Portals as a knowledge repository and transfer tool—VIZCon case study

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Abstract
Today’s business domains are complex and require faster decisions, better allocation of resource and above all dictate the need to share knowledge both within and outside the domain. Managing dynamic projects in such a volatile business environment requires a structured approach. This paper is concerned with using portal technology as a means for storing and transferring knowledge. The paper demonstrates the use of portal technology, via a case study, to increase the overall project reactivity and achieve the objectives, namely to reduce time, improve decision-making, increase productivity and reliability. A portal developed to manage the VIZCon project is described using a novel framework. A five-step approach for developing an effective project management portal is presented with empirical evidence.

Keywords: Portal Technology, Knowledge Management

1. Introduction:
The growth in worldwide communications, and of the Internet in particular, has generated new expectations for global users (Boyson, Corsi & Verbraeck, 2003). This has resulted in creating a turbulent and competitive global environment for business. In such a business environment maintaining projects requires a platform for making faster decisions and most important of all sharing knowledge within the project consortium. Traditionally, a project manager, who solely had the responsibility of meeting all project objectives to time and cost, managed such projects. This method of operation was suitable where organizations had plentiful resources and no constraints on delivery times. However, today’s business models are strictly governed by time, cost and quality. In such environments the project partners are scattered across cities, states and even continents. Managing data, information and knowledge in such a dispersed environment is a complex activity. In addition to this distributed method of execution, project deliverables are strictly time governed and penalties can be of dire consequences. Portals developed with Internet technology can help overcome some of these uncertainties. This paper presents the reader a practical framework for developing portals using Internet technology. The main problem of managing knowledge repositories is central to our discussion. This paper is organized in four sections: section 2 and 3 introduce the reader to the concept of knowledge management and portal technology; section 4 presents the developed framework with example of the VIZCon project, while empirical evidence supporting the developed hypothesis is presented in section 5.

2. Project and Knowledge Management
Methodologies for managing projects might differ based on the type of sector. For example, construction is a knowledge rich industry, both in terms of the knowledge it generates and exchange among participants, as well as the information it absorbs from outside sources (Abdelsayed & Nayon, 1999), on the other hand defense R&D projects generate knowledge mainly from within the organization and do not typically exchange knowledge outside the system. Regardless of the sector all organizations require to manage knowledge for the following reasons:
Location: The idea that projects can be managed and delivered by a single unit is obsolete. Companies have to rely on extended supply chains and collaborative team working to make the project or business successful in the global market place. The strategy of ‘hunting in packs’ seems to dominate the current business domain. Since the
advent of the Internet and Work Wide Web, the traditional pillars of economics – capital, land, plant and labor can no longer determine the success of a company. Instead companies are beginning to realize that their competitive edge lies in "intellectual capital", which is embedded within the employees of the project partners.

**Scale of Operation:** Most companies now have Internet technology as part of their basic infrastructure. A recent survey indicates that 30% of SMEs can accesses the Internet via ISDN lines or higher, while the rest have at least some form of Internet access (Veeramuthu, 2003). This connectivity has provided companies (including SMEs) mechanisms to join forces virtually and create virtual teams. Rushdi and Retik (year?) clearly show how virtual teams provide companies a forum to compete on a much larger scale of operation than the traditional bidding process.

**Time Management:** Central to any project is the ability of a company or consortium to meet all project deadlines. Delay in projects can cost companies millions. For example, British Energy lost over five million Canadian dollars when the Bruce A Unit 4 project was delayed by just 15 days (Perle, 2003). Companies have realized that meeting customer demands in the shortest possible time is crucial to their very survival. Within the context, we define managing project knowledge as ‘managing consortium data which has relevance’. Data in abstraction are either numbers or alphabetic characters, e.g. the number 26 has no meaning if considered in isolation. Introduction of detail to this leads to the emergence of information, e.g. 26°C reflects the fact that an attribute of centigrade is associated with the data. Extension of this fact to include relevance to the situation can be termed as knowledge, for e.g. 26°C = pleasant weather reflects both the information and associated knowledge with this fact. By stating this fact we do not intent to limit the boundaries of knowledge to simple heuristic statement. Our other conviction of knowledge is that it can be captured, stored and then transferred using a portal. One fact that emerges from this discussion is that ‘consortium knowledge’ is key to managing projects. Consortium knowledge refers to technical knowledge used within the project boundaries and can be either articulated or explicit. Articulation may be through speech, writing, drawings, patents, computer programs or mathematical relationships. Tacit knowledge dwells within peoples' minds and governs their interactions with and responses to other people in a particular context (Koskinen, Pihlanto, and Vanharanta, 2003).

