Integrating Knowledge Management Applications in the Enterprise – The Xerox Knowledge Portal Project

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Abstract – In this paper we present the design and deployment of an Enterprise Knowledge Portal in the Brazilian subsidiary of Xerox Corporation. The first unique feature of this project is the use of the Object Oriented Hypermedia Design Method (OOHDM) as a tool to design portal, which is seen as an instance of a Web based Knowledge Management application. The second unique feature is the use of a customized business game devised to trigger changes in corporate culture that lead to the adoption of the portal as a tool to support everyday activities. We describe the technical specification of the Portal as a Web application, and discuss the business game and its deployment, reporting on the experience gathered from the whole project.

1 Introduction

There has been a large amount of resources dedicated to the general topic of Knowledge Management within enterprises worldwide. As seen, for example, in [Alavy 99], Knowledge Management has many different meanings depending on whose point of view one asks, such as “Actionable information”, “Categorizing of data”, “Corporate yellow pages”, “Filtered information”, “People information archive”, “Readily accessible information”, “Collective learning”, “Continuous learning”, “Learning “organization”, “Data mining”, “Data warehouses”, “Executive information systems”, “Expert systems”, “Intelligent agents”, “Intranet”, “Search engines”.

According to [Alavy 99], a useful definition is that “Knowledge is a justified personal belief that increases an individual’s capacity to take effective action”. In this formulation, knowledge differs from information in the sense that information becomes (tacit) knowledge when, being processed in the mind of an individual, it allows him to act in a particular circumstance. When knowledge is communicated to others (through text, programs, speech, etc…), it becomes again information, which may become tacit knowledge again when internalized by some human recipient. From this formulation, knowledge is only useful to others if can be communicated in such a way as to allow interpretation by others, and when it is processed, refined and elaborated in the mind of individuals (as opposed to simply stored). As a consequence, that author defines “Knowledge management” (KM) as a systemic and organizationally specified process for acquiring, organizing and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work.

The two major aspects that must be dealt then when deploying some type of Knowledge Management application in an enterprise are

1. How is the knowledge going to be represented, stored and made available to all potential users? and
2. What organizational initiatives should be undertaken to ensure the cultural change that must occur, so that the deployed KM application is effectively adopted and used by its intended user community?
An additional factor has risen in recent years that must be integrated with the previous concerns, namely, the widespread adoption of the Internet technologies, both outside and inside the enterprise. In fact, the “Intranet” concept is seen by some as almost a synonym for “knowledge management”, and certainly the platform of choice for implementation of most KM applications. (cf [Alavy 99]).

This paper reports on a project undertaken by the authors during the second half of 2000 and the first months of 2001 within the Brazilian subsidiary of Xerox Corp. (XBRA). The goal of the project was to implement the so-called “Xerox Knowledge Portal” (XKP), a site in the intranet that would serve as a focal point for knowledge sharing and dissemination within the company.

The next section details our approach to design and implement web applications, which can also be applied as a method to develop web-based KM applications. In suite, we discuss how this method was employed in the design of the Xerox Knowledge Portal, highlighting the major design and implementation decisions. Next we discuss how we deployed the XKP within the organization using a business game, so as to trigger the cultural changes we felt were paramount to ensure the effective adoption of the XKP as an everyday tool by its intended audience. Finally, we report our experience, draw some conclusions and point to further work being undertaken.

2 KM and the WWW - The OOHDM Approach

The Object Oriented Hypermedia Design Method (OOHDM) is a model-based approach for developing Web applications, which we have been developing for the last 7 years [Schwabe 95, 96, 98; Rossi 99]. It actually began with our work on knowledge based systems [Schwabe 90], and the realization that in actual practice most problems that occur within an enterprise are, at best, solved by a man-machine team, as opposed to a stand-alone computerized system. We have used it for years to build different kinds of applications ranging from CD-ROMs, to Web sites and to complex e-commerce software.

The key concept in OOHDM is that Web applications should be designed based on a set of models that capture different aspects of the problem, namely Conceptual, Navigational Model and Interface Models. Those models are built using object-oriented primitives with syntax close to UML [OMG], which are currently considered as a kind of knowledge representation (cf. [Cranefield 01]).

