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ECKM 2004 (European Conference on Knowledge Management),
Paris, 30 septembre-1er octobre, 2004,
pp 305-315

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Summary: Capitalisation of the history of a technology, a technique or a concept within an industrial company is relevant to historians. However it largely exceeds the historical problems from a Knowledge Management point of view. In this context, it can be the subject of specific approaches especially Knowledge Engineering. However, it faces two types of difficulties:

- The techniques in History have few modelling tools, and are even rather reticent with the use of such tools
- Knowledge Engineering doesn't often address historical knowledge modelling, for tracing knowledge evolution.

It is however possible to develop robust and validated methods, tools and techniques which take into account these two approaches, which, if they function in synergy, appear rich and fertile.

Key words: History, knowledge management, Knowledge Engineering, history of techniques, MASK method.

1 Introduction

Modelling is the basic tool to study the complex systems, (Morin, 1990, Le Moigne, 1977). Systemic vision aims precisely at providing modelling tools which allow not to exhibit explicitly structures, but to understand globally the system studied (here a knowledge system). Intelligibility does not mutilate the vision of the systems, while preserving their complexity.
However, knowledge models largely used in KM are primarily of two types: structural models (semantic networks, objects, taxonomies…) and functional models (processes, activities, tasks…). The third pillar of modelling, that of evolution, lacks . It is thus a problem, which seems new to model the evolution of a system, or the evolution of the knowledge on a system.
In fact, Lamarck's and Darwin's ideas had very early great repercussions, and the evolutionary model was very quickly the object of transpositions in many fields, very different from biology: anthropology (Sapir, 1967), cognitive psychology (Piaget, 1976), philosophy (Durkheim, 1984), epistemology, quoted in Versailles (1999), the theory of complexity (Heudin, 1998), the history of the techniques (Deforge, 1985, Jukes, 1982), data processing (Torres & Parets-Llorca, 1996), knowledge management (Barthelmé *et al.*, 1998, Ermine & Waeters, 1999), etc. The ideas to model evolution are thus already numerous.

To moderate the above assessment, note that modelling knowledge evolution appears in three problems more generally linked to knowledge management (Ermine, 2002):

- **Project memory** (Matta *et al.*, 1999, 2000, MacLean *et al.* , 1991, Conklin & Begeman, 1988, Klein, 1993, Lewkowicz & Zacklad, 1999, Bekhti & Matta, 2003, Longueville *et al.* , 2003, Ribière & Matta, 1998, Eynard *et al.* 2001…).

- **Experiment traces: Experience feedback and Story Telling** (Eichenbaum *et al.*, 1994, Snowden, 1999, Soulier & Caussanel, 2002).
- **Innovation** via the so called "path dependency hypothesis" (Coriat & Weinstein, 1997, David & Foray, 1994, Benhamou *et al.*, 2001, Courteille *et al.*, 2001).

If one admits, according to what has been just said, that modelling systems evolution (or knowledge on systems) is an objective of Knowledge Engineering, it is then necessary to find appropriate modelling methods which are robust, founded, and applicable to industrial fields .

The purpose of this article is to propose partial answers, based on two disciplines:

- History: In a first approach, it can be argued that modelling a system evolution is modelling its history throughout time. Mobilizing the techniques of History is thus relevant in the project of building a method of modelling systems evolution. History is a science, which aims at transmitting a vision of a given system having evolved during a given period. Its tools are multiple. Unfortunately, modelling is still a tool not very used in history, and prone to controversies. There are however approaches which can be useful in our project. We will briefly present them, although these studies are still exploratory.
- Knowledge management: KM is the management of organisational knowledge, as defined in Ermine (2000). The method of knowledge capitalisation MASK (Ermine & Matta, 2003) takes into account the evolution dimension. The first versions of the evolution models of MASK can now be considered robust and operational.

