Technological Needs and Networks

Vincent Giard
Professor at the IAE in Paris (*Panthéon - Sorbonne* University)

In order to survive, companies transform themselves to adapt goods or services to market requirements, striving to increase their competitiveness and their reactivity. This generates new organizational forms and management tools, facilitated or made possible through new techniques. The coverage of the network model has been spreading throughout the last few years; it is thus interesting to ask questions on the potential impact of some characteristics of this organizational mode, observable in network companies created a few years back, on "classically" managed companies interested by this approach. The evolution of techniques generates opportunities that could broaden applications of "network" approaches and also have management tools evolve.

This paper puts into perspective a few salient features of this evolution and ask a few methodological questions. The point of view of this paper is of course partial, and even partisan, but the ideas expressed here correspond to one of the possible angles from which to renew management tools. We will first position the problem before examining the emergence of new technological needs, partly influenced by the extension of the network model.

1 Problem definition

First of all, one must clarify the network and technology concepts at the heart of this article before stating the profound mutations occurring in economic, technical and managerial environments, forcing companies to reorganize.

1.1 *Definitions*

1.1.1 Technology

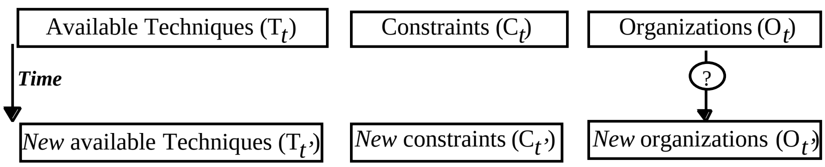
We will select here the acceptance of the term proposed by Morin [9] defining technology as: "the art of implementing, in a local context and for a specific purpose, all sciences, techniques and fundamental rules used in the design of products and manufacturing processes, management methods or information systems of a company". Three significant characteristics stem from this definition.

- First, technology interdependently combines, on the one hand, engineering sciences for the coordinated design of products and production processes, but also in equipment design and, on the other hand, managerial sciences for structure design (organization charts, task distribution, etc.) and control of the production system (definition of procedures for command, control, design and access to management information).
- Technology is considered as an art, not a science. This leads to the development, on a largely intuitive basis, of adequate combinations of engineering and managerial requirements.
- Technology is contingent in two ways. By assigning technology to meet a specific need, the resulting efficiency criterion obviously impacts on the

selected combination of engineering and managerial requirements. Also, this implementation of technology is carried out in a given local and dated context, which generates a selected solution designed to meet a specific need that cannot be universal.

This image of technology must be matched to the one proposed by reengineering pioneers (Hammer and Champy, [8], Davenport, [3]) who relate technique and management into a contingency and organizational innovation theory designed to create leeway by quashing implicit hypotheses on which the organization are based. The rationale, summarized in Figure 1, is simple: at any time, the available techniques induce a certain number of constraints that largely influence the organization. It is clear that technique evolution modifies organizational constraints, but nothing induces it to transform itself in order to take this constraint modification into account. One of the strong reengineering principles is to search among emerging techniques, especially among information and communications techniques, those that modify some strong constraints that weigh, often implicitly, on the organization and, by doing so, give transformation opportunities. It is pertinent to note that this technological approach has all three characteristics mentioned above, but it introduces a certain dissymmetry in the relations between engineering sciences and managerial sciences.

Figure 1: The reengineering approach



Once technology has been defined as above, it becomes obvious that technological needs depend both on the available techniques and their evolution as well as on the instrumentation in use and its foreseeable transformations in a changing socioeconomic context. One of the trends we can observe in the new organizational forms is the focus on the network concept.

1.1.2 **Company and network**

Nicolas Curien [1] considers *network companies* under two angles. The *engineer* focuses on the “spatial interconnection of complementary equipment, cooperating to transport matter, energy or information fluxes and to send them from an origin to a destination”, while the *economist* focuses on intermediation, the function of these companies being to “establish a link between suppliers and consumers of certain goods and services”.

Characterization of productive resources selected in the first design helps classify, without ambiguity, the merchandize or person transportation companies as part of the network company category. The function vision is much less discriminating as it encompasses almost all companies in the distribution field. In medium and large companies, functional specialization is the reason why there is always one or several production units exclusively charged with logistics and that meet the first definition of Curien. We can thus expect that any moderate-sized company meet a few problems facing network companies “in the strictest sense”, whose main specificity is that logistics activity is a *main activity*, and not a secondary one.

