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The use of an information system as a legitimate subversive agent

A system for monitoring French scientific research

Claude Rochet^{*1}, *Johanna Habib*² and *Edina Soldo*³

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¹ ***Corresponding author**, Professor in Public Management, Institut de Gestion Publique et du Développement Economique (Paris), 20 allée Georges Pompidou, 94000 Vincennes, Institut de Management Public, Université Paul Cézanne, Aix-en-Provence, 21 rue Gaston de Saporta, 13100 Aix-en-Provence, France, Phone: 33 676 046 790, Fax: 33 442 174 417, email : claude.rochet@univ-cezanne.fr

² Assistant Professor in Management), Institut de Management Public, Université Paul Cézanne, Aix-en-Provence, 21 rue Gaston de Saporta, 13100 Aix-en-Provence, France, email : Johanna.habib@univ-cezanne.fr

³ PhD, Assistant Professor,, Institut de Management Public, Université Paul Cézanne, 21 rue Gaston de Saporta, 13100 Aix-en-Provence, France, email : edina.soldo@univ-cezanne.fr

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Abstract. The introduction of France's Constitutional Bylaw on Budget Acts (LOLF) in 2006 and its concept of performance-based management implies a profound reengineering of the relationship between the central government and the autonomous agencies in charge of implementing policy. In this paper, we examine the case of French scientific research policy, which is carried out via a network of 160 universities and 40 specialized scientific agencies, all of which enjoy statutory autonomy. Information systems are key in ensuring that processes in the field are in line with central public policy objectives. A new approach to this network is required, one that we call "urbanization", i.e. rethinking the system's overall architecture as a city map, rather than the "spaghetti" networks inherited from the past. Managing such a project raises strategic questions about centre-periphery relationships, and requires a partial solution to the dichotomy between local strategic autonomy and the central impetus the state must give in order to enforce its political objectives. In terms of centre-periphery theory and a strategic planning approach to IT, we explain why information systems are a critical issue in centre-periphery relationships. We then analyze how IS reengineering may foster strategic dialogue between the central administration and autonomous agencies. Finally, we use as an example the difficulties we encountered in designing the new capabilities, and we conclude on the emerging paradigm shift in public administration concepts.

Keywords: Information System, French research policy, centre-periphery dilemma, qualitative research methodology

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Information technologies – after first being a simple tool for automating data treatment, and then used for automating business processes via Enterprise Resources Planning (ERP) software – are entering a third era. Today, are used to reconfigure organizations, using a wide range of technologies based on internet architectures. Brand-new business models may be conceived inasmuch as one is able to align organizational and technological architectures.

In this paper we shall investigate, using an experimental case, how IT may change the center-periphery relationships between a ministry and its agencies, improving the

strategic capabilities of the centre while simultaneously improving the autonomy of the periphery.

This study is based on our experience of building a system for monitoring the French research and university system in the context of a transition toward results-based management. We compare this case study with current literature on the relationship between organizational digitalization and change management and draw from it lessons for public management.

1. IT as a legitimate subversive agent

In his seminal research on how information technologies (IT) create value, Prof. Erik Brynjolfsson (2003), director of the MIT Center for Digital Business, emphasizes the fact that what really counts is the hidden part of the iceberg. Pure technology accounts only for 10%, and technological complements (heterogeneous and complementary technologies) for another 15%. The remaining 75% of value creation come from the renewal of the organization triggered by IS implementation. Brynjolfsson carried out this research among private companies in the US. We have no similar study of the public service, but as far as we know, nothing prevents us from assuming that this is equally valid for the public sector.

In the public sector, IT policies are influenced by a New Public Management (NPM) approach, which includes Business Process Management (BPM), outsourcing, customer-oriented service, downsizing and cost savings. The underlying concept involves focusing on the front office to improve performance within the context of a user-provider relationship, and outsourcing the back office. Within such a framework, technology is seen as an exogenous change agent, and in this respect, expectations have not been met (Dunleavy *et al.*, 2004). On the contrary, a growing body of literature considers IT in a Schumpeterian way, as an endogenous lever of change operated by entrepreneurs (Freeman, 2003) and as an object of design in alignment with strategic goals.

In this paper, we will consider how IT may act as a legitimate subversive agent. Managers mainly consider the tip of the IT iceberg and do not think about how the sea change that designing and implementing an information system represents. Moreover, they frequently think that implementing IT avoids raising fundamental questions about an organization's strategy, business and processes. An IT project can be an opportunity to raise uncomfortable (read subversive) questions that are nonetheless pertinent and legitimate.

We attempt to answer the following questions:

- *What impact does information technology have on the relationship between the centre and the periphery?*
- *What impact does the degree of IT integration have on the degree of cooperation between the centre and the periphery?*

First, we present details of the French case study, where the traditional hierarchical mode of steering universities and research bodies is presently being replaced with contract management, supported by performance measurement. Second, using centre-periphery theory and an IT strategic planning approach as a framework, we

explain why information systems are a critical issue in centre-periphery relationships and foster strategic dialogue between the central administration and local agencies. We analyze how this dialogue raises subversive questions that need political statements and reengineering decisions. Thirdly, we draw on the difficulties we met with in designing the new capabilities that build the monitoring system of French research and university system. We conclude with the paradigm shift required in public management concepts and on the new role of the CIO in public management.