The concern of the conceptual model is to represent domain objects, relationships and the intended applications’ functionality. When modeling an enterprise such as Xerox Brazil, example of core information objects (classes) would be “Client”, “Product”, “Service”, “Industry”, etc. and their corresponding behaviors. Figure 1 shows an example for the XBRA domain, where we have indicated only the class names. A full class schema includes the specification of class attributes and methods, such as “Description”, “Price”, “Photo”, etc… for class “Product”.

Relations can also have attributes, which are represented as “relation classes” (dashed lines). For example, one can say that a “Solution” addresses a set of “Business Needs” that a “Client” has (see Figure 1). Similarly, a competitor is any enterprise that offers solutions addressing the same needs that are addressed by Xerox’s solutions. This allows capturing the fact that other companies besides Xerox may be at the same time competitors and partners – such roles must be always be considered relative to a particular set of needs and solution offerings.
One of the major innovations brought by OOHDM with respect to other methods is the realization that what users actually navigate are not the conceptual items (objects), but rather other types of objects that are combinations (technically, views) of conceptual objects. As an analogy, if one considers “cough medicine” and “decongestant medicine” as conceptual objects in a drugstore, “cough and decongestant medicine” would be a navigation object. Obviously, navigation objects may be identical to conceptual objects, but often are more than that. Another analogy would be “first aid kit”, which mixes more elementary objects of different kinds (such as antibiotic ointment, band-aid, etc…) into a single object that may be bought. Similar reasoning may be applied to relations.

The complete syntax for Node and Link definition can be found in [Schwabe98].

Web applications usually contain collections of pages dealing with similar concepts, e.g.: solutions for a particular need, products using a given technology, clients who use a certain solution, etc. These collections may be explored in different ways, according to the task the user is performing. For example, he may want to browse products of the same category, or products similar to a competitor’s product, or products being used by a given client, etc. It is also desirable to give him different kinds of feedback in different contexts, while allowing him to move easily from item to item. For example, only when browsing products similar to a competitor’s product it may be meaningful to additionally include a feature comparison chart. Another example is the ability to move from an item to the next in a list such as returned by a search operation without having to backtrack to the index.
The design process in OOHDM requires the identification of both the navigation objects and the meaningful sets that support the user’s tasks. These sets are called Navigational Contexts, represented in a Context Schema. Each Navigational Context is described by stating properties of its elements, which may be based on their attributes or on their relations, or both. Its internal navigational structure (e.g. if its elements can be accessed sequentially), and associated indexes are also specified. Examples of contexts are “Solutions by Client”, “Solutions by Business Needs”, “Technology by Product”, and so on.

Access Structures act as indexes to group of related objects, specified by indicating the target objects and the selector to be used in the index. Figure 2 shows a simplified version of the Navigation Context Diagram for the XKP. The notation is as follows – white rectangles indicate contexts (sets or sets of sets) whose elements are of the type denoted in the gray background. Dashed boxes indicate indexes (access structures). Arrows indicate possible navigations between elements of the connected contexts.

To help understand this diagram, we describe a possible navigation. Starting at the main menu (an index), it is possible to navigate to a (industry) “Segment” via the “Segment” index (dashed box). This index takes the user to the chosen segment within the “Segment in Alphabetical Order” context (therefore the user may browse through other industry segments besides the chosen one). Each industry segment typically has particular business needs, so the user can navigate to the “Business Needs by Segment” context, which is a set of sets (called context group) containing one context (a set) for each Segment; each context contains the Business Needs (itself a set) for the given Segment.

Once the user has understood a particular Business Need, he may navigate to the context “Xerox Solution by Need”, and from there to the “Competitor Solutions by Xerox Solution” where he may compare solutions for that particular need. He may alternatively navigate to the “Case by Solution” context, where he will browse through the information about cases that use that solution.
Finally, we specify the abstract interface model that indicates the look and feel of navigation objects. Separating the interface from the navigation specification allows us to cope with varying interface technologies in a modular way. For example, given a particular navigation model we can specify different interfaces – for a browser or for a variety of mobile devices such as phones, palm tops, etc. For the sake of conciseness we do not further discuss interface design issues, as they are secondary to KM.