A third network design is based on the precept that any complex production system can be analyzed as a network of production units linked by exchanges of products or services. From this point of view, the *company boundary* differs from a judicial point of view (“property” of production means) than from an economic point of view (set of production units concurring in a given production). The production of intermediate goods can often be replaced by supply or subcontracting (or co-contracting) and most service activities, especially support activities (personnel management, information system management, transportation, etc.) can also be subcontracted (or co-contracted).

We are witness to the ascendancy of more or less stable alliances leading to the creation of *networks of companies* or, what Paché and Paraponaris [10] call *networked company*, which they characterize as being a “flexible and adaptive structure mobilizing — and no more owning — a set of coordinated and stabilized skills”. Compared to network companies, the interconnection is more organizational than spatial, which poses new coordination and control problems related to a partial integration of management by the partners. Also, certain specificity characteristics in network companies “in the strictest sense” is found although slightly diluted, in networked companies “in the largest sense” or in networks of companies (See Giard [4]).

1.2 *A deeply modified context*

The evolution of technological needs and the interest of network organizations is better understood when put into perspective with major transformations in company environments, characterized by a radical market transformation, by technical mutations with heavy consequences and, finally, by a significant renewal of management tools.

1.2.1 Radical market transformation

The changes throughout the last few years are relatively well known:

- a clear *hardening* of the *competition*, which translates by a significant shortening of both the useful lives and the development period of products;
- changes in *customers*, who became *choosier* and more *volatile*;
- interesting modifications to *attributes of the exchanged object*:
  - these attributes were for a very long time exclusively attributes of *price* and “vaguely” of *technical specifications*;
  - customers' increasingly desired specifications such as *variety* of the offer and the *quality* of products or services were added to these attributes;

- competition spread by the inclusion of *additional services limiting the risk* (after sales service, exchange or reimbursement, consideration of risk of theft or damage, …) *or the discomfort* (home delivery, courtesy vehicle, direct assumption of formalities or of some expenses in case of litigation or accident), translating a more global vision of the needs to be met;
- finally, relatively strong recent competition can be observed based on the *time* required for a product or service to be available; time elasticity (as price elasticity) plays an increasing role, which explains that the *availability date of the object* or service has become a new attribute explaining certain transformations in organization and competition modes.

Hardening of competition and transformation in customer requirements *has become the standard*, no matter what the company field of activity is**.**

1.2.2 **Technical evolutions big with consequences**

It would seem that from a technical point of view the rhythm of innovations has not decreased over the last few decades. We are not dealing with innovations for companies in a given field, but with those all companies can use and, more especially, those innovations know as New Information and Communications Technologies (NICT).

Acquisition, storage, processing and restitution of information are increasingly economic and performing and open new management angles. Within the company, they allow real-time monitoring of product and services production as well as the use of human and equipment resources. Traceability impacts on the performance of production systems, which can be managed in a more efficient and reactive manner, but it also impacts on the quality of processes and products in a total quality perspective. Moreover, overcoming proximity constraints in the collection and processing of certain information, they authorize transient work, which was impossible until then. Finally, they made possible the use of certain management tools to be discussed later.

Transaction dematerialization possibilities brought on by NICT will also transform the inter-company relationships and those between certain companies and their customers. The inter-company commercial relationships are progressively switching from a “paper” logic to a dematerialized logic to transmit information: commercial exchanges are made through EDI (Electronic Data Interchange) and large development projects of new complex products are carried out by a network of companies using the CALS approach (Computer-aided Acquisition and Logistic Support). Commercial relationships between certain companies and their customers are also affected by NICT. E-business is progressively replacing mail-order selling, giving the vendor extraordinary scale savings as a result of the absence of hard copies (electronic catalogue) and the client coming to the company, as the company is not looking for potential clients.

In short, NICT disregard frontiers in a world where added value is increasingly based on information.

1.2.3 Management tools renewal

Managerial techniques never stopped evolving since the industrial revolution, so discussing renewal may seem a tad unreasonable. Nevertheless, from the early 1980s on, three major evolutions need to be emphasized to better point out technological perspectives of network or networked companies.

Process rehabilitation

In the early 1980s, new movements based on a process-focused reflection were born; they were designed to capture it in order to consider it globally and improve on it: Activity Based Costing, TQM, Kaizen, project management, reengineering. In each of these various approaches, the process must first be identified before being modified.

