Co-working for Knowledge Management in Cultural Heritage: Towards a PLM for Museum

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Abstract. Dealing with historical knowledge implies specific approaches. Then, modeling it and the different know-hows involved is a complex task. Indeed, patrimonial objects are historical witnesses whose life cycle is hard to handle. In this paper, we discuss possibilities of managing such heterogeneous content through a PLM system dedicated to historical knowledge and museum. Based on previous research in the field of ancient advanced archaeology, we demonstrate our process through an industrial research and development project with a history museum.

Keywords: Knowledge management, Cultural Heritage, PLM, Museum, DHRM.

1 Introduction

Museum is filled with knowledge treasures and specific, specialised know-how. Many professional domains are involved. Either they are heterogeneous, they work together for a common goal: preserve and promote cultural heritage. In this paper, we propose a dualistic approach in order to capitalise available knowledge related to patrimonial objects. Thanks to systemic analysis methods and tools, we try to identify the lacks of such approaches when dealing with heritage objects as a product knowledge management. In addition, we discuss the importance of human-centered approach for historical comprehension of non-explicit phenomena (political influences, historical sources contexts). To demonstrate our methodology, we present a research and development project done thanks to the collaboration between Nantes history museum, a research center in history of sciences and techniques (Centre François Viète) and IRCCyN laboratory. This project tends to promote an historical wooden model of Nantes harbour in 1900 with historical knowledge and virtual engineering tools.

First, we discuss on usability of engineering tools and methods for heritage knowledge capitalisation. Enterprise modeling such as PLM operating system provides efficient ways to capture information for co-working (FBS, ISO standards). But we identify a significant lack about long-term evolution of objects: patrimonial objects are concerned by this issue. As we cannot imagine what promoting system

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will be used in the future, we have to identify and to link significant data and knowledge provided by experts (historians, museum curators, etc.). This will allow museum to challenge the huge amount of knowledge they host for a better collection management. It will also improve cultural promotion and innovation thanks to digital projects. Indeed, if we look at the number of such projects all over the world, it is significantly increasing.

Then we demonstrate our scientific proposition with the results of a 5-years research and development project. It is led by Nantes history museum (France) and concerns two of their collection objects: wooden models of two parts of Nantes city in early 1900's. Many professional domains were involved such as historians, engineers (computers, mechanics, automatics), and museum professionals. They worked together in order to gather information, link it and design the final museography application. The result leads into a virtual augmented reality system based on the real object. The system is web-connected and allows the knowledge database to be enriched both by experts and general public. The content includes geographical, semantic information and historical links between points of interest. We capitalise both geographical areas (buildings, streets), for which we can store evolution during time and heterogeneous semantic information like people, historical events and so on.

Finally we discuss on challenges that can be handle by our method, especially the way that it can be extended to the whole museum through all the objects' collection. The way the system was designed allows us to connect other museum objects together, through historical links, and also to add know-how knowledge from museum activities. Thus, we imagine designing a PLM for museum that would store the whole processes of object acquisition, protection and promotion.

2 Industrial Knowledge Management for Cultural Heritage

Models and methods for knowledge management in industry offer many advantages but present lacks when dealing with historical information. MKSM/MASK, REX, KOD, KALAM are mainly related to industrial knowledge (nuclear, factory), but give significant clues for effective knowledge management. This would give advices when taking into account communities of practice. In addition, product-process oriented models, implemented for product design management [5] also give interesting trails as a systemic and functional approach. As far as digital documents are concerned, we also have to explore such approach for effective document and archive management [4]. Yet, we need to confront these approaches to historical and cultural heritage needs.

Singularities in cultural heritage come from temporal characteristics (long-time span analysis) and retro-analysis. Usually, knowledge management methods focus on existing knowledge in enterprise modeling.

Yet, a tool for historical knowledge management can take benefit from industrial knowledge management methods. Simply because industrials methods are in most cases reproducible, these should be considered useful. Some tools are already used in the field of history sciences such as archaeology, but they are related to specific knowledge (e.g. GIS). What we aim to do is to gather historical knowledge from different experts' fields as it would be in enterprise models.

New ways of knowledge management yet appear to place humans as a critical factor when dealing with knowledge management [9]. In cultural industry, such approach is more common, and lead to interesting results [7]. We then aim to provide a methodology, inspired by historians' research approach, very close to these methods. That means we have to deal with heterogeneous information and develop an approach mainly based on people's knowledge.

The Digital Heritage Reference Model [6] (DHRM: methodology based on Product-Process approach but dedicated to historical knowledge) has been designed to answer this problematic. The main idea is to combine different "schemes", capitalising heterogeneous knowledge, allowing us to understand and to model one idea under different points of view (internal, external, technical, socio-economic, political aspects).