Once the abstract interface design has been made, it is possible to map all three designs (conceptual, navigation and interface) into a web-based application, which will allow the manipulation of concept representations as part of a web-based application (see [Schwabe 99] for more details about implementation).

3 The Xerox Knowledge Portal

The previous section outlined how it is possible to build a web application that can serve as a knowledge repository to be used, for example, within the intranet of an enterprise. In this section we discuss the major design decisions when building the Xerox Knowledge Portal by applying OOHDM. A subsequent section discusses the deployment strategy used in order to ensure its adoption within the organization.
3.1 Goals

A major requirement for any product and services company nowadays is that it directly contributes to its client business process; XBRA is no exception. This implies that the sales force must understand its clients’ line of business, in order to identify key aspects where the company may add value to its clients by offering solutions tailored to the client’s needs. Given the complexities of the current economy, it requires a great amount of knowledge and experience on the part of salespersons to perform effectively.

On the other hand, there is a tremendous amount of information and experience gathered within the organization as a result of its day-to-day operation, but it resides mostly in the minds of its marketing and sales people, and only a fraction gets captured in some form of documentation that can be accessed by others. The goal of the Xerox Knowledge Portal project was to provide a nexus where information can be systematically stored and accessed to help the various business processes within the company, thus becoming knowledge.

Furthermore, the team was conscious that merely deploying a computerized application would not automatically guarantee its usage on the part of employees, especially its initial target – the sales force. Therefore, a strategy was devised to help break the initial resistance when deploying a system, especially KM applications; described in more detail in later sections.

3.2 Architecture

The XKP was designed as a site within the Xerox Brazil’s intranet. Its initial focus was to support sales activities, especially making available the development of customized solutions that should be tailored to the needs of clients, adding value to their businesses.

After a series of briefings and interviews conducted during a two-month period, the design team came up with a preliminary design, which was validated with users through a mockup application. The revised design resulted in a complete OOHDM design, whose conceptual model and context schema were shown in the previous section (Figures 1, 2).

A major design decision that had to be made at this stage was the granularity of the information to be stored. In a “traditional” design, each class in the navigation class schema (derived from the conceptual schema previously shown) should be stored as tables in an underlying database system. This, however, would have implied that the implementation team would have had to access all the myriad of documents, both on paper and electronic, scattered throughout the company, in order to feed the database. This was clearly an undesirable alternative, both in the initial stage, and, most importantly, during the normal operation of the XKP, since a major design goal was to be able to seamlessly integrate any kind of relevant material produced within the company.

Furthermore, feeding of the XKP should be as much integrated with the usual processes already carried out in normal operation. The company already had a hierarchically structured repository where documents were stored, to be accessed by anybody who needed them, provided they knew the location within the repository where the documents resided.

Consequently, it was decided that the XKP would provide a layer over a storage (repository) layer, which would superimpose a coherent, hypertextual view over the stored documents. This view is precisely the set of models that constitute the OOHDM design.

Thus, in addition to storing documents of all sorts, the XKP also offers an interface where the linking structure between documents is maintained. This linking structure is an implementation of the navigation design, and is stored in a set of specially designed database structures. The maintenance procedures manipulate these structures to reflect the creation, deletion or update of navigation information.
This separation of storage and navigation is also important to support the intended migration from the previous repository into a new one being designed, which will be implemented using the new web development kit and content management services of the Documentum Document Management System (www.documentum.com).

Another design aspect of the XKP had to do with access rights. Clearly, given the breadth of information stored in the XKP, not all users had the same access rights to each item. A simple user profiling mechanism was defined, which allowed categorizing users into groups with similar access rights. Each information item had its “clearance” level defined relative to each user category as well as to individual users, so they could only access either freely accessible information, or information for which they had explicit clearance (which required logging in first).

3.3 Implementation

The XKP was implemented using a set of Microsoft’s Active Server Pages, which include code to access an SQL-Server database where the navigation (linking) structure was stored. In addition, the database also stored the user profiles and access rights associated with each document.

