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**INFORMATION SYSTEM MODELLING :  
FROM REPRESENTATION TO KNOWLEDGE**

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**Abstract**

An information system is generally considered as a structured set of the operating system of a company. Thus modelling is a central activity of its design. The aim of this paper is show the major role of the knowing subject in information system modelling, both in his singularity and his plurality. The study will first show the link between modelling and knowledge. Then we will enlarge the problematics of modelling to its political dimension.

**Information system modelling: from representation to knowledge**

An information system is generally considered as a structured set of representations of the operating system of a company. Thus modelling is a central activity of its design. The flows of information, their signification, their nature and structure, are the raw material of a representation of the functioning of the Organization. The completedness of the representation is one of the qualities expected of the models (Lyytinen,1987).

We are going to show that designing an information system is not only a representation process but also a cognitive process. Above and beyond their function of representation, models participate in a process of selective acquisition of knowledge.

We base our work on the hypothesis, touching on the relationship between the real and the model, on which most information system development methods are based. As the consequences that can be deduced concerning the correspondence between reality and the representation are not always verified by experiments, we will study in particular the design process according to a phenomenological approach. This study will show the link between modelling and knowledge. Then we will enlarge the problematics of modelling by exploring the viewpoints, the values, the interests which guide the acquisition of knowledge.

## **1 Representation of the real**

For certain authors the modelling of an information system sets out from the real and must be faithful to it. "An information system (e.g. a database) is a model of a small finite subset of the real world... We expect a correspondence between constructs inside the information system and real world" (Kent,1978). "The passage from the real world to the conceptual design corresponds to a modelling process where the objects of the real world are classified in categories and are designated by names (Delobel,1982).

These affirmations are in keeping with the tradition of classical rationalism which supposes the existence of an objective reality, composed of objects possessing properties and relationships between them. The mind extracts from this singular reality of observed objects a set of concepts and constructs a mental representation whose structure reproduces the structure of reality. "Modelling consists of defining an abstract, theoretical world in such a way that the conclusions one may deduce coincide with the apparent manifestations of the real world" (Flory,1982). In this perspective, conceptual modelling allows one to move from reality to a formalized representation which possesses a structural resemblance with reality.

The systemic approach, at a theoretical level, and the organizational conflicts during the development of information systems, at a practical level, have made us aware of the importance of the way the actor looks at things. So, a number of authors consider that conceptual modelling does not set out from reality but rather from a representation common to different actors of the organization, which is called "the perceived reality", or yet "the universe of discourse". "The perceived reality is made up of the representation which the decision system constructs for its own usage, referring to the activity of the Organization in its environment as far as its objectives are concerned. (...) This reality is expressed in the usual language of the Organization" (Tardieu,1979). We also find an allusion to the notion of the universe of discourse: "In order to act, communicate, and memorize, the actors of the Organization need a common denominator of interpretation of the information they use. We use the term "universe of discourse" as the logicians and linguists do, to designate the things and events which this common denominator of interpretation refers to in the Organization" (Tardieu,1983).

Thus, the information system development method Niam distinguishes the object system, that part of observable reality for which we want to gather information, and the abstraction system, a mental model of the object system, made up of classes of objects, of classes of activities and rules. "To guarantee an efficient and effective communication between members of a particular environment, it is crucial that all agree about one abstraction system and conform to one interpretation of it" (Nijssen, in Olle,1982). This mental model is formalizable in the form of a conceptual model (conceptual grammar) constructed from

an analysis of the phrases of natural language which will be progressively clarified from the implicit content.

In this second perspective a conceptual model is the formalized representation of a non-formalized representation, a mental model. These mental models are considered formalizable, that is to say describable in the form of a finite set of concepts and of abstract rules.

These two perspectives - a copy of reality or the translation of a discourse on reality or of a perception of reality - imply that the representation supplied by modelling is structurally analogous to the mental representation that the actors have in common of reality. The model would then be finally independent from the modeller provided that he respects the rules of the meta-model and that he conducts his study correctly and thoroughly either by direct observation or by rigorous analysis permitting him to remove all ambiguities and imprecisions.

Now, experience has shown the limits of conceptual models as a support for communication and for the transmission of knowledge between actors. These limits come from the gap which exists between the mental model and the conceptual model, leading to the replacing of the subject activity at the center of the modelling process (Morley-Peugeot,1993).

What interests us here is not the form of mental models nor the question of a self-reality and its nature, but what happens in the design process. To do so, following the method of phenomenological reduction, putting "the thesis of world reality in parentheses" (Hersch,1993), we are going to observe what happens between things as they are given to us, the phenomena, and the activity of conscious mind in the designing of an information system.