The main disincentive to process identification normally lies in the analysis of goods or services production being conducted on the basis of the consolidation of tasks by services to which belong the individuals who perform these tasks. This “vertical” vision has long been considered as adequate, but it must be completed or replaced by an horizontal vision, the process one. This implies that, when depicting a company, we must complete the classical depictions of the organizational charts, BOM, routings, with flow charts and process charts still presenting a limited usage.

A flow chart shows, on a simplified representation of an existing production system (plan with visualization of main production stations), the flow of matter (or of files) passing through various processors to be processed, before arriving in its final or intermediate state of finished product or completed service. This representation differs from the graph of a routing chart, which represents the sequencing of operations, due to its focus on the sequencing of mobilized production stations and the absence of detailed information on the operating modes used.

The process chart is more extensive as it allows features related to several points of view:

- multiple ratings for each operation: operation with or without added value for the client of the process, time spent waiting or in processing, nature of the operation from a decisional or a materiel point of view;
- multiple ratings for each process in a general process map: e.g. main or support process, each category could be broken down;
- multiple ratings for each mobilized resource: assignment to a functional entity or, for people, role played in the process, rating or hierarchy level.

These multiple points of view of course complicate our representation of reality and only present an interest as it allows a better understanding of the process in order to improve it; this implies the use of the “relevant level of details” for the analysis.

The cause for reengineering

Until recent times, the evolution of production systems observed in response to the transformation of the competitive environment consisted in an *emphasis* on *process fragmentation* and in the *specialization of actors*. This movement, justified by the search for a “local” reduction of complexity, induced increasing needs for coordination, which were tentatively met by using ever increasingly sophisticated managerial techniques. The assumption behind reengineering is that this organizational response revealed itself to be less efficient, to a point now where it can really generate significant scale diseconomies.

As for this trend, with roots in scientific work organization and value analysis, process defragmentation and simplification then seem to be efficient means to reduce the co-ordination work of the productive activities. This process revision procedure seeks to breach the implicit hypotheses on which the organization is based and which are "false constraints", by resting on an inductive procedure (which stems from technical solutions to seek the problems to which the solutions could apply) and on the NICT.

The application of this procedure leads to a transformation of the processes and can be seen by a compression of the structures, both vertically (reduction of the line of command mainly due to the fusion of analyst, decision maker and operator roles) and horizontally (simplification of processes to widen the circle of actors responsible for a process).

Introduction of new resolution approaches for complex problems

It is evident that micro-computer evolutions allowed the development and use of processes that could not have been foreseen twenty years ago or that, for economic reasons, would only have known limited developments.

- With the arrival of *relational databases* and extremely performing and rapid tools to create prototypes and to update and operate these ergonomic and user-friendly bases, we have, at acceptable cost, raw material that is easy to use to analyze and to take more or less structured decision and that allowed the development of mechano-type integrated architectures based on the same relational databases with ERP (Enterprise Resources Planing).
- This computer progress opens a door for the solution of *Operations Research* problems that describe complex decisional situations. When doing this, the difficulty of defining problems of a certain dimension in an operational manner and the modification of such problems led researchers to propose an innovative approach, that of *Algebraic Modelling Languages*, that rely on the separation between the description of the model and the units it uses; this gives rapid fine tuning and an immediate generalization of the formulation obtained to a class of problems (Giard, [6] and Rosenthal, [11]). In a related field, this computer evolution favored the development of several, economically affordable, specific tools: *Expert Systems*, *statistical processing software* (the more recent, based on the Exploratory Data Analysis approach or the Data Mining one help the user understand his data and formulate hypotheses), etc. Of course, *spreadsheets*

must be placed in this category, with their basic functionalities totally different from the ones available about a dozen years ago, they are increased tenfold by the various add-in possibilities (especially the ones that facilitate the sensibility analyses in certain universe or random universe).

- Interests for the Monte Carlo management approaches was underscored in the early '60s The first formal approaches allowing *simulation* of problems of a certain complexity go back to the early '70s but they are based on programming languages that are quite closed. During the '90s, new software generations came into being that were based on graphical approaches; they greatly reduced the difficulty of describing a complex process. These last few years, for a little more than the cost of a spreadsheet, we can have simulation software that is easy to use and the performance of which place this class of tools within the grasp of managers who can now think differently on the transformation of the controlling rules for a complex production system.
- The *DSS* (Decision Support Systems), dating back to the '70s focus on helping to formulate a problem that is part of a complex category of problems and on helping to operate systems. The solution of the stated problem, which can rest on sophisticated tools of operations research, is generally carried out without the intervention of the *DSS* user, who can now concentrate on formulating the problem and on applying the proposed solution.
- For about ten years now, Groupware tools have been developed for mixed-initiative work, on poorly-structured problems that do not require the players in a workgroup be all at the same place at the same time. Micro-computer evolution and the generalization of networking lead to an interesting extension of these approaches to formulate and solve poorly-structured and very complex problems.