2. The Case Study

2.1 Monitoring French scientific research

France's Constitutional Bylaw on Budget Acts (LOLF⁴) was introduced on 1 January 2006. Its results-based management approach is reminiscent of the United States' PPBS (Planning Programming Budgeting System) of the 60's, and the French *Rationalisation des Choix Budgétaires*, circa 1970. This new reform involves the creation of a number of performance indicators and the deployment of substantial measuring efforts. It is to be applied to all sectors of the public budget. Budgets are voted on in terms of missions defining a public policy, divided into ministerial programmes, each of which is accompanied by a set of results indicators: the annual performance plan (PAP), and a corresponding annual performance report (RAP). Accounts must be given before the N+2 year's budget is voted.

The largest of these missions (more than € 20 billion) is that for scientific research and universities. France has 105 universities and professional schools, and about 40 research organisms, including such well-known institutions as the CNRS, INSERM, INRA and the Institut Pasteur. Each agency enjoys statutory autonomy and a complete administrative apparatus (board, budget research, academic policy, etc.), in spite of the fact that most of their budget comes from the Ministry for Higher Education and Research. Public expenses globally represent about € 23 billion, which is completed by private funding via research contracts. The global amount is far below the critical target of 3% of GDP⁵ that is required for France to maintain leadership in its traditional fields of excellence (including mathematics and physics) and to earn a place in new research fields such as IT, as well as in high-level teaching.

The landscape for this reform is somewhat troubling:

- A new legal framework for public research has been implemented concurrent with the LOLF. An agency has been established to fund research projects presented by operators, whether public or private, based on a global public research agenda defined by a scientific committee close to the President. Simultaneously, a new evaluation agency is being set up as an independent body in charge of evaluating universities and other organisms, both in research and teaching activities. A leftist movement, "*Sauvons la recherche*" is

⁴ *Loi Organique sur les Lois de Finances (LOLF)*, a constitutional law that defines the way state budgets can be voted and how ministries must be accountable towards the parliament.

⁵ France expenses in R&D are about 37 billions euros, including public research performed in dedicated institutions and universities (but not including higher education) and private research.

accusing the government of subjugating research orientations to short-term private interests.

- The standing of French universities is on a downward trend according to the Shanghai Academic Ranking of World Universities. French research ranking in the SCI is also falling, partly due to the rise of Chinese publications.
- The reform affects the structure of the Ministry for Higher Education and Research (the fourth-largest bureaucracy in the world, with 1.4 million employees), which has a poor track record in monitoring research activities and in defining clear strategic intent.
- Student demonstrations in spring 2006 against reform of the labour law have undermined governmental authority among academic authorities.

Over the past five years, most universities and research organisms have invested heavily in their information systems. According to the principle of autonomy and due to the lack of a unified state-level strategy led by the ministry, each agency and university has built its own information system, without regard for common standards and interoperability, whether for data or for technologies.

When the LOLF process was launched in 2001, the case of autonomous research bodies and their relationship with the parent ministry has not been considered (Rochet, 2004). Strictly speaking, such organisations are not affected by the LOLF, since they receive public funds via their parent ministries and are thus not accountable to parliament. Practically speaking, however, they are affected, both as instruments of public policy and within a global trend in public machinery that makes agencies accountable via hearings, inquiries, reports of the Court of accounts, and others direct relationships with both MPs and citizens (Rochet, 2002).

In the same way, few people at the highest levels of the public machinery realize that the true strategic perimeter of a public policy is not a program's ministerial budget, but rather a virtual perimeter involving many public and private stakeholders. For instance, when the government wants to know how much the nation is spending on cancer research, it is not enough to consider the expenses of INSERM (the agency in charge of medical research). It also needs data from a wide range of participants working in various fields such as information, prevention, hospitals, research and rehabilitation. These activities are the work of many public bodies as well as non-profit and private groups, using heterogeneous data and information systems.

It is clear that if the government wants to take up the challenge of evaluating public policies and to be accountable to the parliament for public expenses, as well as how a public policy has been achieved according to the three LOLF criteria (process efficiency, service delivery and socio-economic effectiveness), it must consider the key issue of information system design and architecture.

2.2 The subversive role of IS

There are two ways to be accountable to the parliament. One way is to build huge statistical scaffolds (the first LOLF report in 2007 presented more than 1,500 indicators!) that satisfy requirements for quantified results, but do not interfere with

day-to-day administrative business. Such an option is easy to achieve and does not threaten vested interests. The second option is to build a fully integrated monitoring system for collecting data within the various operators' information systems and consolidated it in a central balanced scorecard.

Implementing the second option raises two major issues:

1) HOW should it be done? Implementing a fully-integrated monitoring system does not fit with the dominant rationale of the so-called "Weberian bureaucracy", represented by standardized procedure (rule-following), formal power divisions and over-arching hierarchy. It requires a new kind of relationship between the centre and the periphery, no longer based on command and control management (Rochet, 2004) but on strategic monitoring, shared objectives, empowerment and clear accountability in an atmosphere of mutual trust. This represents a cultural sea change, and requires new IT capabilities that those in charge have not fully mastered.