This article results from a seminar gathering researchers of the UTT (University de Technologie de Troyes) (B. Pauget, JL. Ermine, O. Pottier), actors of the PSA Peugeot Citroen company (A. Beretti and P. Coustillière), and historians of the Toulouse University Mirail (J-f Soulet and Rene Souriac). This seminar was followed by an action within the AEL (Electronic Architecture Electricity) entity of PSA (D. Charny and G. Tortorici). The action, based on the historical book written within the company "Electricity, electronics: one century of automobile development" shows that the two approaches, history and knowledge management, are in fact of comparable nature and bring complementary elements.

2 Modelling in History

Despite the reserves raised within the community of historians, it is, as J-F Soulet stressed it, in its communication at our seminar: "necessary for the historian (either as a researcher, or as a teacher), facing processes or complex systems (involving a great number of data), to extract from them simplified and serial representations". Facing such problems, it is especially the structuralist school (in particular the work by Fernand Braudel) which thought of the concept of modelling according to three different methods:
The first one is based on modelling of a systemic type. See the example by R. Souriac below.
The second one, due to JF. Soulet, is known as semiotics. It is based on the basic units of meaning.
The last one, completing the two previous ones, aims at including space in historical modelling.

2.1 Modelling of the systemic type: the example of Henri IV's advent, by Rene Souriac

Following systemic modelling principles (Le Moigne, 1990), the method consists in describing, on a model, the subsystems in interaction, actors positioning, key functions to identify the constraints, making it possible to explain an historical process (actors' games).
Take the example of the advent of Henri IV. The traditional historian, following the temporal unfolding and the successive dates, will build a "dialectical" model as described in Figure 1. However, facing series of events, it appears difficult to understand the determinants of the last actions. Figure 1 shows the complexity, (alliances, treasons) of the main protagonists around the succession with the throne after the assassination of Henri III (1589). France, torn by the religion wars, had difficulties to find peace and a sovereign to guarantee it.
In fact, modelling of the systemic type makes it possible to better understand the stakes and the difficult accession to the throne for Henri IV. It is the enshrining of the religious system (Protestant and Catholic) with the official political system that poses problem. Monarchy is indeed of divine right (Catholic) and accessible by blood to the males (Salic law).