According to this approach, we now explore ways to implement and to validate DHRM on practical use cases. This brings new problematic, especially about knowledge extraction modes and historical information visualisation [3].

3 Industrial Use-Case of an Interactive Knowledge-Based System: Augmented Historical Mock-Up

3.1 Context of the Project

In 2008, Nantes history museum started a research and development project about a wooden model, exposed inside the museum. This mock-up, designed in 1899 for the "Exposition Universelle of 1900" (world's fair held in Paris) by Paul Duchesne, represents Nantes harbour in the very end of nineteenth century. It is a great historical object, due to its size – 9.20 meters long and 1.85 meters wide, but also due to the geographical area it represents (approximately 7 square kilometers). As for now, museum visitors cannot interact with the mock-up, nor get any historical information about it (except those provided by the museum label).

The goal of the project is to design an interactive system, connected to a database in order to provide information to visitors. Database would host both experts' contributions and general public material: photographs, postcards, etc.

3.2 An Historical Information System

We then designed an information system, according to what we discuss in section 2. This would allow us to manage heterogeneous historical contents, and other materials coming from the process of "advanced industrial archaeology" described in [6].

A glimpse of the data structure is given on Fig. 1. The information system can store both semantic and geometric data. We can therefore store the whole structure of an object (for example a factory) from a macroscopic to a microscopic point of view (Fig. 2). The system also provides links, or relationships that represent historians' knowledge. Visualisation of such knowledge is somehow a complex task, both from

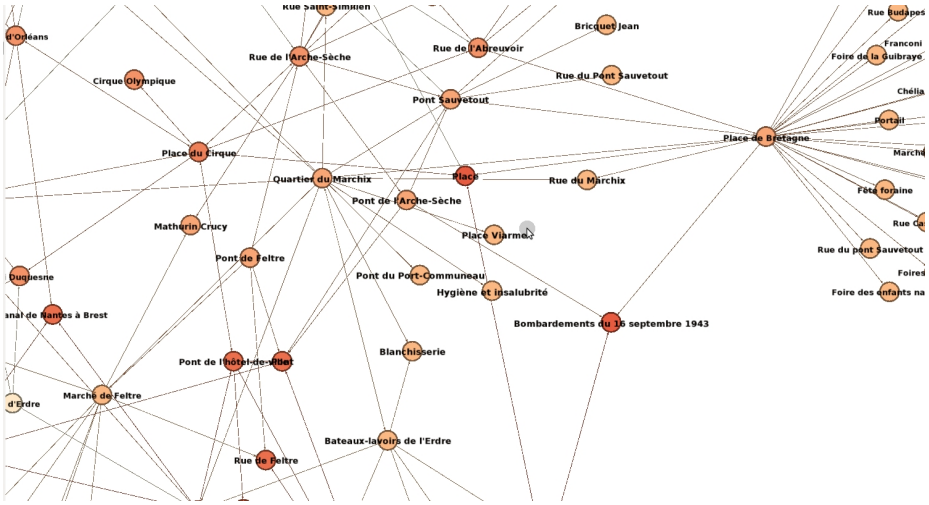

Fig. 1. Glimpse of the historical data structure

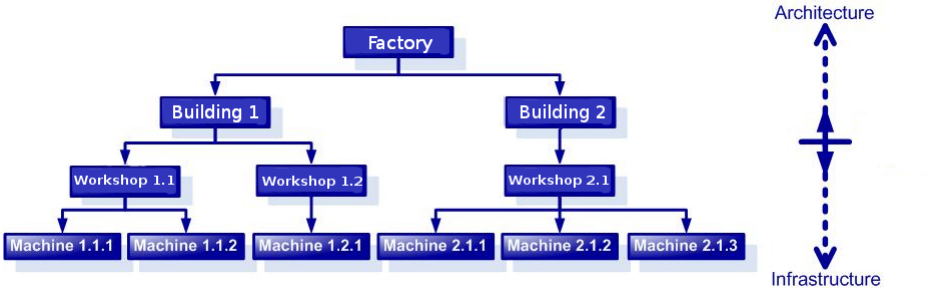

Fig. 2. Example of multi-dimensional levels of old industrial objects

ergonomics and computer programming points of view. At this point of the paper, it is important to notice that many skills are involved when dealing with cultural heritage capitalisation.

Based on this concept-knowledge space, we now want to identify historians' knowledge-mining modes. That means identifying ways the system will interact with historians whether they want to consult or to fill information.

3.3 Knowledge Visualisation

The proposed system (Fig. 3) is composed of a knowledge database, the historical object, and some visualisation devices: touch-screens and video-projectors. In fact, due to the process we applied in the project, we can now imagine any other interactive application: virtual worlds, augmented reality, web application, or any other future fruit of imagination… The system is scalable, and free from technology evolution, contrary to most of museum promoting systems. Scalability is provided by semi-automatic processes,

whether it concerns 3D model acquisition and treatment (automatic semantic recognition algorithms) or content updates of visualisation applications.