2) WHY should this change be implemented? Roles need to be redefined and vested interests are threatened. Although the centre's political legitimacy to monitor the system is not questioned, its practical legitimacy is yet to be established. Why should operators share their information systems with the parent ministry? All agree on the need to share data and to integrate their systems, but principally on a cooperative and horizontal basis in which control is absent. The issue is a very different one when it comes to sharing data with the ministry. Currently, when the ministry wants information from autonomous operators, it sends questionnaires that are filled in on a declarative basis. In other words, each autonomous operator declares 1) what it knows, depending on its proper IS, data format, IT standards and accounting systems, and 2) what it wishes to tell the ministry, based on its own strategy and the strategy it attributes to the ministerial administration.

Nevertheless, there is a wide consensus that IS interoperability is an issue that implies:

- Common tools and software
- Common standards to make legacy systems fully interoperable
- Assessing the performance of universities and research organisms in a context of stiff international competition, France's poor standing in the Shanghai index and the new obligation to be accountable to parliament.

Implementing an IS raises subversive questions at each stage. By "subversive", we mean questions that the current consensus prudently avoids in order to preserve a delicate institutional equilibrium. These questions are meant to clarify and design business processes, spring from the need to render invisible information explicit. We may classify these questions as follows:

1) Concerned questions:

"I share my data, but how will the system use it?" Being independent with heterogeneous IS has an obvious advantage: not being accountable!

"If I share my data, I know what I will lose, but not what I will gain". Laboratories and research centres are generally eager to share data as long only scientific issues are at stake. Handing over information that will be used by the centre to monitor (and to gain control) is another issue.

As an example, an attempt to build a monitoring system based on a fully compatible IS and data warehouse at the IT Science Department in the CNRS made it clear that:

- A researcher has no more publications than a professor researcher in an university⁶
- Raising the number of administrative staff does not increase researchers' productivity
- ...Increasing the number of researchers and doctoral students in a lab doesn't increase its efficiency
- The bigger the research team, the fewer results it produces.

To put it bluntly, it seems there is a Brooks's Law⁷ in the structuring of research organizations: increasing resources and staff decreases efficiency. Efforts must focus on architecture and process networks, without surpassing an optimum efficient size.

2) Paradoxical demands

In the absence of a central IT monitoring architecture, whether at state or university level, the IT community organized itself in much the same way as the free software developers' community did. A limited number of major applications exists at a central level (finances, HR, student databases), but current management applications are chosen, and frequently developed, on a local basis. Thirty-four universities (out of 105) have developed a shared application that is a *de facto* ERP⁸ – a common data warehouse and a set of businesses applications known as "Cocktail". There is a clear call within the community for common standards and tools designed by a central architect. This could only come from the central university pooling agency. But what the IT people demand is only for the agency to act as a free software service centre, not as an agency overseeing a global IT policy that threatens their independence. However, when the centre is asked to support bottom-up approaches and developments, it cannot only act as a technical agent. It must validate architectures, and this is not an area that it currently masters, either technically or politically.

3) Highly politically sensitive questions:

The prerequisite to designing an IT architecture is the definition of the basic building blocks. Questions that initially seem mundane are in reality quite sensitive, such as:

How should students be counted? There is a difference between the number of registered students and the number of students actually attending classes. In some regions, illegal immigrants may account for the difference.

How should a research unit be defined? Apart from the increasing number of

⁶ A researcher in a research institution has no teaching tasks, whereas a university professor is supposed to divide his or her time between research and teaching.

⁷ Brooks's law was formulated by Fred Brooks, the designer of the IBM 360, in his seminal book, *The Mythical Man-Month*. According to his law, adding resources to a late project makes it later because these new resources disrupt the project's architecture.

⁸ Enterprise Resources Planning: software built around a common data warehouse and state-of-the-art business processes. Implementation requires an important organizational redesign to fit this process that is currently estimated to be 90% of the project costs.

Chinese publications, France's bad standing in the Shanghai ranking system is a IS-related problem. There is no common description and identifier of a research unit and thus of its related publications. Research at the University of Lyon I is published under 41 different identities! This problem is well-known, but reaching a shared definition and a common identifier requires building a consensus among universities. Who will accredit research units and using which criteria? What common identifiers will be used?

3. IT architecture implementation: a critical issue in centre periphery relationships

3.1 The Centre–Periphery Dilemma

The centre-periphery model provides a relevant framework for analyzing the relationship between a public policy and the agencies in charge of its implementation – in other words, the different games and strategies within a political system (Eisenstadt, 1987, Crozier and Thoenig, 1975, Bendix, 1968).

Social organizations are understood as hierarchical structures comprising a centre and a periphery. The centre-periphery relationship includes mechanisms of domination, influence and dependency, the autonomy strategies of local structures to be understood. In the specific case of French public policy research, the centre-periphery dialogue is a relationship of influence and dependency. Influence because the local agencies produce knowledge and deliverables that in return legitimise central actions. Dependency because major decisions are made by the centre, which controls the principal resources.