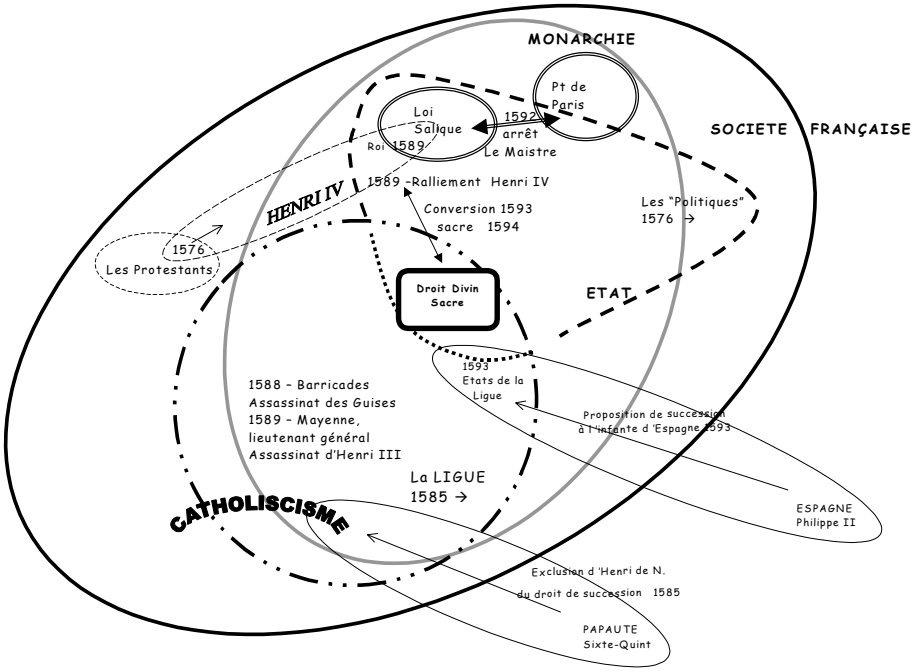

Figure 1 - The advent of Henri IV, systemic diagram

Henri de Navarre, future Henri IV, acquires from 1589 to 1592 the recognition of his subsidiary claims but runs up against Catholicism which constitutes a subsystem of monarchy. The non-articulation between the two systems allows the existence of dissensions (States of the League) and the continuation of the civil wars, maintained by the "very catholic" Spanish kings. When Henri IV converts (1593-1594), the system can again find its balance. A diagram and some lines thus make it possible to model 15 years of particularly chaotic French history (Figure 1).

2.2 Modelling of the semiotic type: immediate history by JF Soulet

The structuralist school forged great principles to release meaningful representations of complex systems. See Ermine (2000) for a discussion on this topic. It is based on the basic units of meaning (of "semes", justifying the "semiotic" term). Some combinations of them are

likely to provide relevant clarifications of complex systems. Consequently, the method consists in identifying significant elements for the concerned study ("signs" or "criteria") and to determine a relevant combination of these signs to work out understandable models.

We give here two examples due to J-f Soulet.

2.2.1 Modelling the Communist system

The Communist system showed very notable evolutions and alternatives since 1917. The total understanding of the system is not sufficient. If the History wishes to model, it must authorize the comparisons between phenomena of comparable nature. It is what JF. Soulet tries to do. The Communist systems are good examples. They indeed showed significant evolutions since 1917. Consider, for example, the differences between the system applied by Stalin from the 1930's to the 1950's, and the system practised by Nagy in Hungary from 1953 to 1955, that of Deng Xiaoping since 1978, or even that of Pol Pot in Kampuchea, from 1975 to 1978.
We may then build a classification of a semiotic type in three steps.

- Practices of the power
- Types of foreign relations
- Degree of socialization [1]

These criteria make it possible to build an efficient "reading grid", leading to 3 major models (see Figure 2): utopian, liberal and national-communist. It allows the comparison of the evolution of the systems until their disintegration after 1989.

		MODEL 1 (National-Communism)	MODEL 2 (Utopian)	MODEL 3 (Liberal)
POWER PRACTICE	Effective practice of the power	Individual	Clan	Central Oligarchy-committee
	Privileged support of the power	Army	Army-police force	Party
	Party-State Ratio	Supremacy of the Party	Supremacy of the Party	Promotion of the State
	Relationship with civil society	Conflict	Destructors	Compromise
	Relationship with the past	Instrumentalisation	Rejection	Continuity
TYPES OF OUTSIDE RELATIONS	Towards the non-communist States	Expansionism-bellicosity	Folding up	Coexistence
	Towards the leader Communist State	Independence	Independence	Independence
DEGREE OF SOCIALIZATION	Progressive socialization			Progressive socialization
	Integral socialization	Integral socialization	Integral socialization	
	State intervention and planning	State intervention and planning	State intervention and planning	

[1] Three "families of criteria", comprising each "subfamily", with various "entries"

	Introduction of market mechanisms			Introduction of market mechanisms
	Exchanges with outside			Exchanges with outside
	Closing (autarky)	Closing	Closing	
EXAMPLES OF COUNTRIES		North Korea – Albania - Vietnam- Cuba - Romania	China (Cultural revolution 1965-1971) Kampuchea (1975-1979)	Yugoslavia – Hungary (1953-1955) – USSR (1953-1964) – Czechoslovakia (1968) - China (1978-2002) – USSR (1985-1991)

Figure 2 - Three models of communist systems

2.2.2 Modelling the desatellisation process of Eastern Europe Communist countries in 1989

The point is to seek whether the changes achieved in 1989 in 6 Eastern-European communist countries followed some great models.
The method, like the preceding one, consists in developing a series of relevant criteria making it possible to characterize and compare the six changes, while distinguishing clearly what concerns the factors of the fall of the communist systems on the one hand and from catalysts of the process on the other hand. Three models of change are essential during the explosion of the communist system:

- The compromise (friendly process between Communist power and civil society, for example in Poland or Hungary)
- The change imposed by the "civil society" (e.g. GDR or Czechoslovakia and its revolution of velvet
- The palace revolution (which refits the internal system of the party: ex. Bulgaria, or Romania)

2.3 Grataloup's geohistory

We present here some elements resulting from the historical geography according to theses' of C. Grataloup (1996).
This approach complements the preceding ones. Indeed, for this geographer, "the course was of geography and geography only. The toolbox was made up of basic notions of the analysis of space: place, distance, position, centrality, complementarity, scale, diffusion; axe, barrier, territorial control and some others. The list remains short "(Figure 3). The goal is not to describe reality but to propose an interpretation of it: "a prime objective was to test the effectiveness of the models in different contexts, unusual compared to their everyday usage. It was thus to make the assumption of their capacity not only light the charts of the past, but contribute to the comprehension of the passage from one chart to another ". Between two charts "there is history", and it is in this sense that C. Grataloup makes history models as illustrated on Figure 3. The aim here is to represent the decline and the fall of the Roman Empires on the one hand and of Baghdad on the other hand.

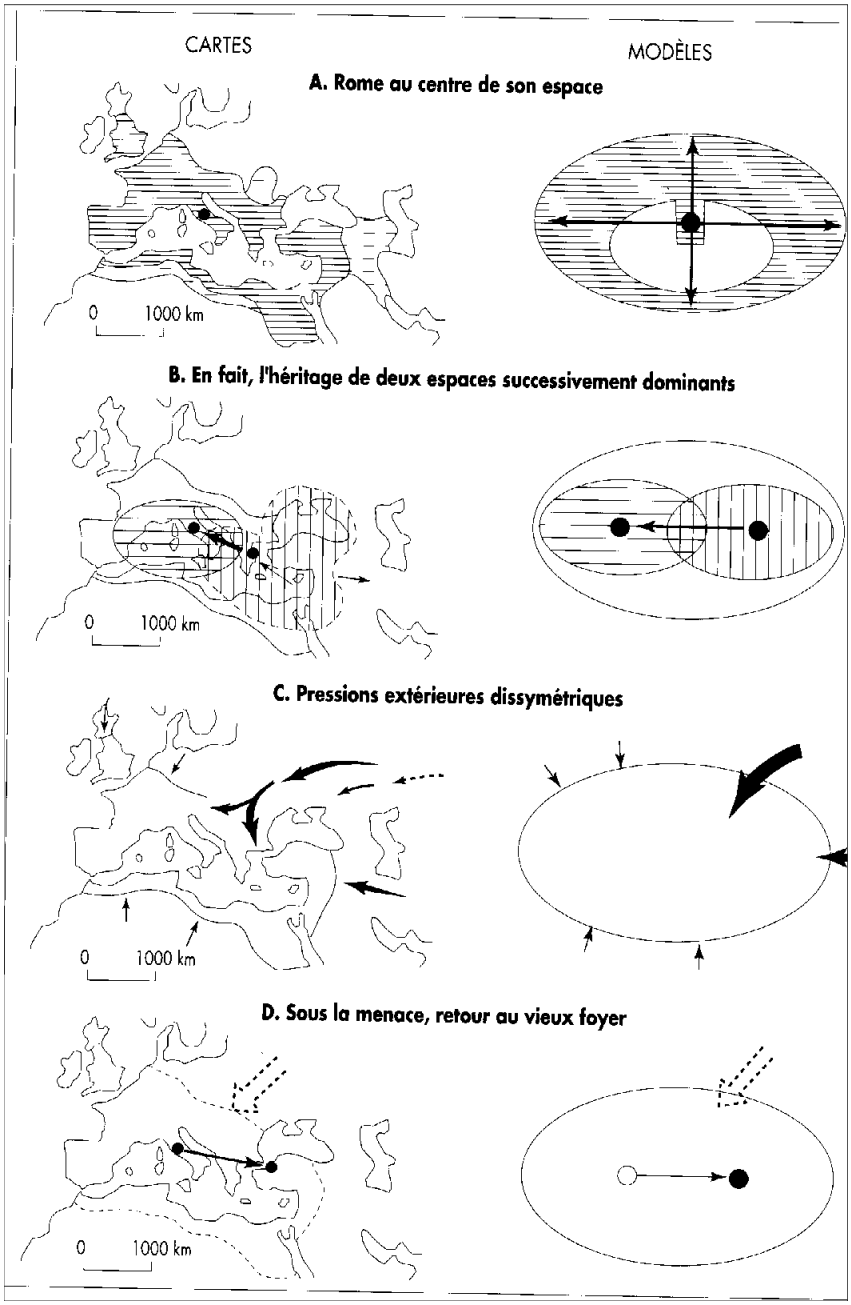

Figure 3 - The space of the Roman Empire

The modelling techniques rely primarily on the work of the geographers, especially R. Brunet (1992)[2]. He indeed developed a modelling space from certain "choremes". The chorotype is then "the recurring composition of choreme, expressing more or less complex structures which appear in certain places on earth, and which can be expressed by simple models".

3 Modelling evolution in MASK method

MASK is a Knowledge Engineering method, to model, in general by interviewing experts of the field, elements of knowledge in a company.

[2] To know some more about the modelling techniques of in geography: to see J-p Edge: *Geography and graphic semiology: 2 different glances on space*, with the following address: http://www.cybergeo.presse.fr/semiogra/bord/bord.htm

Since large needs to model knowledge evolution appeared, MASK grew richer with models inspired by history of techniques. Their purpose is to describe in a structured way the history of a knowledge set, with the objective to better understand and control the evolution laws of this knowledge, necessarily specific to the organization. MASK method is characterised by the combination of the semiotic and the systemic approaches as evoked above. The theory of the knowledge macroscope (Ermine, 2000) makes it possible to integrate the two approaches and to build models answering the two problems. See Ermine and Matta (2003) for more details on the two models in MASK method.
