detailed structure of decisions). The new business process was organized as follows:

- the lists of suppliers and purchased articles are managed centrally by the corporate purchasing department, in PGI;
- for the core procurements (maintenance of production and engineering sites), the corporate purchasing department negociates frame contracts;

- the maintenance technician defines a purchasing request (PR) without consulting any supplier PGI in PGI; in the PR, he must select the relevant frame contract, the relevant article code, the corresponding accounting code and tax regime (VAT);
- the maintenance manager (the technician's hierarchical supervisor) validates the PR both from the technical and the budget point of view;
- a local or regional purchaser orders the good or service;
- the maintenance technician accepts the delivery both from a technical and an economic point of view; he gives the green light for payment;
- the regional accountant receives the bill, controls and pays.

Consequently, important changes affected the pruchase and procurement process:

- in some units, there was a strong decrease in the number of employees who can make a purchase request; for instance, in the engineering department the number decreased from 140 to 60, whereas in other units the number did not change;
- at the same time, there was a strong increase in the number of the direct users of the information system users; traditionnally, 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 automatically involves budget imputation, accounting imputation and tax regime;
- the management of suppliers, articles and contracts bases being centralized, technicians lose the direct contact with suppliers;
- the acceptance of deliveries, which was before a 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 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 on the production sites had been limited to define technical requirements for purchases, but accounting and budget data were captured by the controller (budget) and the accountant (accounting). With PGI, the majority of data would be captured by employees with a low managerial culture. To make it easier and safer, the project team developed an ergonomic intranet interface for maintenance technicians to capture "purchase requests".

Halfway in the history of the purchasing-procurement PGI subproject, in view of time and budget limitations (expenses proved to be much higher than planned), a sharp turn was given. The team leader was replaced by an IS expert. From 35% of the team, IS experts moved to 70% and several purchasing specialists left. One of the major consequences of this turn was a substantial reduction of resources available for change management.

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 (seen Annex 2 for the format of ipact studies). For each professional profile, a local team built a "COPT" matrix to weigh the importance of professional changes on four axes: Culture, Organization (number of modified procedures), 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 of 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 no cross-functional, business process-oriented approach; there is no impact study about entire professional groups, across units;
- change actions are focused upon training, documenting, 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 the nuclear plant we visited, 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 project the utilization phase: little was said about the ongoing design adjustments during utilization.

These remarks are not only an "ex post " view, since there were precise alarms before, notably because some units had already experimented previous versions of SAP. In 1999 a consultant was asked to audit 1997-1998 implementations of SAP. He concluded that "Business process reengineering efforts have been insufficient; the new system proves to be difficult to use for unfrequent users, which means that there are too many users; changes have

been understimated 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, there were on site preparatory meetings with local purchasers. On several sites, the participants recommended to extend the training of maintenance technicians to basic accounting and management. In one nuclear site, they added: "technicians will not only capture their purchase request, they will also participate in the whole process: they will participate in the negociation of contracts, they will follow up the 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, a big consulting firm was asked to audit the situation of the accounting function after PGI implementation. The productivity gains expected 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". The consultant did not make any specific study about the effect of "automatic reminders" upon collective activity: workload of technicians, tensions, cooperativeness…

A methodological feedback about collective interviews: 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 (in charge of establishing purchase requests), 4 local procurement managers (in charge of ordering). An interesting phenomenon took place during many 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. It often happened then that one of the other interviewees, who was also one of his/her professional peers, responded to him to present some solution he/she had found. Then 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 about their collective activity. The conversation was a reflexive collective activity about the collective activity of daily operations.

There is a limit to this observation. Collective interviews were always achieved with professionally homogeneous groups of people (purchasers, accountants…). never with business process groups (heterogeneous groups gathering the different actors of the same business process), which would have been more complex to organize, for political and geographic reasons. The collective interviews were often "haunted by ghosts": there were strong calls from present actors towards absent ones, in a dialogical but truncated exchange.

Main results of the case study: variety in the local design of collective activity instrumented by PGI

The architecture of SAP, based upon a business process model, imposes physical constraints to the collective activity: unique data capture, cross-locked transactions. Nevertheless, though constraints imposed by EDF PGI version of SAP were strong, we could verify that the actual design of collective activity could significantly vary from one unit to another (see three examples in annex 4).