It is in the central administration's interests to control local decisions and behaviour, but, conversely, it is in the local agencies' interests to preserve their autonomous power as a defence against a central bureaucracy (Thoenig, 1982). In other words, the centre-periphery dilemma characterises a process under pressure and the complexity of an organized social system. In the French research system, the centre-periphery model reveals both a localization of central policy and a nationalization of local policy. In addition, the role of local structures gives rise to a paradox. They drive initiatives and innovations (essential for revitalizing the central power), and are also places of resistance to change when directives arrive from a central power. This raises the question: Is there an ideal distribution of power for implementing public policy?

There is a clear trend in French management literature to assume, contrary to Weberian theory, that local authorities should be involved in defining centralized public policy. However, operational autonomy must be distinguished from strategic autonomy. Until recently, operational autonomy – central intervention at macro level and managerial delegation via a four-year contract – was the official management method used by the French research system. Currently, due to budgetary constraints and attempts to measure performance, a new configuration is emerging. President Sarkozy's government has committed itself to granting autonomy to universities, and a new law was voted in 2007. Local agencies, such as universities, can now undertake direct exchanges with the various institutions within their environment to

obtain resources, design their own strategies, and request strategic autonomy. To be efficient, strategic autonomy requires a strong, resourceful central government to link scientific production with wider strategic orientations. This shift from bureaucratic centralism to strategic centralism has not yet been achieved. The issue of the role of the centre is a controversial one (Rochet, 2007, Chevalier and Rouban, 2003). Public policy performance relies on the strategic capacities of the centre and on the mobilisation and coordination of local agencies. Implementing an effective public policy requires reconfiguring the centre-periphery dialogue based on adaptive learning of their interdependencies. This paper assumes that IS can be a cornerstone of the centre-periphery dialogue and thus a strategic instrument for piloting research policy.

3. 2 IS for fostering strategic centre–periphery dialogue

Although the strategic dimension of an integrated IS has been largely accepted in the literature, the results of field experiments are more mixed (i.e. Davenport, 1998, Botta-Genoulaz and Millet, 2006). Most of the failures can be explained by a lack of IT competencies, problems of cooperation between units and stakeholders, resistance to change and generally a lack of clear strategic objectives and leadership (Stefanou, 2000; Themistocleous *et al.*, 2001).

Strategic localization of IS depends on the IT being in line with the specific strategy being pursued (Baumard and Benvenuti, 1998). In others words, in order to be effective, integrated IS must foster synergy between strategic objectives and the IT architecture. Designing an IS requires rethinking business processes, organizational structure, connections between activities, etc. and requires in-depth change. Such reflections are unavoidable for IS, which is a lever of performance. Strategic IS governance, by assigning objectives to purchase policy and general organization of means, creates a framework for developing and implementing future projects, business and activities. Several authors drew a line between IS and the concept of collective learning (Amabile and Gadille, 2006), a prerequisite strengthening cooperation between stakeholders and organizational structures. IS implementation also refers to reflections on the process of strategic decision-making and information exchange (Reix, 1998).

We thus assume that implementation of an integrated IS is a means to foster new cooperation between a central administration and local agencies. The principal issues of the centre-periphery dilemma focus on questions of interoperability – whether technical or semantic – that are prerequisites for strategic information sharing. Processes of organization, socialization and influence may predetermine cooperative relationships between the centre and the periphery, and may result in unequal collaboration between stakeholders. This can be defined as interdependency links and degree of relationship stability (Amabile, 1999). This is far more than transactional interdependence, implying rather a pooling of resources, information and knowledge. The role of the central administration in this IS design appears crucial in terms of coordinating local agencies actions and creating strategic interdependencies. Successful implementation of an IT architecture relies on strategic centralism enabling development of relational networks between local structures and the central administration, and promotion of mutual adjustments and interactions within their dynamic and competitive environments.

The definition of IT architecture varies between authors. Österlé *et al.* (1993) attempt a definition of IT architecture as consisting of strategies and objectives, business processes, organizational units or structures, external agents, geographic localizations, kinds and attributes of entities, relations between entities, IT applications, information flows and databases. These components are connected in different combinations, i.e. entity X is involved in process Y and mobilizes application Z (Reix, 1998). A global IT architecture means designing a coherent system based on components association and common data warehouses (e.g. organizational view, operational view, data view, information view, security view, IT view, etc.). The concept of IT architecture reflects global system monitoring through harmonization of different policies. Therefore, as a complex and risky project, IT architecture also appears to be a vector of performance and efficiency. The case study presented below intends to illustrate this dualism.

3.3 IT architecture implementation and organizational change: four stages to develop IT architecture competency

The construction of an IT architecture to monitor a system like French research activities represents profound change. It implies major changes in organizational processes and cooperation between central and local structures.

In terms of public policy, “change” seems to be an emergent and dynamic process involving discussion about a system’s present and future IT capabilities: *Double Loop Learning* (Argyris and Schön, 1978).

Usually, IT architecture projects fail due to emphasis on the current core business rather than on opportunities for creating new processes and businesses. Indeed, most organizations build their IT architecture as a set of isolated applications and decisions to respond to specific process needs (Broadbent and Weill, 1997). Participants do not take into consideration the strategic context and the organizational vision of and need for IT architecture. As a result, they end up building architecture without factoring in new capabilities and the required skills.

According to Roos (2003), creation of a strategic IT architecture competency, defined as a learning process, takes place in four stages: 1) an application silo architecture, 2) a standardized technology architecture, 3) a rationalized data architecture and 4) a modular architecture.