The main concern in managing project in dynamic environments is to make this "tacit knowledge" available across cross-continental consortiums without the risk of losing vital captured knowledge. One of the key concerns encountered by us while dealing with project knowledge is its loss. Knowledge loss can occur due to some of the following reasons:

- A project manager is overloaded, and cannot deal with all requests for his particular knowledge and expertise.
- The culture of the project consortium does not encourage sharing of knowledge.
- Knowledge is available but lies dormant waiting for a catalyst to release it. For example, a person might be working in one context, yet possess substantial knowledge that might be far more useful in another context.
- Knowledge is rejected because of the 'Not Invented Here' Syndrome.
- Knowledge may be lost in a consortium through neglect.
- Knowledge may also be lost in the consortium through retirement, redundancy, resignation or even through promotion.

It is not the intention of this paper to discuss the details of knowledge loss, but the authors feel that it is essential to mention some of the causes of this loss. Using portals as a means for project management can overcome some of this knowledge loss.
The lessons learnt philosophy is a promising approach originating in the US Army (1993) and later developed at MIT as the learning history process, including research on organizational learning, in collaboration with the Ford Motor Co, Hewlett Packard, National Semiconductor, AT&T, Federal Express and others (Kleiner and Roth, 1997). More recently these principles have been adopted by a number of construction companies - David Bartholomew Associates, Gardiner & Theobald, Amicus Group, BAA, BP, Bovis Lend Lease Global Alliance, Buro Happold, SecondSite Property and Transco (2003) - who have developed a Learning from Experience toolkit that includes powerful anecdotes. A key characteristic of construction projects is the formation of temporary, virtual organizations which by their nature make the retention and reuse of knowledge particularly problematic. This has been recognized in the government’s Rethinking Construction report (Construction Task Force, 1998) which stated that ‘...continuous learning is not part of the industry’s vocabulary.’

An simple prototype portal was developed in another recent EPSRC funded project called CoBrITe. This was concerned with the use of IT to support construction briefing and involved a generic design process model and simple portal to capture and exchange information (Rezgui et al, 2003).

3. Portals as Knowledge Repositories

Tacit knowledge exists within project partners in either an internal or external form. Internal knowledge resides within the minds of individuals and is based on personal experiences. For example a design engineer might remember that the last time he designed a boss for a crankshaft it was too thin and resulted in undesired vibrations and noise. The next time he faces a similar situation; he designs the boss to be thicker. External knowledge on the other hand resides in repositories. For example, the same design engineer might look for boss designs in standard design books and based on his calculations determines the thickness of the boss. It is obvious from above that internal knowledge is more effective than external knowledge. Figure 2. below shows the relationship between the project consortium, the knowledge repository and the project domain. In an ideal situation all knowledge from the repository should be ‘used’ by the project domain. However in practice less than 20% of tacit knowledge is reused within the project domain. Some of the main reasons for this include (Fruchter and Demian, 2002):

- Consortium members do not appreciate the importance of knowledge captured because of the additional overhead required to document their process and rationale and as a result of this knowledge is not captured.
- Even when knowledge is captured, it is limited to formal knowledge. Contextual or informal knowledge, such as the rationale behind design decisions or the interaction among project consortium members, is often lost, rendering the captured knowledge not reusable.
- There are no tested mechanisms, from both the technology and organizational viewpoints, for developing, applying, assessing, preserving, updating, transferring and transforming knowledge.

Since the advent of Internet technology and the development of portals, knowledge management has become an achievable task. Portals as the name suggests are gateways to a knowledge domain. User can access knowledge repositories, like the one shown in Figure 1, via Internet portals.
Philosophical discussions about portals are not within the scope of this paper, and the reader is referred to the works of Clarke and Flaherty (2003). However it is important to understand that web pages and portals are not the same. Portals are gateways into a certain horizontal or vertical knowledge domain, whereas website don’t necessarily lead the user into a knowledge domain. In addition to this portals have ‘stickiness’ incorporated within them to ‘keep’ the user glued within the portal domain. As can be seen from Figure 1, knowledge management consists of developing, applying, assessing, preserving, updating, transforming and transferring knowledge. This paper is concerned with using portals as a knowledge repository and transfer mechanism. Table I shows how portals can offer the required technology to create a knowledge repository and transfer knowledge.
It is evident at this point through experimentation and literature, that portal technology provides the best infrastructure to store, access and transfer knowledge. Let us consider some of the portal modules that help store and transfer knowledge.