Several parameters could have influenced the local design of collective activity: geographic dispersion, structure of supplies (more or less concentrated and standardized), nature of supplies (mix of parts and equipments, subcontracted work, studies, office supplies). But variations also seem to proceed from history and culture. For instance highly specialized and qualified engineers in the engineering unit considered that PGI transactions would be a waste of time for them. It also depends upon the sensemaking vision for the future. For instance, the sentence: "we must move towards a real project-based organization, the project manager must hold the technical and the financial levers" could be heard in some units, not in others.

The collective activity varies, but it is always highly cross-functional, whereas, as we saw before, in the design and preparation phase, it seems that the business process dimension was not really anticipated (impact studies were only made for units, not for business processes; PGI training was strictly organized for homogeneous professional groups, with no cross-participation of other functions). In the actual use of PGI, cross-functionality remains a

sensitive point, particularly in the relations between three key groups of actors: maitenance technicians, purchasers and accountants.

The technicians-purchasers relation

Both professional groups 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 renegociation, but hydraulic technicians conclude that their colleagues in the purchasing function do no 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 limitations in the use of suppliers which do not take into account the specificity of their activity.

On the other 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, and 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 with periodic 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. Tensions appear between both functions, which do not know much of the others' constraints and objectives.

The accountants-technicians relation

Technicians impact accounting directly through the choice of an article-code in the purchase request (PR); 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 help and coach them when they have doubts. They observe that the textual definition of accounts is not always clear and self-explanatory and that the link between article and account is not always logical (for instance, some articles which they often need for current maintenance happened 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' too systematic reminders ("they behave in a bureaucratic way").

Many problems are raised by the decomposition of the supplied services into lots, partial deliveries based upon technical considerations and partial bills based upon financial considerations: how does a partial bill reflect the state of partial deliveries? Difficulties can derive from the supplier (unclear bill), the technician (incorrect timing of deliveries), the accountant (misunderstanding of the technical nature of the delivery), the purchaser (wrong modelling of the frame contract)…

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 and the way it can be billed. Purchasers also specify the article codes which must be used in a certain type of supply. Article codes determine accounts and VAT regime: accountants complain that purchasers do not really know tax and accounting constraints when they design contracts.

Problems often appear as bilateral problems 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. Through these “loops” the ignored collective activity comes back to attention and gets revenged… (example of “the steam valve story” in annex 5).

The importance of redefining professions as 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 a narrow technical craft: his official title was “preparator”, because he had to prepare the maintenance intervention of subcontractors. In the new organizational model introduced into PEB with PGI, technicians are assigned another role: they accomplish accounting gestures, they authorize suppliers’ payment, they check budget availability, they define their requirements from a technical but also from a managerial (delivery and bill scheduling) point of view. They can no longer benefit from any supplier’s support. To summarize they are supposed to become project managers. Their title changes from “preparator” to “intervention manager”, with basic competences in management (accounting, scheduling). By writing the specifications of the purchase, they constrain future tenders, contract negociation, 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 official answer to this question was: “all the maintenance technicians should be PGI users”. Actually it appears that the so far homogeneous population of “preparators” is splitting into two different professional populations: some technicians, who have neither the aptitude nor the will to widen their range of competences, remain technical agents, whereas others are ready to acquire new managerial competences and diversify their career opportunities. This is not a consequence logically driven by PGI implementation, but rather the effect of the general redesign of collective activity, which focused upon the new role of the technician as project manager. It was instrumented and not determined by PGI.

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 negociator. He is now asked to manage the economic performance of purchases, by following financial and non financial indicators. He 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 their frame contracts, by coaching technicians when they use them. Here again the purchasers' population tends to split in two groups: those who believe their legitimate competence is negociation and consider managerial tasks as a bureaucratic waste of time, and others, who wish to widen their range of competence and feel they are "purchase managers" rather than "purchasers".

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 (service decomposition into lots, articles identification…). It constrains maintenance and procurement activities. Purchasers must demonstrate a good knowledge of accountants' and technicians' jobs to design frame contracts which are easy to use.

The same type of observation can be made with accountants, as many researchers have already observed (Scapens, Caglio). 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 knowledge and understanding of technical operations that most of them did not have.