In the following figure, we can see the four-stage learning process of IT architecture skill development.

Insert Figure 1 about here

1. *Application silo architecture* “consists of architectures of individual applications rather than an architecture for an entire enterprise” (Roos, 2003, p.5). In this initial stage, IT applications are developed to address specific business needs and are limited to a single functional system or unit. Many independent applications based on different technologies and data make information

transactions difficult. This is a stage of local optimization.

2. *Standardized technology architecture* relies on implementation of technology policies and standards, and on the development of a shared infrastructure. The aim is to limit the number of platforms to manage and to introduce data warehouses in order to render transactions between the different organizational units easier. Standardization and interoperability efforts play a role in IT efficiency (especially by lowering both costs and complexity). This stage also increases IT reliability and security. However, standardized architecture can create resistance to the standards principle, to the top-down approach needed to develop restricted IT applications and to data sharing, for example.
3. *Rationalized data architecture* consists of the definition of core processes and activities (“Core Processes Integration”) and the implementation of a shared and centralized database. At this stage, IT architecture is aligned to strategic business by standardization processes that ensure the relevance of IT infrastructures and quality of stored data. “As long as the data is reliable, core process activities become predictable” (Roos, 2003:9). Implementing rationalized architecture can help optimize core processes and improve business performance. However, this process requires negotiation with local operators to obtain a clear and accepted definition for each core process, to specify the data on which these activities rely, and to determine the share proceedings. In other words, identifying and defining core processes requires a strategic dialogue between the central approach and the various views of local units. Such strategic dialogue requires the leadership of a strong, centralized organization. There are also limits to this type of architecture. First, process standardization results in a rigid infrastructure, making changes difficult. This situation does not encourage radical innovation. Second, optimization (or merely management) of core processes depends almost entirely on the quality of the data that is collected and shared. Finally, rationalized architecture has the most top-down approach of the four stages, and in order to limit resistance from local operators, a relevant management change must be defined, and the stakes of rationalized architecture must be communicated.
4. The final stage, *modular architecture*, enables strategic flexibility through customized or reusable modules. “These modules extend core processes, which have been wired into the infrastructure during the rationalized data stage.” (Roos, 2003:11). Modularity allows both system flexibility and local autonomy to be strengthened. This stage is characterised by the opportunity given to local units to select the modules that they need and to create new support system processes. Local structures can thus experiment the use of new modules and anticipate organization-wide needs and opportunities. Local customization combines with standardized core processes in order to develop the capacity to identify strategic opportunities and innovate. However, in order to support this local flexibility, modular architecture requires distinguishing single-standard processes from multi-standard processes. Though modularity is difficult to implement, it is especially relevant when core business strategy depend on changing environments. Customized and reusable modules provide greater efficiency in combining third-stage standardization advantages with application silo innovation.

Insert Figure 2 about here

Each type of architecture provides different IT capabilities and relationships between central and local units. Change across these four architectures stages is only possible when the learning process of the previous stage has been completed.

We examined the state of progress of the French scientific establishment using this taxonomy. Rationalized architecture implementation seems particularly relevant in the current context of measuring the performance of French scientific research. In such an architecture, the central government issues large-scale strategic orientations by identifying core processes together the local operators. Meanwhile, local agencies adapt the central strategy and produce research. Moreover, the shift to the modular fourth stage will reinforce the strategic autonomy of local agencies and prevent central intervention at the micro-level. However, this architecture implies that stages 1 and 2 have been carried out by operators. The shift to the third stage also implies the development of a technological “absorptive capability” (Cohen and Levinthal, 1990). Absorptive capacity is an organization’s ability to identify, assimilate and exploit knowledge from the environment. In our case, absorptive capability focuses on the effectiveness of the assimilate of technological knowledge.

Some questions remain: How shall we organize the centre-periphery strategic dialogue to develop IT architecture skills? How should the implementation of IT architecture skills be monitored? How should the IT stage of each operator be evaluated? Finally, where should efforts be focused to implement a rationalized architecture in the French public research system?

4. Implementing an integrated IS in the French public research system

4.1 Qualitative Research Methodology

Designing and implementing an integrated information system is a clear vector of change, due to the fact that it triggers a new framework between the centre and the periphery. But since the change is on such a large scale, it is difficult to carry through to a successful conclusion.

We try to assess these paradoxical interactions through a case study methodology (Eisenhardt, 1989, Yin, 1990). A qualitative investigation was chosen (Miles et Huberman, 1984) based on a single-case study: the monitoring of French scientific research policy. This methodological choice is justified and relevant as the case presents a unique and original characteristic and allows us to test and complete an existing theory (Yin, 1990).

The project of monitoring French public research policy is a relevant field because it provides an exhaustive amount of information. In addition, this methodology offers an original intervention (in the view of Lewin, 1951), based on a researcher-practitioner

binomial. The practitioner led the monitoring system design project and as such wore two hats, as both expert and researcher. The second author assumed a guide role, notably in information collection and analysis. The practitioner's personal experience allowed him to develop a true sector-based expertise (Wacheux, 1996) and an extensive understanding of the project situation and context. In addition, his strategic and continuous participation allowed for meetings and exchanges with a multitude of participants with different responsibilities, and the development of relations of trust favourable to information collection. The aim of the intervention approach was to build an in-depth understanding of how the system works and produces knowledge (Hatchuel, 1994; David, 2000) through a hybrid, exploratory logic (Allard-Poesi *et al.*, 1999), where abduction has an important role to play especially regarding the analytic phase.