The first model recalls the general *history*, the history of ideas and relates to the evolution context. The second model is an *a posteriori* analysis, a reasoned, comprehensible and synthetic rebuilding of the principal objects or concepts which marked out the evolution of the concerned knowledge domain. These concepts are organized in *lineage* which follow a temporal line and which identify why and how each concept evolved. The models presented are much indebted to the pioneers in a new way of approaching history of techniques, inherited from history in general and more specifically from ethnology (Deforge, 1985, Jacomy, 1990). Numerous applications of those models can be found in Ermine (2000, 2003), Benhamou et al. (2001) or Courteille et al. (2001).

4 Convergence of the historical and Knowledge Engineering approaches

We will show, on an example which proceeded in PSA Peugeot Citroën Company, that the historical approaches and Knowledge Engineering, as outlined above, are of comparable nature and complementary for dealing with a knowledge management problem.

4.1 The history project

Electronics in the automotive field is nowadays a strategic and unavoidable component. It is often stressed that the current *Peugeot 607* contains more electronics than the first Airbus. However, electronics is a very particular field in automotive. Electricity and electronics embarked in a vehicle constitute a "transverse" subsystem associated to the totality of the subsystems "bodies" of the vehicle. It is thus a system associated with a field that is in constant interaction with the other fields and the other traditional mechanical systems of the vehicle. Control and maintain abilities and reference frames of abilities within the group in this field are thus of particular nature.
PSA technical direction, in particular the Electricity/Electronics community field ("Gélec"), ordered a knowledge management project, in order to come up to general expectations in the group, to maintain and develop field competences, namely "raise the fields to the best world standards", "live and communicate the passion". This project took the form of a technical project of history, namely the constitution of a historical memory of the Electricity/Electronics field. Its objective is to write the history of automotive Electricity/Electronics in order to capitalise knowledge, to understand technical progress and to clarify the future. It is intended primarily to engineers and technicians of the technical direction, more particularly to the young recruits. It also addresses all the PSA Group engineers and its direct or indirect partners. It thus does not limit to recalling a technique history, but rather develops a genuine tool of knowledge capitalisation and transmission.
The approach consisted in analyzing the technical evolutions and finding their determinants to show how technical choices were made. This complete historical base was built using internal and external sources: within PSA group and at the equipment suppliers who directly contributed to vehicles technical progress. It was performed in a professional logic, it stresses