The general aspiration for functional communities of practice

In front of such radical transformations of their function, all actors we met expressed the same 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 we met at the nuclear plant suggested to organize a community of technicians using PGI on this nuclear site (i. e. a potential population of around 150 persons). The managers of maintenance services (mechanics, control and command, logistics, boilers, etc.), a potential population of around 10 to 12 persons per unit, wished the establisment of a community of maintenance

managers across the 5 or 6 nuclear plants of the region. Actually, in a strikingly convergent way, all those interviewees stressed their need for communities of practice (Wenger, Wenger & Snyder). PGI appeared as a trigger rather than as the real focal point of this requirement. In many cases, the exchanges we observed in collective interviews started from PGI problems of utilization, but quickly moved to more general professional issues.

Key competences in design issues

Today the debates about the improvement of the "purchase and procurement" process more and more focus upon three critical issues: the modelling of frame contracts; the design of suppliers, articles and accounts bases; the design of purchase specifications. We have here typical examples of dialogical activities. 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 the order. Again, this is a dialogical activity: what is at stake is not simply the technician's individual competence, but also the capacity of purchasers and accountants to formulate their requirements in understandable ways.

Hybridization of competences

EDF generic trio "purchaser-technician-accountant" clearly illustrates the dialogical nature of collective activity. Due to this dialogical nature, actors need to have some understanding of other actors' specific roles. This observation is not new in research about ERPs: with ERPs "we are witnessing a phenomenon of *hybridization*" (Caglio), i.e. "the enlargement in the set of practices and legitimated competencies which make up the domain of a specific expertise" (Kurunmäki). This evolution is not particularly linked to ERP implementation. It 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.

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 (here, for instance, PGI, frame contracts, purchase specifications, accounting structure) which do not 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 compatible meanings from the same discourses. “Everyone of us knew the problem of everyone else, independently from the specific function” (Caglio): everyone knew some shared repertory of meanings.

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 such as ERPs can help this dialogical construction if actors use them for this purpose. They can also 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.

The history of PGI project as a sequence of “abductive shocks”

The American pragmaticist philosopher W. S. Peirce (Peirce) defined abduction as the third reasoning scheme (with deduction and induction), but as the only one in which new knowledge can be created. Abduction is the “creation of a new hypothesis”: a surprising fact defeats the existing interpretive schemes; it requires a narrative reorganization of experience, to create a “plausible story”, an account which allows the surprising fact not to be surprising any longer. The surprising situation which triggers this narrative rebuilding of experience is what we call an “abductive shock”. It is close to what Weick calls “cognitive dissonance” (Weick), but it is not only cognitive. It is a strong experience, which has important emotional and corporal dimensions: it can destabilize professional values and ethics, it can destabilize

the corporal balance ("when doing this I get bored, it makes me sick"). It is also collective rather than individual: it concerns professional groups and social categories.

Abductive schocks trigger an intricate combination of action and reflexive thought, an "inquiry" (Dewey), to build and test exploratory hypotheses. The inquiry is collective: it is generally impossible for an isolated subject to gather the elements of a new hypothesis. But the inquiry can be collective in a deliberate way: actors join forces and competences to inquire the defeating facts, they debate it; or the inquiry can be collective in a purely *de facto* and unconscious mode: actors grope their way in the dark, sometimes bump with others, sometimes converge with them.

In EDF-PEB history of PGI implementation, it seems to us that the actors faced three successive abductive shocks. Each abductive shock can be described as the encounter between artefacts designed by a first group of actors with other actors who were not involved in the previous design.

1st abductive shock: EDF had a very old tradition of functional organization with strong specialized professional cultures. SAP was designed (of course out of EDF) with a cross-functional business process architecture. The EDF actors involved in the design of PGI (EDF corporate leaders, EDF IS department and PGI project team) faced the gap between EDF functional practices and SAP architecture. PGI designers opted for an ambitious reengineering, i.e. a complete redesign of collective activity. They designed a theoretical purchase and procurement process easily implementable with SAP.

2nd abductive shock: New actors appeared on the scene: the field actors – technicians, accountants, purchasers, line managers –, who faced the gap between the theoretical business process defined by the PGI project team and existing practices, or what they viewed as reasonably accessible practices. Two main difficulties appeared: the planned functional roles proved to be difficult to achieve with existing competences; the required cross-functional cooperation proved to be complex to obtain. Practical responses were empirically designed according to the specific characteristics of units (annex 4). The actual collective activity can be quite different from what was planned by the project team: it still uses PGI, but it enacts utilization schemes that the designers had probably not always imagined.