However, data collection associated with intervention research is a delicate task to control data authenticity. The case study was designed using a combination of different collection methods. First, collection of primary data included interviews (20 one-hour interviews) with the practitioner in charge of project and participant notes collected by the practitioner. Second, we organized a collection of secondary data (Weick, 1993) through a set of internal and strategic documents explaining the project stakes, its implementation, the actors, etc. This collection provides data triangulation and a robust chain of evidence (Miles et Huberman, 1984). The data analysis was qualitative via thematic content analysis (Bardin, 2001) and was achieved with the assistance of Nvivo (qualitative data analysis software), organizing the verbatim into categories of themes and sub-themes.

4.2 Designing new architectures and capabilities

Implementing a rationalized architecture in the French public research system is a complex project of the type described by Miller and Lessard (2001) – it is unique, complex, irreversible and instable. If this type of project fails, it is not due to technical difficulties but to a turbulent institutional environment. It will experience difficulties not so much because engineers cannot cope with technical complications – although IT projects unfold in a rapidly evolving technological environment – but much more because of the managerial abilities of project's sponsor in coping with unforeseen turbulence. Such turbulence originates from two sources: exogenous events such as changes in the political orientations of the research policy or the bankruptcy of a technological partner, and endogenous events such as internal contradictions or needs for evolution that the project reveals. According to Miller and Lessard, turbulence is negatively connected with project performance.

The basic laws of complexity tell us that a large complex project may not be merely the sum of decentralized participants' projects. It is a meta-system emerging from participants' interactions, but needs central governance that will model its overall endogenous and exogenous complexity. Setting up project governance is a two-fold architect job, involving creating an institutional framework that fosters arrangements between stakeholders and – once this is in place – the practical work of anticipating risk management, building a global vision and arbitrating between the various options.

As long as this governance is not in place, the project will be at risk from unforeseen

risks, subversive questions, institutional psychodrama, caprices and difficult negotiations with participants who cannot see the project except from a vested interest point of view. The role of the centre is to build a holistic system in which technology, policy and finance interact. Decentralized actors may legitimately worry that this might lead to greater Soviet-style centralization. It is obvious this is a risk in the eyes of the dominant so-called Weberian ministerial administrative framework. Avoiding such centralization requires the project to meet three standard conditions (Miller and Lessard, 2001):

Long-term stabilization to ensure the investments of each stakeholder: In our case, the project horizon is at least five years, in order to be able to effectively monitor public research. Although they increases environmental complexity, the major legislative changes in French public research guarantee that the project is not a short-lived political caprice that will change with the next government. On the other hand, a long-term project cannot wait five years to produce the first results. Confidence and commitment among stakeholders will be built by both formulating a long-term vision and by quick wins.

Flexibility in the face of turbulence: Once agreements have been negotiated and commitments made, the centre will have to manage risks, both foreseen and unforeseen. A modular project architecture, where the project is split into a series of projects managed by stakeholders, is likely to strengthen the project's ability to to face turbulence.

Enhancing the legitimacy of the project: This project, as mentioned above, faces opposition from vested interests. Although initially weak, opposition may increase when subversive questions arise and threaten those interests. Answering these questions requires new institutional arrangements, negotiated settlements and public debate. A successful sponsor will not start a project until its legitimacy is no longer in question, and is prepared to continually rebuild this legitimacy in the face of risks and challenges that threaten to undermine it.

Fulfilling these requirements implies a governance architecture in which the roles and responsibilities of both centre and periphery are clearly defined, and one that combines bottom-up and top-down approaches. In our case, we adopted the following arrangement:

Instead of a plethora of steering committees with excessive non-decisional members, a central directorate is set up around the central ministerial function entitled to make and enforce decisions, including representatives of universities and research organisms.

This governance directorate will deal only with strategic issues and will be kept from being overwhelmed by technical issues, which will be delegated to a project management staff. These strategic topics were listed as follows:

Funding and budgeting: who will pay for what? What is to be charged to universities and other research bodies, and what is to be funded by the ministerial budget?

What are the decisions to be made at this level? For instance, only decisions with an impact over X millions euros will come to this committee.

Validating the global architecture of the Mission's IS: data, interchange standards, systems interoperability, business processes and quality standards are

key norms, since each actor is autonomous. Whatever technology is chosen, interoperability must be mandatory.

Large shared processes and their owners: This may consist of central monitoring, shared process among universities or research players, data warehouses and indicator production. A global architecture must be based on common building blocks, and assigning their design and ownership to peripheral stakeholders will strengthen both ownership and trust in the global system.

Outsourcing rules and relationships with IT providers: NPM has fostered the idea that the best thing for public administrations was to outsource IS to private providers. This resulted in a loss of control over the system, a loss in reliability and higher costs (Dunleavy and Margetts, 2002). In a decentralized system, where participants deal directly with providers, there is a need for common procurement rules and practices, and, most of all, a need to define the strategic capabilities that should not be outsourced that is enforced by the centre. This means defining common strategic capacities, particularly the centre's capacity to act as an architect.