Another function implemented was a log of each access made to each item in the XKP. This allowed the designers to observe the usage patterns and fine-tune the navigation structure over time.

In order to make the XKP more concrete, we next present a few screen dumps illustrating a typical navigation path. Figure 3 shows the index to the industry segments available within the XKP. It should be noticed that the navigation bar at the top (under “Portal do Conhecimento” – Knowledge Portal in Portuguese) contains links to the major sub-sections of the site, corresponding to the dashed boxes in Figure 2.

Figure 3 An index for the Industry Segments Context within the XKP
Let us suppose the user has chosen the “Utilities” industry segment. He will see the screen shown in Figure 5. Here the user has a list of documents associated with this segment, and links to the other segments (in the left vertical bar).

If the user chooses to see the “Billing Document Flow” document (of type .doc), he will see the following screen.

If the user clicks on one of the proposed solutions within the document, for instance “COLD” (Computer Output to Laser Disc), he will see information about it, including links to cases where this solution was used. As part of the information about the case, there will be links to products used to form the complete solution reported in the case; if the user chooses one such link he will see the screen shown in Figure 7.
Figure 7 A sample product page in the Internet, accessed via the XKP

The interesting aspect in this screen is that the product information is actually taken from the company’s Internet website, exemplifying how the XKP is also integrated with other sites, both in the intranet and in the Internet.

4 Deployment of the XKP

As previously mentioned, the mere availability of the XKP, as a computerized tool was not enough to ensure its adoption by its target user community within the enterprise. The design team devised a business game as a device to allow the intended users to experience working with the XKP in as realistic situation as possible, without disrupting their established daily practices.

It should be pointed out that the business game is not of the same nature as other games, in which users play against a computer model that simulates real life situations, and then measure their performance against expected results. Rather, this was a game played by human players among themselves, exclusively over the company’s intranet. We next give additional details.

4.1 Premises for the Business Game

The following premises were assumed for the game. First, it had to create a realistic situation in which the players would get a feel for what it would be to have a tool such as the XKP available for everyday use, as part of their normal activities.

Second, since most sales efforts are undertaken as teamwork, the game should be played by teams, as opposed to individuals, that should cooperate to achieve a common goal.

Third, due to cost reasons, the game should be played entirely over the company’s intranet, with no face-to-face contact. The team members were selected among the sales force stationed in the entire country.

Fourth, users should be allowed, and encouraged, to submit new information for the XKP. In fact, a situation should be created whereby users would be rewarded when adding such new information. Moreover, users should also be encouraged to provide quality material, and not just irrelevant information.
Fifth, given the large number of unforeseen factors that certainly would require improvements in the XKP and in the business game, this was regarded as the first version in a series of refinements of both the XKP and the game itself.

Sixth, higher management should be heavily involved in supporting the initiative, sending a strong message to the lower ranks about the perceived importance of the project. As a consequence, an attractive prize was offered to the game winners.

Seventh, the initial contents of the XKP should be such that they would provide actual support for the activities of the game. Moreover, the technology to navigate in the XKP environment should be easy and friendly to use, as should the tools for game play and group collaboration.

4.2 The Business Game Rules

The goal of each participant team in the game was to elaborate a sales proposal for a hypothetical client. The groups were given very summarized descriptions of their clients, and told to interact with the “Oracle”, an anonymous entity that would play the role of the client. This interaction should take place in chats and email messages exchanged between team members and the Oracle. The result of this interaction would be a more precise characterization of the client.

Next the teams had to identify the business opportunities presented by the client, and devise a sales strategy to cover the most profitable opportunities. For each submitted list of opportunities, the “Oracle” returns a ranked ordered list, assigning a certain number of points to each of the identified opportunities. This ranking reflects the company’s strategic interests and the profitability of each alternative. From those opportunities, they had to choose a few to be further refined into a sales proposal to be presented to the client. Figure 8 presents a graphical summary of the game’s steps, and shows all the participants.