### Forums
Forums are part of portals where consortium members can post messages or questions that are added to ‘threads’ or ‘topics’ on a real time basis. Other members are notified about this via emails and can respond or post new messages at their leisure. As forums provide a medium for members to discuss about a message, they are also referred to as message boards. The main advantage of this is the ability of the portal to provide consortium members a platform to discuss on topics relevant to the project. As the message conversation is documented using a time line, this can form the basis of a document control system in ISO 9000 certified companies. In addition forums provide a sense of “virtual place” that is lacking for the most part in a traditional email discussion list. With newer technology still evolving there is possibility to have real-time conversation via forums.

### Chat rooms
Chat rooms provide a real time discussion medium for project partners. They allow multiple yet relevant project partners to log into a real time interface and exchange ideas, drawings and can converse with each other. Chat sessions can be planned and partners can meet and talk as in real meetings, thus reducing costs and time.

### Short message service (SMS)
Short message service (SMS) is a globally accepted wireless service that enables the transmission of alphanumeric messages between mobile subscribers and external systems such as electronic mail, paging, and voice-mail systems. Portals can offer SMS service, which enables partners to contact each other regardless of their location. For example, a site engineer in UK can SMS a query to design engineer in Germany and can get a response back to him within a short time.

### Document Repository
Document Repository is a collection of relevant documents that lists tacit knowledge about the project using textual, pictures and diagrammatic forms. Documents with short movie and audio clips can also be uploaded to the portal for additional knowledge transfer.

### Publication Basket
Publication Basket is similar to the concept of a shopping cart as in a real supermarket. The portal allows project partners to ‘shop’ from the document repository and assemble a list of documents they require for their tasks.

In addition to this flexibility, ease of development, ease in complexity and development are additional boons in the use of portal technology in this area.
An example of a commercial portal that adopts some of this technology is the Information Channel (BIW Technology, 2003), one of a number of project extranet/collaboration tools. This one works in an AP environment and is designed to provide all project members with live project information, electronic documents and drawings plus the ability to track the dialogue and decision making that is undertaken by the team.

4. Portal Development Framework

The rarity of knowledge transfer mechanisms in knowledge engineering literature as opposed to the knowledge management literature is one of the motivational factors in our attempts to derive this novel methodology. We will use the example of the VIZCon project while explaining the framework for portal development. The VIZCon project is funded under the auspices of the Engineering and Physical Sciences Research Councils (EPSRC) IMRC grant. The project, led by the University of Warwick [P01], consists of the following global partners:

<table>
<thead>
<tr>
<th>Partner</th>
<th>Company</th>
<th>Main Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Arup</td>
<td>UK</td>
</tr>
<tr>
<td>3</td>
<td>Christie Digital</td>
<td>Canada</td>
</tr>
<tr>
<td>4</td>
<td>PTC</td>
<td>USA</td>
</tr>
<tr>
<td>5</td>
<td>Red Box Design Group</td>
<td>UK</td>
</tr>
<tr>
<td>6</td>
<td>Sun Microsystems</td>
<td>USA</td>
</tr>
<tr>
<td>7</td>
<td>VR Systems UK</td>
<td>UK</td>
</tr>
</tbody>
</table>

This project represents a typical consortium, where multi-continental partners are involved in a complex project. As can be seen the portal development process is a function of the complexity of the objectives for the portal. In developing the VIZCon portal as a knowledge repository and transfer system we adopted a sequential development process as shown in Figure 2. below:

![Figure 2: Model for building a Portal here]

The model has been used to define and develop a portal for the VIZCon project. As can be seen from the model, the last step requires the assessment of the developed portal. If the outcome of this assessment requires any changes the whole sequence is reiterated until a satisfactory model is obtained. Each step is now briefly described in the following sections:

**Definition**: First as with most strategic projects, the starting point begins with the definition of measurable objectives. For instance, some broad-based objectives that can be pursued include conducting online transactions, to provide timely information, to

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increase sales, to improve customer service, and to reach new market segments. More
specific objectives include examples as provide real-time price quotes to customers, to
allow customers multiple payment methods, to increase delivery service by 3%, or to
allow customers to talk with one another in community oriented settings. Regardless of
what the objectives are the focal point of a successful portal evolves from clearly
defines objectives. Definition of portal strategy is a joint activity and must involve the
close support and cooperation of all project participants. The first step in this process is
to involve all project partners and determine the most relevant objectives of the portal.
This can typically be done by a series of focused group meetings or group workshops.
Lists of key portal objectives are drawn up and each partner is asked to assign
importance weights to them. A five point Likert scale (Harvey, 1998) can be used to
assign values to each of the objectives. For example, following is a partial list of results
from the VIZCon definition phase:

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Min</th>
<th>Max</th>
<th>Average</th>
<th>Std Dev</th>
<th>Relative Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Allow quick &amp; efficient dissemination</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2 Real time contact regardless of location</td>
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<tr>
<td>3 Ability to discuss issues at leisure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Ability to ‘collect’ relevant documents from knowledge repository</td>
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<tr>
<td>5 Obtain relevant news</td>
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<tr>
<td>6 Ability to collect users comments on relevant issues</td>
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<tr>
<td>7 Ability to discuss with peers and experts</td>
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</table>

As can be seen from Table II above the project consortium is responsible for forming
measurable objectives and then finalizing and ranking the objectives of the portal.