Scenarizing and managing risk: Stakeholders must not rely on technology but on the resilience of the architecture to exogenous as well endogenous risks.

Alongside this strategic governance committee, a project management committee deals with technical issues: evaluating and costing projects, managing budgets and planning, negotiating with providers and insuring both quality and reliability.

4.3 Architecting the organization and the IS

Designing the architecture of the new monitoring arrangement resulted in the design of a new layer between the centre and the peripheral agencies (fig 3)

Insert Figure 3 about here

Layer I is national research policy formulated by legislation or budgetary orientations by the State, by EU research programmes – i.e funded by the Member State – and by the regions via cluster-creation incentive programmes.

Layer II is a new programming function. It is represented by the scientific management of agencies and the contractual links between the State, universities and research agencies.

Layer III is a classic production function that produces deliverables according to the orientations set up at levels I and II.

In terms of information systems, this arrangement may be represented as follows:

Insert Figure 4 about here

Level I is the global monitoring system, i.e. the balanced scorecard of public research policy. *Level II* defines the business process architecture, i.e. the meta-process of

academic and scientific production, metrics for measuring performance, international benchmarks and criteria to render these processes auditable. Level II also makes the link with the software architecture – the key layer to make information systems interoperable. Using the framework defined in figure 2 helps identify where to put emphasis in constructing this global architecture. Stages 1 and 2 (local and functional optimization and IT efficiency) are to be dealt with by agencies while stage 3 (rationalizing data) needs a global architect to define core processes and key performance indicators – what we call urbanization constraints to be integrated by agencies when developing on their own. These constraints integrate both business process and software architecture and deal only with the technical infrastructure (*level III*) inasmuch as technical leadership is needed to meet interoperability requirements. These pave the way to stage 4 (modularity) that will allow increased autonomy for both agencies and universities, and more monitoring of research public policy.

The subversive way we adopted allows us to slowly reveal the hidden part of the iceberg, and at a pace defined by the progress in solving unforeseen strategic organizational issues, via the process of completing the initial building-block projects and by the first quick wins.

5. Lessons learned from the case study

5.1 The need for new skills

It is obvious that such an approach requires new skill-sets in both administrative and scientific research circles. There is still a gap between IT people and business people, who speak different languages and do not share a common vision, which is required for such a project. In the absence of clear political leadership, meeting such a large change head-on would result in decisions to postpone the project or to rely exclusively on technology to side-step difficult political and organizational questions.

5.2 Key success factors

We drew on the conclusions of Miller and Lessard concerning management of large engineering projects, and on the literature about complex systems in order to construct a framework for monitoring of large, complex and multi-participant IS projects. There are five key success factors:

Upstream design: Strategic issues must be clearly laid out and a critical path defined for the coming years. An initial list of the principal risks must be drawn up. When many vested and conflicting interests are at stake, the issues must be progressively laid out, from the simple to the more complex. This is what we call a "subversive" approach. IT is a powerful change agent, and designing a new IS will raise many difficult questions that, if fully and simultaneously disclosed, would provoke a groundswell of contradictory vested interests to maintain the status quo.

Strategic governance: The project manager must first win political support from top management and elected officials. Given the medium-term range of the project, such

support is not easily gained. Projects with clear outputs, such as online income tax filing, have won such support and take place in spite of government changes. This is not the case for monitoring scientific research policy, since issues and outputs are difficult to define and highly controversial. The less legitimacy the project manager has in the eyes of his strategic governance, the more subversive his approach must be, and *vice versa*.

Quick wins: To appease stakeholders', quick wins that demonstrate valuable results are necessary. They in turn will a problem-solving dynamic that will help when it it time to deal with increasingly complex issues.

Skill-building: Public-sector IT skills are low, due to the lag in integrating the role of IT as a change agent, as well as to low salary levels that prohibit recruiting highly talented individuals. There is currently no CIO function in the French administration, a role that would introduce reflections on global architecture and business change. It exists in agencies that are more experienced in IT projects, and which can thus continually question the centre's competency and legitimacy in designing a global monitoring system.

Joining bottom-up and top down approach: To avoid these obstacles (poor legitimacy of the centre in designing IS and conspiracy-theory thinking among the periphery's stakeholders), we must rely on initiatives from the periphery and federate them into a global project, while at the same time following the strategic initiatives laid out by the centre.

5.3 A public-sector CIO

From this framework arises a concept for the change agent that a public-sector CIO, or IT project leader, must be. In the private sector, the role of the CIO passed through three stages over the past few decades. In the 1970s and early 1980s, a CIO acted as a support in charge of automating recurring tasks. In the late 1980s and early 1990s, the role became more that of a re-engineering business processes agent, focused on cost control and downsizing. Following this, CIOs became concerned with process improvement; process automation became closely linked to productivity, lower costs and increased efficiency. This trend culminated with the arrival of ERP software and e-business in the late 1990s, and expensive and large-scale IT projects that promised a great deal but delivered less. With the end of the dot com bubble, the CIO role became concerned with information management as a source of creating competitive advantage (Marchand, 2004, Rochet, 2006), and CIOs became part of top management with a full strategic role (Cigref – McKinsey, 2004).