![Figure 8 – The steps of the business game](image)

The groups were evaluated on the basis of the quality of the material produced in each step. Since there were a total of nine teams, three problem sets (hypothetical clients) were drafted, one in each of the Telecom, Utilities and Banking industry segments, where XBRA had previous expertise and material was available. Hypothetical, but realistic, clients were defined,
so that each would have an average of ten business opportunities to be solved using XBRA’s portfolio of solutions.

To encourage contribution by the teams, part of the final grade assigned to each team includes points earned by submitting new material for inclusion in the XKP. Material sent to the game organization was submitted to company experts in each relevant area; if it was deemed acceptable, it was immediately included in the XKP. If other teams actually used the contributed material, additional points were assigned the contributing team. With this rule users were discouraged from “hoarding” information, since they would always get more points by submitting them for inclusion in the XKP than by keeping them to themselves.

4.3 Game actors

As seen from the diagram in Figure 8, a number of actors are part of the game, detailed next. In order to minimize possible extraneous influences that might detract from the game play, all participants are anonymous, except when noted. This means that all interactions between game participants were made within the game environment in the intranet, which ensured anonymity.

4.3.1 The “Oracle”

The “Oracle” is an anonymous entity whose role is to present the players with challenges regarding the client characterization, as well as more detailed information. Like clients in real life, the “Oracle” doesn’t necessarily give accurate information, and doesn’t volunteer solutions to the challenges posed in the problem statement. At best, he will point the teams to places in the XKP where relevant information may be found.

A team of company experts in the various problem areas played the role of the “Oracle”.

4.3.2 Judging Committee

This committee was composed of five high-ranking company officials whose responsibility was to examine all the material produced by the teams and assign numerical grades to several evaluation items previously agreed upon. Besides weekly evaluation, it had a final evaluation meeting where the winners were chosen.

4.3.3 Virtual Audience

The virtual audience was a device created to allow the participation of other company employees not directly involved in the teams. They were allowed to follow the team activities, and participate in all the public chats between the team members and the Oracle, and between the team members with the game organizing committee. As in real life, the Virtual Audience could “cheer” and “boo” team plays, by sending them email messages or by participating in team sessions.

4.3.4 Teams

Each team was formed with four players chosen among designated sales persons, branch managers or local market managers. Care was taken to ensure that no two players belonged to the same local branch, but all belonged to the same region; furthermore, no team had players with direct hierarchical relation between them. These rules ensured that every team member had already met his teammates personally on some previous occasion, even if only briefly, alleviating somewhat the distance imposed by the exclusive net contact.

Although the team members knew each other’s real life identities, within the game environment all team members were anonymous to other game participants.
4.4 Game Deployment

The game was played during a three-week period. All activities in the game were undertaken within an environment provided in the company’s intranet. Players had scheduled chat sessions with the oracle and with the game organization. They also had private chat sessions, which were moderated by a member of the organization to ensure smooth communication. In addition, players used email extensively, using anonymous identities provided by the game organization. Each player was expected to allocate a minimum of six hours per week to the game.

An introduction to the game environment to all actors was considered necessary to ensure they got the same timely information about rules, problem definition, questions and answer mechanisms, teamwork evaluation and prizes. All the information could be found in the Game site in the intranet, including:

- Game objectives and operation;
- XKP resources and available functionality for the Game;
- A video with encouraging the exploitation of XKP potential;
- Game problem sets, working rules, expectations of the organization on group behavior, schedules and documentation;
- A game simulation – an example made available so that each team had an idea of what kind of material should be produced
- Team evaluation criteria and results publication;
- Communication mechanisms, accounts and passwords;
- “Oracle”, Judges, Virtual Audience and Game Organization role descriptions;
- Winner prizes.

Information in the XKP was such that it had to be used by the teams in order to accomplish their tasks. Care was taken to assign problem areas to teams in such a way that no player had previous experience in the problem area assigned to his own team.

As in real life, opportunities should be treated in different time frames. Each group should treat at least one short term, one mid-term and one long-term opportunity. The choice should consider maximizing the number of points accumulated at the end of the game. So, depending on complexity, each team had to balance the effort required to exploit each one with the reward value, and to decide the best strategy to follow. The judges also evaluated the reasoning followed in each choice.

The final sales proposals must contain all elements that allow the client to evaluate its convenience, alignment with his business goals, added value, solution description and what XBRA can provide.