innovation (its determinants, temporality, actors and context), and wants to be a knowledge tool intended to engineers of the field.
Beginning in 2000, the project first lasted thirty months. It was led by a multidisciplinary team involving three history laboratories (Cnam, Sorbonne and University of Evry), an engineering school (Supélec), and PSA Group. Historians' techniques (sources research and analysis, actors' interviews, iconography…) were applied scrupulously, in binary interaction with field specialists. This resulted in a historical book, "Electricity electronics: one century of automobile development "(Loubet *et al.*, 2003). It mixes historical documents, technical and photographic illustrations of PSA archives, interviews with field specialists who lived certain periods under study, etc. It covers all the subjects that rely to automotive electricity and electronics: lighting, battery, ignition, theft protection device, electric motor etc. It recalls the technical evolution genesis of the PSA Peugeot Citroen and shows the determinants and conjunctions governing the choices. The historical perspective, as an organisational memory, is particularly informative and allows a better understanding of technological dynamics and of the role of people who initiated innovation.
The 6000 printed copies of the book must be distributed to a large number of collaborators inside and outside PSA.

4.2 The project of Knowledge Engineering

The design, realisation and diffusion of the work "Electricity electronics: one century of automobile development" is a first stage in the diffusion of knowledge and the preservation of the professional culture. The book is a specific form, its contents is presented in a particular way, according to historians' criteria. For a Knowledge Management perspective, the project was continued by the conception of a more dynamic and operational form of this historical basis, in order to offer to design engineers a fast access to useful knowledge, and to be integrated (or at least to articulate) with the existing systems for knowledge capitalisation.
The objective was thus to prototype a "professional knowledge portal", in order to restructure the historical database collected during the preceding project, and to make it available on intranet, with a browsing interface corresponding to the expertise on domain knowledge. The aim was thus to re-design and re-use the results of the history project from a Knowledge Engineering viewpoint. This knowledge portal is dedicated to PSA engineers and technicians. This project made it possible to note a certain number of key points.

4.2.1 Collection and diffusion of sources.

Initial historical work allowed collecting a considerable number of great value documents of all kinds. However, this corpus was only managed for a *printed* book. Collecting the source files of the book proved much more tiresome than expected. In particular, it required many contacts with the printers as well as handling on very dedicated professional software. It was fortunately possible to reconstitute an electronic version of the book (for online diffusion) and in addition to constitute an iconographic database for which demand already existed.

4.2.2 Method of knowledge reorganisation

The choice was made, in this project, to use MASK method as a knowledge structuring method. Dealing with historical knowledge, it was thus planned to use two structuring models: the history model and the lineage model.
The history model (milestones and stakes) re-places the evolution of electricity and electronics in its scientific, technical and social context, in order to offer a global overview of the conditions and events that led to knowledge creation in the domain. However, this model

did not correspond to the contents of the book (the historical context largely exceeds the subject) and was not used.
The lineage model is more adapted to the book structure and to the study of the evolution of the selected objects. The model of lineages makes it possible to describe the genealogy of knowledge: lineages, evolution determinants, contributions and limits. It offers a more detailed viewpoint to recall the evolution of knowledge on the objects, by detailing the factors, justifications and constraints that governed each passage between generation. The lineage model is thus better adapted to the contents of the book, which attempts to describe the process of innovation with its determinants, temporality, actors and context. Indeed, all the evolutions described in the work on each topic (or object) are quite detailed to feed a lineage model. However, certain data to fill the model (in particular "evolution determinants" or "argumentation") required an additional information collection in collaboration with experts of the domain.