3rd abductive shock: New actors appeared (or came back) on the scene: PEB leaders and functional experts. PGI worked but they faced a gap between actual results and objectives. In an informal inquiry, managers, field actors, IS experts agreed to identify critical activities:

modelling contracts; designing purchase specifications; designing suppliers, articles and account bases. Training programs, working groups, cookbooks focus upon those critical activities.

The prolonged design of collective activity: a collective activity about collective activity

Articles, suppliers and accounts must continuously be adapted and redefined. Frame contracts are permanently renegociated. Technical specifications are daily written. That is why we assume that training purchasers in contract modelling and writing cookbooks will not be sufficient. 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 rebuilding. What is at stake is a collective activity about collective activity.

The successive abductive shocks appear as a groping trial/error building of this reflexive collective activity. At the beginning the view was characterized by the separation between design and execution: the operating actors were not invited to actively contribute to the initial construction of activity. At each step new actors came in, questioning the previous design of the collective activity and obliging to redesign it. Instruments were always designed as the repositories of previous experience, to memorize it and to impose it to future activity, instead of being seen as a living semiotic material with which actors could continuously interact and build dialogical sense.

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 construction which determines expected results in the subsequent phases of organizational history, whereas we see the “genesis” of an instrument as exploratory trials submitted to partially unpredictible practical consequences. The effectiveness of collective choices is not so much a static issue of “making options visible” in one precise moment, it is rather a dialogical issue: how do actors interact, how do they make sense of their interactions? For instance, in Dechow and Mouritsen’s case study, SAP consultants used an instrument (the “EPC diagram”) which did not make the practical implications of architecture options visible.

But this diagram was only an instrument produced in the living interaction between the internal Timecorp team and the external consultants. The consultants probably used it because they felt it could answer some of their customer's questions and expectations. What is really at stake is not the static limits of the diagram, but the way the dialogical exchange between Timecorp managers and consultants developed to make sense of their collective activity: "what are we doing? what is exactly the sense and the reach of our activity? what does it mean? what are we designing? what are we designing out, excluding? whom does it impact? who should be involved?". The EPC diagram like any instrument is an element of "something" of a conversational nature which develops in real time and situations.

The construction of collective activity can be more or less reflexive. The use of instruments does not guarantee reflexivity: "Neither Timecorp nor Spacecorp focused in any detail on such issues at the outset… (They had) not realized the global implications of the system architecture" (Dechow & Mouritsen). To ensure reflexivity, actors must cooperate: 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. Only communities can enact the reflexive construction of collective activity.

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 computer codes, users modified PGI as an instrument by transforming its practical meaning. There was a continous reconstruction of instruments – and of instrument utilization, i.e. of collective activity. But if the corresponding community configurations are not enacted, absent actors become problematic "ghosts": designers design utilization without users, users redesign the instrument without designers… The collective activity becomes a major source of frustration if actors cannot speak to each other and listen to each other in a reflexive construction. For lack of "collective activity about collective activity", collective activity becomes a difficult challenge.

By making communities effective, the actors make their collective activity arguable and actionable, because the relevant communities can argue and act. They can even argue about sensemaking "off the screen": "non activity" (impeded activity) and "non instrument" (activity escaping the instrumental representation). There can be different types of communities, according to the configuration of collective activity:

process communities are formed by the actors who must achieve complementary activities and use complementary transactions in PGI; together they can adapt the structure of roles, the coordination modes; in some cases, process communities are so badly needed that they emerge spontaneously and transform the role of managers, who “must learn to: identify shared goals, share information, reach consensus, promoting the trust necessary for developing and sustaining such relationsships” (Scapens);

professional “genre” communities are formed by the actors who must achieve the same generic activity and who use the same generic transactions in PGI; together they can build generic professional practices, generic competence profiles and generic instrument schemes of utilization, which the stylistic innovations of actors dynamize.

Collective activity is a challenge. Perhaps the most difficult issue it raises is to ensure that this challenge is met by somebody – some relevant collective subjects.

It does not stop with what is commonly viewed as “the design phase”. Instrument utilization is a prolonged genesis of collective activity.

ANNEX 1: 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 negociated 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.
3. at the unit level,
    - the list of technicians using PGI for "purchase requests" authorized had to be established,
    - for the smaller amount purchases, some units decided to establish a local central team to make all orders, other units chose a more decentralized organization.

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 iterface 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 superviser (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 pruchaser agreed to find accounting constraints very disturbing (dialogue 3 technician-purchaser)…

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