On the whole, the manager's toolbox has considerable expanded. We now have means that the '70s managers could only imagine with difficulty. The problem with which we presently face is the development of new “decisional models” that take advantage of these possibilities to take strategic types of decisions that are more or less structured (design of productive systems, …) tactical (definition of typical organizations) and operational (real-time control, ,…).

2 New technological needs

The technological needs taken into consideration here pertain to the necessity of the development of new managerial techniques and new “mechanos” based on the NICT because issues changed for the manager. The emergence of new approaches will be illustrated by an innovative example of complexity processing for network companies.

2.1 *Changing issues for the manager*

Placing this into perspective is undoubtedly debatable and reductive but, according to us, it translates the prioritization of the efforts required in the coming decade, to be able to adapt the managerial techniques to the new market requirements. It seem first necessary to facilitate the passage of a process decoupling logic to a process integration logic. It then seems necessary to improve the knowledge and the mastery of the complexity. These research axes are not exclusively linked to network nor networked companies, but the attractiveness of the network model is closely dependant on the innovations realized in these fields.

2.1.1 Switching from a decoupling logic to an integration logic

The observation of complex productive processes, both for designing products (or services) and their manufacturing routings, and for producing and distributing these products (or services), evidences the successive use of a certain number of productive sub-systems. Several means are available, outside the continuous efforts taken to make the processes reliable, to ensure decoupling between the sub-systems, and to avoid that problems occurring in a sub-system spread to the adjacent systems. The oldest, is undoubtedly the building of stocks at the boundary of these sub-systems, the size of these *stocks* corresponds implicitly to a time period available to locally solve the problems before they spread to adjacent sub-systems. Other means are classically mobilized to solve more rapidly the problems and to thus allow a decrease in stocks, considered as a source of inertia and waste; this is mainly having *surplus resources* (mainly as equipment and tools) and the search for minimal *multipurpose* resources (personnel, equipment).

We now understand the importance of a final decoupling technique used implicitly, the *sequentiality* of the processes. Thus, until quite recently, the industrial organization of mass production clearly separated the definition of project specifications for new products, the design of these products and the design of the manufacturing routings of these products. This sequentiality has the advantage of a precise determination of roles and responsibilities and facilitates the local optimization of each process. The transformation of company environments and especially chrono-competition led to question this sequential logic and to begin a partial fusion of the processes that question the independence of the productive sub-systems. The disadvantages of sequentiality were known and had led to the installation, in large companies, of transverse structures, often called matrices but the aim of which was more to improve co-ordination than to question once again the sequential organization.

This switch from a decoupling logic to an integrated logic raises several problems that are not specific to the network or networked companies but have an increased complexity for this type of company.

- Companies that have opted for a *"project" approach* to manage the design of new products implement specific organizations that can include up to the merger of services (for example the merger of studies and methods departments at Renault). Most often, integration goes through an organization of the Concurrent Engineering between partners of a global process often belonging, for important projects, to different companies and leading to co-development. This implementation is shown by the creation of project platforms to design new and complex products, which pose relatively new problems (determination of the number of platforms to create, determination of the players to involve in these platforms and for how long, determination of their decisional power, etc.). However, sequentiality allows relationships of the ownership – contractorship type that is supplanted in part by the concurrent engineering: the definition of certain specifications implies a more collective responsibility and another approach for the risks encountered that lead to the implementation of procedures to help the early emergence of problems, and to their solution by instruments that rely on principles ranging from mutual adjustment to contractualization.