4.5 Evaluation

Although measuring the actual results of this kind of project is still difficult due to the lack of established metrics, there were several indications of the projects success, which we briefly summarize.

4.5.1 The establishment of the XKP

The deployment of the XKP as a focal point for knowledge representation and dissemination has become a reality. Although not all sectors of the enterprise are included, the core departments, notably Industry Marketing, have adopted it as their medium of choice. As a result of the game, several information deficiencies were identified, and new projects have
been started to generate appropriate contents to be inserted into the XKP. Moreover, this has become part of routine activities for this unit.

Other units are slowly beginning to insert new material into the XKP, especially newly produced content; for some, the cost/benefit for migrating old material is still not very clear. By most accounts, it could be said that such material will tend to be discarded in the near feature, as it is becoming obsolete.

In spite of the short period of time, several contributions to the XKP were submitted during the game. All have remained available after the game’s end, continuing to be routinely accessed. The company is actually considering ways to financially reward employees who contribute to useful information to the XKP, although they have not yet defined the criteria by which this will be measured.

4.5.2 The Business Game

Knowledge Portal and the Game were, by all accounts, a tremendous success; both were voted as one of the best overall projects within the company for the year 2000. As a result of the game, several regional units have adopted local initiatives mimicking the game, with simplified rules, as a promotional device to increase sales.

In addition, the Education unit is now interested in exploring the game as a new educational device to provide on the job training for employees, not only for sales but also for other areas as well.

5 Conclusions

This paper has presented a project that established a Knowledge Portal within a large corporation, with offices spread geographically throughout the country. This portal was built using a design method based on modeling approaches also used in constructing KM applications. To ensure adoption within the enterprise, the implemented KM application was used as part of a business game designed to highlight its usefulness in real life situations.

5.1 Lessons Learned

There are several factors we have observed to contribute to the success of the project, which we briefly summarize next.

The first lesson was that management support at all levels was crucial. This was obtained starting with a strong position taken by upper management, coupled with innumerable meetings with middle and lower level managers, emphasizing the alignment of the project with the business goals of the company and, at lower levels, how it could reinforce lower-level goals. In some cases, we were able to actually contribute to provision of the needs of some sectors. Special care was taken to be able to integrate with existing systems and applications, trying, whenever possible, generate positive feedback loops between the XKP and the existing application. Consequently, technology was kept as unobtrusive as possible, and always compliant with internal standards. In addition, deployment was planned in a careful and controlled manner, in order not to disrupt working systems.

The second lesson was that motivation should be maintained throughout the whole process, supported by a variety of initiatives, such as news stories in the company’s internal newsletter, videos, and talks at company meetings at all levels. The biggest motivation was the recognition and visibility awarded to the winning team by the entire company, with the added bonus of the actual prize. In general, it could be said that, although monetary awards are always a good motivation, recognition by peers and superiors counted almost as much.
A third lesson was that game-like activities are very popular, but the rules must be very carefully thought out and explained very clearly at the outset. The rules were planned to allow both upper management and the sales force itself to get a feeling on how it would be to work under different sets of rules and values than those they normally work with. Because of so many new factors, a great deal of care was taken to insure all the rules were understood by everybody, and that they also had time to get familiar with the systems, the environment and their teammates.

The current version of the XKP is being migrated to a version that will use the Documentum document management system as its storage support layer. In addition, workflow features of this environment will be used to support insertion and maintenance of existing content with the XKP. A second aspect that is being investigated is the integration with “conventional” databases, i.e., where information items have granularity smaller than a document. This is already being deployed for the new contents being produced by the Industry Marketing unit. In addition, the XKP will be integrated with other corporate information systems, such as the Sales Force Automation system being deployed.

As far as more advanced functionalities are concerned, we are now investigating the use of metadata descriptions integrated within the XKP so that the navigation structure and even contents can be personalized according to previous navigation history, for each user.

In addition, we are also looking into the use of ontologies as a support tool for authoring, to help users who are entering new material into the XKP, but do not have extensive knowledge of the existing content, to find meaningful contents for linking.

6 References