In the public sector, the landscape is more varied. In some pilot sectors, e-administration has become a means for re-engineering business processes. But in most places, the CIO function is still largely similar to the above-mentioned support role. This has a number of negative consequences for administrative productivity. In the absence of a central architect, information systems accumulate layers and become costly to maintain. In the Ministry for Higher Education and Research, there are more than 250 such systems without a shared plan. Maintenance consumes 75% of the IT budget, thus impeding new investment. There is a clear need for a policy of "applicative euthanasia" that would simplify what has become a "spaghetti network", turning it into a fully urbanized information system.

But this requires strong political support. The emerging role of the public-sector CIO is helping top management and politicians to become aware of the issues and to understand the powerful change role that IT can play. This will help make public policies monitorable and to stop wasting money in maintenance of underperforming systems.

6. A stronger centre to create more peripheral autonomy

These three lessons appear to be prerequisites for bringing an IT project to a successful conclusion. Let us return to our initial questions: *What impact does information technology have on the relationship between the centre and the periphery? What impact does the degree of IT integration have on the degree of cooperation between the centre and the periphery?*

The answer to the second question is clear: an integrated IS means rationalizing the IT architecture, defining common objectives and a common language and designing key relationships between various entities. This stage means that all participants, both central and peripheral, must cooperate in order to define these elements. Strengthening the centre by appointing a CIO whose role is to identify and federate local experiments is thus an essential prerequisite to implementing a modular architecture. This will then foster increased autonomy on the part of peripheral stakeholders.

In this meta-approach, IT represents a strategic piloting tool, and consequently a spur to change in the ways that centre and periphery cooperate. The implementation of an integrated IS requires taking into account experiments already led at the local level, which enhances their standing and increases the legitimacy of peripheral stakeholders and their initiatives with respect to the centre. However, mutual recognition of central and peripheral entities constitutes the base of the project's political legitimacy.

Finally, an integrated IT can weaken the periphery's reservations with respect to the centre, since the centre is not seen merely as the seat of control and sanction, but also a knowledge-sharing tool, concerned with improving scientific performance.

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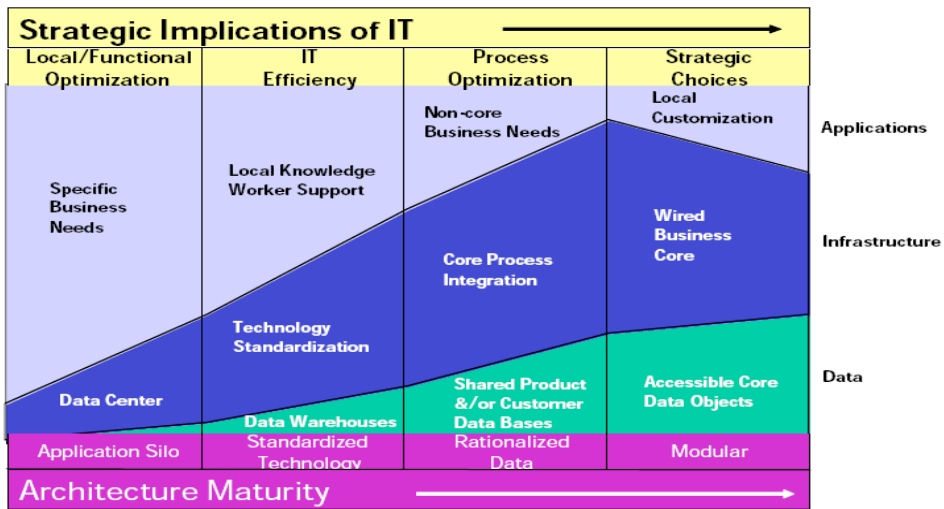
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FIGURES

Figure 1: Changing Resource Allocations Across Architecture Stages



Source : Roos (2003), Center for Information Systems Research, MIT Sloan School of Management

Figure 2 : Key IT Governance and Management Mechanisms

	Application Silo	Standardized Technology	Rationalized Data	Modular
IT Capability	IT applications serve isolated business needs	Firm-wide technology standards	IT focused on wiring core process	Modules enable business model extensions
Key Management Innovation	Technology-enabled change management	Standardization and exception management, refresh	Recognizing essence of the business	Practices facilitating reusability
Business Case for IT	ROI of applications	Reduced IT costs; interoperability	Improved business performance; integration	Speed to market; Strategic agility
Locus of Control	Local control	Senior management support of CIO	Senior management, IT, and process leadership	Senior mgmt, IT, process, and local leadership
Key Governance Issues	Estimate, measure, communicate value	Establish (local/ regional/ global) standard setting, exception & funding processes	Determine core processes and funding priorities	Define boundaries for business experiments

Source : Roos (2003), Center for Information Systems Research, MIT Sloan School of Management

Figure 3 : Layers of governance to measure the French scientific research performance

I: Strategic orientations, financial framework (National, EU, regions...)

II: Programming = scientific agencies management, contract with universities: defining the demand

III: Execution = agencies and universities production function: defining an offer and producing deliverables

Figure 4: Information system governance layers