- Decoupling systems allow the use and design of independent and heterogeneous *information systems*. The integration of design and production processes does not tolerate well this juxtaposition of information systems that implies carrying out "transcription" tasks with no added value and thus puts a brake on reactivity.
- Switching from a decoupling logic to an integrated logic involves *taking greater notice of the client*, based in a synergy logic in the value chain. This is how we can observe a taking charge of wholesaler or retailer stock management by suppliers who thus greatly increase the added value of their services, that were before mainly based on time and price; this transformation allows a global decrease in the cost of supplies and, for the supplier, more faithful clients, when he is competing. Among the services given to the "integrated" client, there is a whole series of added value services from a better matching visits to clients needs (frequency, time window, orders traceability of orders in process, etc.) to a better handling of client logistics (presentation of merchandise in a certain order, etc.), especially in JIT organizations.
- This accentuated coupling generates *new problems* not only for activity *co-ordination* to ensure a satisfactory synchronization of coupled systems, but also for risk management, bringing forth a new problematic.
  - The co-ordination of coupled systems involves increased complexity in production management, better integration of information systems if we want to tend toward a real-time type of collective control and finally, a transformation of management control practices that can no longer rest on a restricted and stable perimeter. These multiples challenges give rise to several problems which must be solved on a theoretical level as well as on a practical level.
  - Risk management must also be adapted. Therefore, the supply of optional components to install on an assembly line can be done several times a day according to a daily production programming, taking onto account the constraints related to the individualization of finished products; in this context, the quality requirements can lead to work being done twice at certain work stations, thus modifying the initial sequencing (the retouched product would let the following ones pass)

which lead to modification of the effective demand for these optional components on the production time intervals related to deliveries. This risk is evidently dealt with by a safety stock but this safety stock is determined according to a radically different basis from that classically used in stock theory (Danjou, Giard and Le Roy, [2]).

- The problem of the economic perimeter brings us back to the debate on the integration or the outsourcing of certain processes. This outsourcing of certain activities is justified by stating that a regulation by the market based on "market" prices is more effective (in terms of efficiency and reactivity) than an internal regulation based on the "transfer" price, this outsourcing allows to refocus on the reason for being of the company. This type of strategic decision must be conduction rigorously.
  - For value-added activities, such as designing, the decision is more complex because, implicitly, outsourcing involves relationships of the "ownership - contractorship" type , that is it supposes the definition of a "good" set of specifications independent of the solution to the problem stated. This sequential process often leads to less performing solutions than those based on concurrent engineering.
  - For quite standardized support activities, outsourcing poses, a priori, even less problems so it often becomes difficult to economically establish the speed and reactivity characteristics of certain services. This outsourcing movement, often amplified by poor use of management accounting (use of total costs), rests implicitly on a fragmented vision of the processes that could bias strategic thinking. For example, we know that integrating transport logistics to supply the stores of a chain can be the key for a decidedly competitive advantage over the competition who prefer to outsource this activity. This type of decision must be taken according to analyses not based exclusively on some elements retained in a simplistic modeling of the production processes, because they are easy to beneficiate. It is also necessary to integrate in this thinking the fact that the competitive advantage of outsourcing may be attenuated by the comoditization of expertise by performing and low-cost software and also by savings generated by the integration of modules in the "modern" approaches to management systems that are based on relational data (especially ERPs).

This reflection on the degree of coincidence between the economic and legal perimeters is therefore difficult to undertake and must rest on several complementary points of view for which the available instruments must be improved.

2..1.2 **Understanding and mastering complexity**

Any quest to understand and master complexity is most certainly an impossible goal to fully satisfy. Efforts should be made in two complementary directions: improving process analysis techniques and productive systems design.

If there is a consensus on the necessity to *analyze the process*, there are also multiple approaches to carry it. The reengineering trend led to the publication of several documents and software to aid the representation of the processes. One can distinguish between the deterministic approaches and the stochastic approaches.

- The deterministic approaches, computer assisted or not, are mainly designed for multidimensional representation of the processes by selecting several qualifications. The more the information retained is detailed, less it will be directly exploitable, this leads to the creation of filters to only display the information deemed relevant for the point of view selected. Then there is the question of the detail level of the information that is handled, as one can imagine working on aggregated processes, using all points of view simultaneously, or on detailed processes, using only a very limited number of points of view. The aggregation of a process generates formidable methodological problems as to the transmission/adaptation rules of the available characterizations on the "entities" available at a detailed level (resources, material or information flow, procedures), on the ones of the aggregated "entities". Solving of some of these problems places conditions on "automatically" supplying information corresponding to the points of view and detail level wanted by those who wish to understand the operation of a complex process to improve its control or its design.
- There are two types of *stochastic approaches* to represent the process. Simulators allow to know the response of a productive system to a given or random demand and to calculate a certain number of indicators that play a role similar to certain filters (the possibility of referring to outsourcing programs and the possibility of interfacing with certain spreadsheets now allow to do everything). Certain software also offer the possibility of aggregating production centers that simplify the analysis of a complex process. However, for the last few years, new software has been developed combining a flow mapping logic formally close to certain deterministic approaches (explicitation of branch tests for choosing alternate routings, roles, services,…) and a stochastic definition of operating time and flow orientation coming from an elementary production center; this approach is according to certain more detailed aspects (especially for the production of services) but it has its limits (to call on multiple resources, for example). In both cases, the software can study quite easily the impact of planned transformations for certain processes but the methodological problems stated for the deterministic approaches are also found in the stochastic approaches.