In addition to this visualisation application, the system can be enriched (currently through web-client software) by experts and general public. This is a significant aspect because we cannot ensure that the whole knowledge related to the object was capitalised in the first iteration. We thus allow the system to capitalise future knowledge. The use of such promotion applications would generate new knowledge for example that the system has to take into account for its new knowledge reference basis. We also have in mind to improve the system in a way that it can assist researchers in their work. For example, it may be able to provide decision help while doing some research on particular historical subject.

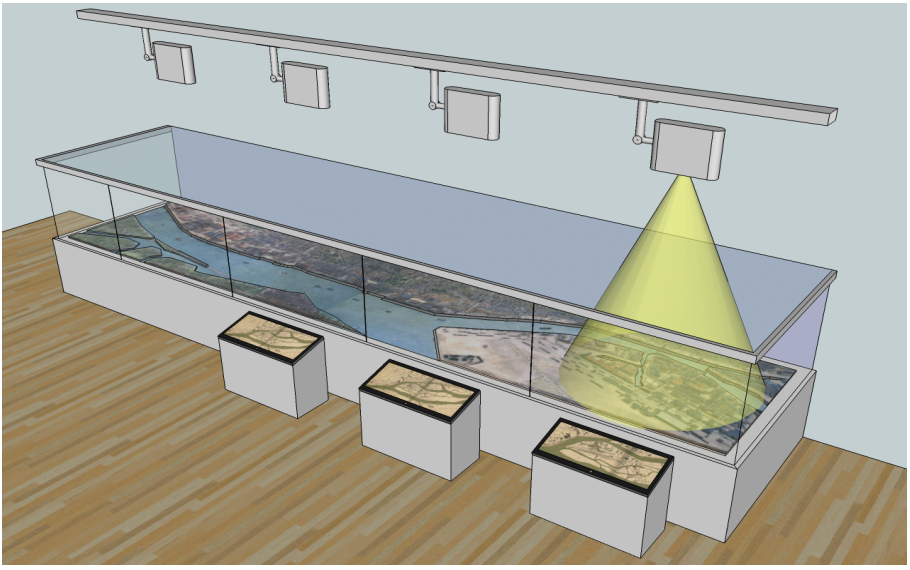

Fig. 3. Augmented historical mock-up

4 Our Proposition: Towards a PLM for Museum

According to the results of our demonstrating system, we can imagine reproducing the process on other patrimonial objects and extending the process to the whole museum collection. Indeed, as done in contemporary industry, patrimonial objects are concerned by PLM paradigm. From preservation to promotion, many actors are involved, and so is the related knowledge. During these steps - museum lifecycle – several processes and resources are engaged.

The challenge now is to introduce this methodology in a PLM system for museum, allowing the different business areas to work together for better management of historical knowledge (Fig. 4).

4.1 Historical Knowledge Management and Museography Issues

As discussed before, when capitalising historical knowledge, we need to involve working areas that do not usually communicate. That leads to new processes of cooperation in the design of products and services [1]:

- Products as implementation of cultural mediation devices, which in turn may become heritage objects.
- Services when creating new heritage preservation processes: 3D scanning, structuring documentary corpus…

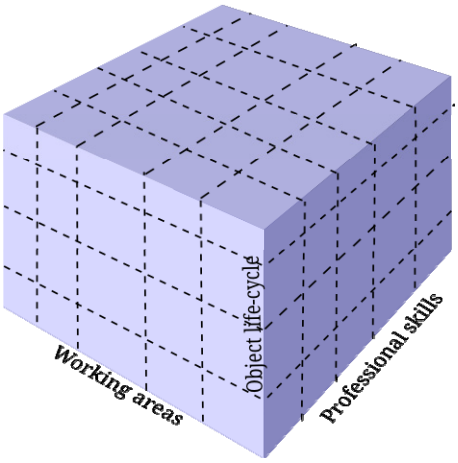

Fig. 4. Co-working on patrimonial objects

Interdisciplinary Aspects. An overview of the skills needed has been given in the preceding sections of this document. However, let's detail it a bit further:

- Expertise on contemporary engineering tools. These tools will be used for the capitalisation phase external data, but also for structuring information. Indeed, the concepts involved may be different depending on the scope (archives, museums, libraries, industry, etc.). This kind of expertise includes mostly engineering skills: experts in modeling and 3D scanning, and IT engineers.
- Expertise on the manipulated objects (mostly conservatives)
- Expertise in object's contemporary period that leads to an understanding of the object's environment. Mostly historians, historians of science and technology, and archivists for the corpus of documents. These skills are also required for translation of object's contemporary semantics in a current comprehensible language (contemporary to heritage capitalisation stage). Here we see the importance of communication among businesses that usually do not communicate. In fact, each business adopts a vocabulary related to its field of activity. From this point of view, we can assert that different occupations as historians, engineers, conservators, computer are able, under the banner of the common concern of preserving heritage to communicate and work together. This can probably be explained by the common goal, but also by a shared passion that

is a community's heritage. Indeed, and this is easily conceivable, heritage and history of a group (in the ethnological sense of the term) is a common root. This can also be seen through the craze that is observed among students working on a subject of their history, yet coming from all sides (engineering schools, universities, etc.).

- Expertise on the development and dissemination of information. This includes occupations related to cultural mediation, ergonomists, psychologists, cognitive scientists, or all occupations related to science communication, and data visualisation. This field is therefore also involved in automation or computer programming.

4.2 Management of Museum Collections and Associated Knowledge

The museum management complexity is as important as for any business. The main difference comes from the nature of manipulated objects. Indeed, the life cycle of products is remarkably different from those in the contemporary design process: the accumulation of knowledge is made retrospectively. It should be used to understand the object's life, influence he has had in a given space-time, and influence of the space-time evolution of the object, described by J.L Ermine in [2]. Therefore, the goal is not related to manufacturing process optimisation. However, the tools developed in the field of engineering are designed to be reproducibles. Then, a reproducible method for capitalisation and modeling of historical knowledge would be an answer to many problems. As an example, it would allow the establishment of a reading grid for cultural heritage preservation as recommended by UNESCO [8].

Another significant difference comes from the multi-dimensionality of the concerned knowledge. The phenomenon of reverse capitalisation requires a crossing of objects' life cycles and links between multi-dimensional information.

This is why the implementation of DHRM introduces a slightly different definition of the product life cycle as the one usually used in a current industry. Involved concepts and knowledge capitalisation contexts are differents.

Currently, the management of museum collection is provided by dedicated software (usually a specific Database Management System for museum) associated with a thesaurus. These DBMS are often under proprietary license, which prevent from efficient interoperability and implies specific skills. However, only people related to the administration of collections (museum curators, conservators, system administrator, research associates) work on the museum collection database. Indeed, cultural mediators, although the first link between visitors and museum collection objects exposed cannot interact with the collection management system. The information contained in the database is also often codified in a well specified and structured thesaurus. Knowledge of technical teams involved in the maintenance of cultural promotion systems are not taken into account in the system except for some characteristics such as illuminance maximum rate.

In the case of temporary exhibitions, whose aim is to expose heritage objects related to a particular theme, some objects are provided by donors. However, some of these objects are merely loaned and other data are permanently leaved to the museum.

It also frequently happens that many museums work together and proceed to exchanges from their own collections to meet the general discourse of the exhibition. However, only objects definitely bequeathed to the museum are then being digitised and loaded into the collections management system (through an historical sheet). Even if the exhibition is stored in the database as an event and linked to exhibited objects, the whole process of the exhibit design and discourse is not capitalised.

Thus, accumulation of knowledge in the sense we have explained in this paper would move towards a knowledge management tool museum, both for collections but also for people working in museum. Moreover, interaction and multi-disciplinarity is evident in the museum world where skills are extremely varied and heterogeneous. Yet, they work toward a common goal: preservation and promotion of cultural heritage. It is therefore a source of knowledge that just waits to be transmitted from generation to generation.

5 Conclusion

Trying to handle historical knowledge with industrial knowledge management methods is a great challenge. Both researchers and museum experts would take benefit from a global information system dedicated to cultural heritage. Yet, such methods are still incompatible when dealing with ancient objects. Moreover, the way of thinking usually used in industry and enterprise research is very new to history.

The approach detailed in this paper may allow researchers in history fields (archaeologists, historians, historians of science…) to develop new issues that would be underlined by the system (e.g. comparison of historical sources or intuitions analysis). To do so, we now have to identify which ways the system would use to communicate with semantically different working areas.

Another challenge we point out is the management of knowledge inside museum. Most of the knowledge from cultural heritage is hosted by such institutions (like libraries or archives). Designing museographic discourses involve many professional skills (designers, curators, and technical staff) and need accurate vision of knowledge provided by museum collection. In fact, many of exhibited heritage objects are linked through this discourse. Specific information system being able to host incremental knowledge related to museum collection would support museum activities, heritage preservation and cultural promotion.

Finally, what we aim to do is to make every community of practice involved in this heritage capitalisation process to take benefit on from each other. Industrial knowledge management should take inspiration from these works in order to improve innovation and design processes.

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