## **2 The design process**

The design of an information system is an occurrence of the process of problem-solving in general (Sol,1983), but of a problem for which we must find the terms, that is the "information requirements". Determining the requirements is a form of constituting knowledge. Since they are not given beforehand (Le Moigne,1986) we are going to look for them through the perception of the Organization, understanding how the three sub-systems of organization, decision and power, function and link together (Tabatoni-Jarniou,1975). This learning process generates mental models which can be partially translated into conceptual models; the formalization will stimulate mental images of another possible organization. Using the kantien phrase, we can consider that "concepts

without intuition are empty, intuitions without concepts are blind". This creative loop of intuition/formalization leads to the conception of a new information system.

The images used in conceptual modelling are not figurative: they are the result of an abstraction. Their elements are symbols whose signification is to be sought in the concepts they represent. They get their evocative power from the language on which they are strongly dependent. The words of natural language encourage the analogy; they are not simply labels. The image permits the articulation of entities and suggest their dynamics. Conceptual models, in their schematic form, use the brain's capacity to treat topological relationships. They stimulate the two grand categories of cognitive functions (Piaget-Inhelder,1966): the figurative which tend to apprehend reality through the configuration of entities, and the operative which constructs another view focusing on transformations (the action of one entity on another, the communication between entities...).

Indeed, selecting phenomena which allow organized views to be established requires a previous interpretation of these phenomena. Neurobiological research on vision has shown that the images received on the retina only represent a small part of the information sent to the brain, as large parts are supplied by the brain itself (Varela,1989). In the same way, understanding a conceptual model relies on using a body of meta-knowledge. This meta-knowledge includes, on the one hand, a conceptual grammar (meta-models and rules of construction) and on the other hand, the management system and its environment (general working of a constrained human organization, typology of the economic actors and their relationships..). Only the latter allow the interpretation of the model, in other words its assimilation with prior knowledge into a self-referential loop. This requirement indicates both the extent and the limits of conceptual models as a support for transferring knowledge (Morley-Peugeot,1993).

Thus the perceivable reality is complex, it is made up of multiple elements having different characteristics which often overlap. Therefore it cannot be approached by simply refining a representation into more and more detailed ones (top-down approach), but rather through filters which establish a selection. Modelling is not a deterministic process emphasized by applying rules; it is series of choices, it is a finalized process. The mind is guided by an intention which alone gives meaning to perceptions. Phenomena have the meaning that intention gives them. "We perceive the intentional relationship, understood in a purely descriptive sense as intrinsic characteristics of certain realities, as an essential determination of phenomena" (Husserl,1963). Intention, even if it is often only implied, guides modelling; it makes it possible to pick out the relevant elements from among all the single facts, to apply abstraction operators (classification and generalization) and to organize them into rational views. In this way forms in which an organization appears are

established from the perceived reality and it is with these forms that we can work. Without intention, modelling is not possible.

The difference between a representation process and a cognitive process lies in the role played by the subject. A representation can be produced without the intervention of the actor by means of an automatic device (recording the image for example); these representations can exist without anyone looking at them. On the contrary, there is no knowing without a knowing subject. The modelling of an information system is indissociable from its designer. It is linked to the designer in the sense that the production of a model must necessarily involve a human operator; there is no automatic modelling. It is linked to the designer to the extent that the result produced is not independent from the modeller.

We can therefore consider that the modelling process is a cognitive process: it is a selection by actors who are supported by their meta-knowledge and are guided by their intentions, clearly stated or not. In this way they build a system of relationships between objects, which also represent the relationship between the developed models and themselves, knowing subjects (Grize, in Andreewsky,1991).

### **3 Intentions and modelling**

To determine information requirements the designer of the system must acquire knowledge about the Organization for which he is designing the system. The sociology of knowledge, especially the analysis of changes of paradigm, has shown that knowing is never absolute knowledge. Its terms are understood only relative to a system of pre-established references, which also determine possible orientations. When he has constructed knowledge through interaction with the phenomena he perceives, the modeller is guided by intentions, by interests whose nature we must explore. Our hypothesis is that the two big categories of interest which can bring about the production of knowledge in the society (Habermas, 1973a) are found while seeking knowledge in an Organization, notably while developing an information system.