If these process analysis tools can be improved, the problem of help to diagnose an existing situation and to propose its transformation stays the same and is a major field of research for the coming years. To build these universal sets used to facilitate this search for improving the process, managers could benefit from taking advantage of the important company modeling work carried out in the last twenty years (Vernadat, [12]) in related fields of study, in the United States as well as in the EU. That being said, the multiplicity of points and angles of view to attack this problem lead to think that using these approaches will, for the manager, remain art and for a long time to come.

Mastery of complexity also goes through a design improvement of productive systems; this has two categories of issues:

- the search for better flexibility, reactivity and efficiency of productive systems, right from their design, especially in mass production industries, must be caught upstream within the scope of a strategic inquiry on:
  - the degree of component standardization (Giard, [7]),
  - the interdependence between occupational logic and project logic (respective roles, concurrent design of the manufacturing products and processes, finishes and standardized components, …), but also on the interdependence linking projects for finished products with the ones having largely standardized components,
  - the design of a range of products technologically close that can share, during production, equipment and manufacturing or assembly lines; this involves taking into consideration certain constraints right from product design, but, on the other hand, it counters demand instability on each product routing; similar problems are also found in the production of small series, with the creation of temporary virtual cells allowing to strike a balance with flexibility requirements.

  These transversal problems do not generally stem from a clearly identified direction, they are not independent from one other and pose challenging methodological economic control problems (transfer costs systems, coherence of the specific management controls, …) that are far from resolved and for which the "network" orientation complicates things.
- Competition exacerbation drives companies to adopt differentiation strategies. One of them is based on the search for sources of added value for the client through the design of a productive system. For on-demand productions, an improvement in traceability is not only an improvement in physical control, it is also, for the client, a reduction element of the variability in delivery delays and product quality. For stock production, this differentiation can be obtained by moving the limit of the productive system that can "penetrate" client's facilities by offering value-added services as a complement to products or deliveries sold: specific merchandize conditioning limits client handling, helps him manage his stocks, etc.

These changes in perspective, now made possible by technical evolution, involve decompartmentalization of expertise and are a major challenge for companies.

2.2 *Example of a possible way to process complexity*

When faced with very complex problems, a manager classically favors the Cartesian approach of dividing up a complex problem into simpler elementary problems, related to one another by a set of constraints ensuring coherence for the whole. This processing of complexity is based on a prior analysis that rests on the joint use of a certain number of analytical grids that structure, sequence and simplify the problems encountered. The productive system is divided into interdependent sub-systems that have a certain decisional autonomy. The decisions that must be taken are structured and sequenced to limit their boundary (object, constraints, degrees of liberty) and to ensure coherence by basing itself on sequence dividing (pertaining to resources, products, clients and processes) and time dividing logics (distribution among the strategic, tactical and operational levels,…).

These problems of dividing up and coordination, more formidable when it concerns network companies or networks of companies, can only hope to receive answers considered satisfactory within a given context. For those who favor reengineering, the usual solutions of "divide / simplify + co-ordinate" have reached their limits. Two remarks are then required:

- One of the major obstacles found in the traditional approach undoubtedly lies in the lack of foreseeability of the impact of certain planned innovative organizational transformations. Within this perspective, an improvement in foreseeability will push the limits of this approach by making easier to manage "limit displacements" that allow better management of increased complexity without increasing the fragmentation of processes, even by introducing a certain defragmentation.
- Reengineering a network organization seems difficult without a minimum of dividing up into elementary processes, based on an "client - supplier" type of architecture. From this point of view, we are also faced with "division/coordination" problems, but with a major difference, by accepting to question the actors' roles and a significant revision of the procedures and services.