4.2.3 Interviews of experts

The characteristic in this Knowledge Engineering project was the existence of the work *before* modelling, whereas modelling by MASK method is usually used to realise a "knowledge book", which generally results *later* in the publication of a book. This anteriority had significant consequences on the project.
On the one hand, it eased modelling and made more efficient the discussions with the experts. The models could be built initially without relying upon the experts. However, the material contained in the book left holes in information needed for modelling, and moreover, it did not allow to validate the modelling viewpoint retained by the Knowledge Engineer. In this type of project, complement to the historical project, the implication of experts thus appears essential.
In addition, it showed that most of the material collected during the project of history could be re-used for the Knowledge Engineering project.

4.2.4 Graphic Modelling

The historical project led to a printed book. To consult a book is a particular activity, both at the process level and at the cognitive level. This type of consultation cannot be directly transposed on a Web navigator. Although one of the first tasks of the Knowledge Engineering project was to transpose the book in an electronic form to put it on line just as it was, it was thus quite obvious that it was largely insufficient for a knowledge portal on the history of the domain, accessible to engineers on their working station. A graphic navigation interface was conceived accordingly, based on the lineage models of MASK (Figure 5). Graphic Modelling consists in using diagrams to express knowledge in a graphic language open and natural, immediately understandable by all. The lineage models realized respect the graphic rules of MASK (using Visio software).
For online diffusion, the graphic languages were adapted in order to take into account the constraints and possibilities of interactive consultation. A colour code was selected for this purpose to facilitate graphic reading of each line. In addition, argumentations are accessible by simply clicking on the main screen, which allows reducing the diagram. Each element of the graphic model gives access to a menu pointing to the other related items (text, diagram, and image), when available in the historical book. The links to texts directly point to the corresponding page of the book, in which the relevant extracts are highlighted, which required a preliminary reading and systematic indexing of the book. The diagrams and images in the book were extracted, structured in a database and the links point to graphic element isolated from the text surrounding it in the book.

4.3 Contributions of the Knowledge Engineering project

This project lasted six months and achieved its goal, namely to show that the history project could be continued by a Knowledge Engineering project, from a global viewpoint of Knowledge Management. It showed

- that all the historian work could be re-used, through a reorganization of the collected data, via text indexing and iconographic databases (this work could have been envisaged initially).
- the usefulness and the complementarity of knowledge modelling, via a structured Knowledge Engineering method, in order to design graphic interfaces of navigation in a knowledge portal.
- the necessity of implicating experts for completing knowledge modelling.

It is now clear that carrying out such a project again with synergy between the history techniques and Knowledge Engineering techniques would lead to an undeniable profit in terms of time for collecting and structuring the data, in terms of quality and richness of contents, and in terms of diversity of the deliverable products (book, databases, multimedia portal…).

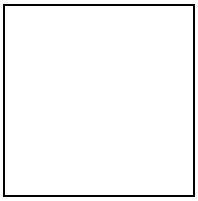

Figure 5 - Example of graphic interface for accessing to the data of the historical book

5 Conclusion

The capitalisation of the history of a technology, a technique or a concept within an industrial company is relevant to historians. However it largely exceeds the historical problems when it concerns Knowledge Management. Replaced in this context, it can then be the subject of specific approaches, in particular thanks to the Knowledge Engineering. However, that meets for the moment two types of difficulties:

- The history techniques have few modelling tools, and are even rather reluctant to use such tools
- Knowledge Engineering rather little raised the problem of modelling historical knowledge, recalling the evolution of knowledge.

It is however possible to develop methods, tools, and robust and validated techniques which take into account these two approaches, which, if they function in synergy, appear rich and fertile.

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