J.Habermas brings two categories of fundamental activities into opposition, which he calls "work" and "interaction" (Habermas,1973b); we can compare these to production and communication (Klein,1993). Of course, these two activities are often highly intermingled. The distinction allows us to put forward each one's own system of logic. These two categories, production and communication, correspond to the two dimensions of a company, at the same time a production system and a political system. The term "political" must not be understood in its limited meaning of the distribution of power and power

struggles. "Politics have little to do with human nature, but it has everything to do with the human condition" (Arendt,1974). Human nature means our belonging to an animal species. The human condition is what distinguishes man from all other species. Singularity in plurality characterizes him. Each singular human being is the actor of a unique history. Each man carries within himself the ability to undertake, to create something new. Man also has the ability of acting with others. Man's condition is not to live alone. As H.Arendt stresses, the Roman, "a political people par excellence", identified life with "inter homines esse" and death with "inter homines desinere". Each unique individual largely finds himself through relationships with other singular individuals.

The company is a political space because it is a place where men meet, communicate, and interact: it is indeed a "place where the transformation of a field of action into an organization is in operation", the definition of a political system (Touraine,1973). It is also the sub-system of a social system to the extent that it allows value systems concerning collective living to exist: "The company participates in the evolution of the social reality by producing standards which interact with the standards of society" (Jarniou,1981).

The development of an information system is at the same time a rational process and a political process (Robey,1984). Technologies are the result of scientific activity; but setting them up can have a political signification when they touch on the organization of group work. The production of an automatic system is accompanied by decisions about the division of work, its control, its coordination, and also about the independence, the self-organization, the breaking down into public space and private domain...

The two categories of activity, work and interaction, are also the transcendental framework of knowledge. J.Habermas considers that there is no continuum on which we can place the state of each science at any given moment (Habermas,1973a). There is a break between the two big categories of science, the exact sciences and the human sciences, in their wide definition. They are found in a framework which orients their production of knowledge beforehand, which he calls their "interest". The exact sciences have a technical or instrumental interest; the human science have a practical, even emancipatory interest.

Each of these two categories of activity, production and communication, is regulated by a specific logic, the first a technical logic, the second a relational logic. We see here the rigorous distinction made by Aristotle between what is necessary and what is contingent. Science and technology are interested in what is necessary and immutable; they can be taught. On the contrary, things that are susceptible to change cannot be locked into laws; they are of the domain of judgment, of wisdom, of reflection: "No one deliberates on what is not susceptible to change" (Ethic to Nicomaque,Book VI).

As an agent of production, the company is run by a technical rationality setting up efficient means in relation to a given finality, which leads to define rules and criteria that can be used in all circumstances.

As a political system, the company is run by a rationality of domination, but also of communication, of argumentation, of the exchange of opposing viewpoints.

The different approaches of developing an information system seem to divide up following one or the other dimension, according to whether they consider their target is a technical system or a social system (Lyytinen,1987).

How can we reconcile the two approaches ?

Habermas proposes three models to think through the relationships between the technical and the political: technocratic, decisionist and emancipatory.

The technocratic model, the one which often prevails, is based on the idea that there is no choice except inside the technological rationality. We must always obey the technical constraints at any given moment while hoping to be able to push these constraints forward.

According to this model, modelling an information system presents the characteristics of a determinist technical know-how: it is applying the modelling technique to a perception of reality in order to build a database.

The decisionist model is based on Max Weber's model which presents the relationships between scientist and politician. The experts are clearly separated from the decision-makers, the technical plays a dominant role. There are however certain decisions which remain political decisions. The majority of projects developing information systems follow the line of this model, unfolding according to a series of steps which are its validation points. Experience has shown the difficulties encountered in the validation of models by managers, users and decision-makers (Morley-Peugeot,1993).

The third model is based on the idea that technical progress can be the instrument of emancipation, of human progress. The couple, political decision/technical rationality, is involved in a process of reciprocal adjustments; the solution to a problem is found in a back and forth movement which results in a progressive determination of the problem itself in terms of solutions that become possible to find (a dynamical spiral of analysis). Information systems development methods such as Ethics (Mumford,1983) or Soft System Methodology (Checkland,1990), which are linked to a political dimension, grant less importance to the production dimension. The key of an "emancipation" is in a real dialogue between these two viewpoints, all along the development process and not only at validation points: that implies a dialogue between models and principles whose origin and finality are notably technical, and other models which take human characteristics into consideration, in the singular as well as in the plural.

To conclude, we have underlined the central role of a knowing subject in modelling an information system, in its singularity and its plurality. The formalization of the knowledge



acquired is centered on the company as a production system, which in its political dimension is also a place made up of common sense, shared experiences, confronting initiatives. Through the evolution of tools and methods, the development of an information system could also encourage emancipation in Organizations.

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