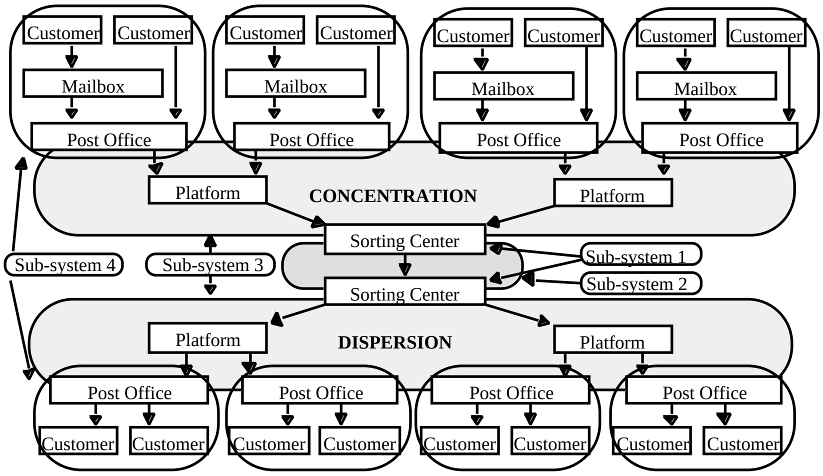
In both cases, the search for performing solutions must be based on methodological principles that rigorously favor the problem raised by the design of management systems able to solve more complex situations.

A new approach to the "division/coordination" problem in a network company (*La Poste*) has recently been studied (Giard, Triomphe and André [5]). Its methodological bases can be used several times to solve either problems of network companies or network of companies and, because of this will be rapidly presented.

It was to ease the taking of strategical or tactical organizational decisions concerning the concentration and distribution of the mail between the post office and sorting centers, and to define the level of mail processing carried out by these various production centers. The postal network is can be divided into four sub-systems, as illustrated in Figure 2; it shows the mail path from the sender to the receiver, as well as the main sub-systems.

This logistical organization has been operating for more than a century in a quite satisfactory manner but the adaptation of the organization to market segmentation (implementation of specialized networks sharing or not certain resources), to the greater requirements in terms of reactivity and the cost of the variability of the demand to be met (existence of cyclic components and a strong random component) involves being able to transform the productive system (modification / network creation; modification of processing locations) but also to be able to modulate it according to the time and stochastic characteristics of the demand. The problem stated is challenging as it is evident that each sub-system has a certain decisional autonomy but the decisions still have an impact on the flexibility of the other systems forcing them, in certain cases, to mobilize additional resources. The "division/coordination" problem involves sufficient visibility of the interactions between sub-systems. We shall show the proposed method by analyzing the problem stated by sub-systems 3 and their relations with the adjacent sub-systems (sub-systems 2 and 4), by focussing on the problem of mail concentration.

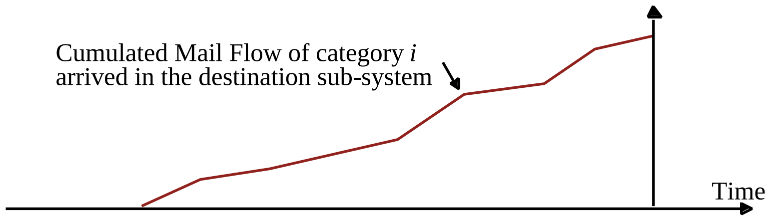
Figure 2: Systemic analysis of the postal system



From a system command point of view, the volume of mail to process is an exogenous datum and the decisions to be taken concern 1) the allocation of offices to the sorting centers for all or part of their mail, 2) the segregation level of the mail coming from these offices (this involves processing upstream and a segregation level of the tight flows) and 3) the temporal profile of the emitted or received flows (as shown in Figure 3 for the receiving sub-system). If the main characteristics of these exchanged flows between sub-systems are considered as constraints by the given sub-system, each sub-system can be considered independent from a decisional point of view. It follows that, for a given "division", "co-ordination" fundamentally rests on a negotiation based on the characteristics of the flows exchanged between the sub-systems.

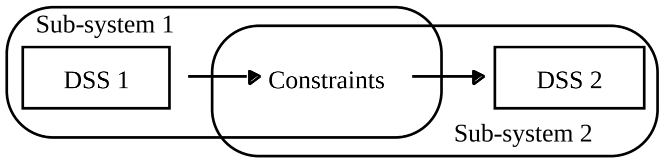
It is evident that improvement of global performance depends not only on the quality of the decisions taken by the players in each sub-system but also on the characteristics of the flows between sub-systems. These characteristics are the result of compromises of force ratios and the local points of view for several reasons amongst which strongly figure the low predictability of the incidence of foreseeable reforms, due to the players visibility, which is limited by the relative partitioning of the sub-systems. To go beyond this local point of view in the transformation of a productive system, it is necessary to set up a mechanism to negotiate constraints, which mechanism is associated with rapid development of transformation scenarios (resources, control rules,…) of two "adjacent" sub-systems. In a DSS-oriented approach, the DSS must have two properties, as seen on Figure 4:

Figure 3 : Characterization of the flows between two sub-



systems

Figure 4 : constraint negotiation mechanism between two sub-systems



- As we are in the presence of a negotiation process between sub-systems, each DSS must be able to function under two modes: establish new constraints resulting from the transformation of the given sub-system or take into account the constraints imposed by the other sub-system.
- Constraints negotiation involves a certain reactivity on both sides. The DSS dedicated to one of the sub-systems must allow to get rapidly a “good” solution to a problem characterized by a series of organizational hypotheses that are different from the implemented ones. DSS operational credibility then largely rests on its capacity to rapidly propose an innovative, efficient and coherent solution. Innovation implies that the DSS allows to easily define the main hypotheses of contrasted scenarios. Efficiency and coherence imply relying, when possible and if justifiable, on an optimization approach to solve the “hardest to solve” problem, on the condition that the DSS user can modify the proposed situation since it rests on a modeling that cannot pretend to resolve the complexity of the given constraints and because the man–machine interaction limits the time allotted to searching for an optimal solution.

These characteristics are a sort of a DSS specifications book and they allow refining coherent scenarios in which one can avoid the too classical “Old Maid” game that characterizes the search for local improvement at the price of global performance degradation. This approach was successfully used in the Departments of the Ile de France delegation of *La Poste*. On a strategic level, it allowed the construction of innovative organizational scenarios for postal concentration, and on a tactical level, it allowed modulation of an organization as a function of seasonal demand characteristic, thus avoiding the inconveniences of over dimensioning according to “peak”.

3 Conclusion

Adaptation of companies and the displacement of their boundaries is first of all, a question of men and willpower, but in an open economy, it is also an adaptation of technology and thus a mastered and coordinated evolution of techniques and tools. For companies, this implies training efforts and a favorable attitude towards innovation and therefore towards research on managerial technique.

4 Bibliography

[1] N. **Curien** et al., *Economie et management des entreprises de réseau*, Economica, 1992.

[2] F. **Danjou**, V. **Giard** and E. **Le Roy**, « Analyse de la robustesse des ordonnancements/réordonnancements sur lignes de production et d'assemblage dans l'industrie automobile », *Revue Française de Gestion Industrielle*, n°1, 2000.

[3] T. **Davenport**, *Process Innovation: Reengineering Work Through Information Technology*, Boston, Harvard Business School Press, 1993.

[4] V. **Giard**, « Gestion de production et entreprises de réseau », *Le manager des entreprises de réseau*, n° 5, 1994.

[5] V. **Giard**, C. **Triomphe**, and R. **André**, « *Organist*: un Système Interactif d'Aide à la Définition du niveau de traitement du courrier des bureaux de poste et des tournées d'acheminement à un centre de tri », Cahier du GREGOR 97.06, presented at the 2e Congrès international franco-québécois de génie industriel, September 3-5 1997 and adapted for the n°1 of *Cahiers du Génie Industriel* (2000).

[6] V. **Giard**, *Processus productifs et programmation linéaire*, Economica, 1997.

[7] V. **Giard**, « Economical analysis of product standardization », presented at the *2nd Conference IFAC/IFIP/IEEE Management and Control of Production and Logistics*, Grenoble, July 2000, Elsevier.

[8] M. **Hammer** and J. **Champy**, *Le reengineering : réinventer l'entreprise pour une amélioration spectaculaire de ses performances*, Dunod, Paris, 1993.

[9] J. **Morin**, L'excellence technologique, Publi-Union, Paris, 1985.

[10] G. **Paché** and C. **Paraponaris**, *L'entreprise en réseau*, PUF, 1993.

[11] R. **Rosenthal**, « Algebraic Modeling Languages for Optimization », *Encyclopedia of Operations Research and Management Sciences*, S. Gass and C. Yarris, Kluwer, 1996.

[12] F. **Vernadat**, *Techniques de Modélisation en Entreprise : Applications aux Processus Opérationnels*, Economica, 1999.