Functionality Selection is the second stage of the portal development framework. This
phase of the project requires the participation of a technical person. It is important to
have functionality selection as the second step as it gives the portal developers an
opportunity to look at a wide ranking list of technologies that can meet the strategic
objectives of the portal. It also gives the project consortium members an opportunity to
rethink some of the earlier stated objectives based on either the limitation or
advancement of technology. For example, the project team might request intelligent
searching capabilities based on a new user requirement. During this phase portal
developers need to evaluate possible Internet technologies that can satisfy the objectives
stated by the consortium. From our experience it is advisable to use open source
modules while constructing portals, wherever possible. Table III below shows how
functionality selection was done for the VIZCon project.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Strategy</th>
<th>Technology Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Register portal details with</td>
<td>1. Use Meta tags and title tags</td>
<td></td>
</tr>
</tbody>
</table>
At the end of this phase, the portal developers deliver a detailed technical analysis matrix to the project consortium members.

**Content Selection** entails designing the information content. Project consortium members can conduct focus groups and other exploratory methods of marketing research to assist in designing the contents of the portal. Decisions need to be made on topics such as: 1) Which major categorical areas of content will be included in the portal, 2) with what frequency will the portal be updated, altered, and archived, 3) what level of access to the content will be granted, 4) what languages will the portal be displayed, 5) are there any copyright and privacy issues that need to be sorted out. These questions need to be considered and debated in detail as these form the basic specification for the portal. Another aspect of content selection is aesthetic appearance and navigational methods of the portal. The main objective of any portal is to maintain ease of navigation and maintain a common and standardized look. As project partners are expect to spend a considerable amount of time ‘surfing’ this portal, a layered approach should be adopted like the VIZCon portal. The VIZCon portal provides registered users access to information through different perspectives and angles. For example, the user can move and adjust the portal layout based on his/her personal choice. The key feature of the VIZCon project is in ‘simplicity of its use’. A specification document was developed by the project consortium members, which also provided the portal developers a formal specification document.

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<td><strong>2</strong></td>
<td>Adopt Short Message Service (SMS) to obtain real time messaging.</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Give appropriate space to review and discuss issues at leisure</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Give users the ability to shop for documents</td>
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<tr>
<td><strong>5</strong></td>
<td>Obtain relevant news</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>Ability to collect users comments on relevant issues</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td>Ability to discuss with peers and experts</td>
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</table>
Establish Relationship entails developing a pilot portal that project users can test on a small group of users. Before doing this the portal developers have to match the content documents to the technical specifications. A simple method adopted during VIZCon was to develop a pilot demonstrator on a private intranet. The main intention of this pilot was to ensure that all functionalities of the portal objectives were met. Testing to ensure that there were no flaws or bugs were carried out on a 256KB intranet line to simulate real-world usage. A series of internal uses with varied experience were invited to view the portal. Data obtained from them was used to fine-tune the portal. A portal feedback mechanism was added to collect the traffic flow and ‘access’ data.

Portal Validation is the final stage of the development process. However a portal is never ‘complete’ due to the fluid nature of the Internet. During this phase data from the actual users is collected and analyzed. It is not the intention of this paper to describe in detail techniques for developing questionnaire and hence will discuss the validation output from the VIZCon project. The VIZCon project involves the active participation of about X members (population size = X). All of these X project partners were invited to respond to a pre-prepared questionnaire via emails. The questionnaire was divided into 3 sections, with a total 8 question. The first section was concerned with the functionalities of the portal. The intention was to understand if all objectives stated in phase 1 of the portal development process was met. The second section was on the aesthetics of the portal while the last section was about ease of usage. The survey required the respondents to grade the questions on a Likert scale of 1 to 5, where 5 was the best. The questionnaire was emailed to 100% of the population, and received a response of XX%. To ensure the full representation of samples, this study takes a chi-square test to demonstrate their homogeneity. The result shows that all parts in the questionnaires received are of no significant difference. Therefore, the unreturned questionnaires will not create an impact in the accuracy of the research findings.

Survey Results
The outcome of the survey showed some interesting facts. The project participants were asked to answer 8 comprehensive questions related to objectives, aesthetics and usage. The results of which are as shown in Table IV below:

<table>
<thead>
<tr>
<th>Question</th>
<th>Cases</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Median</th>
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<th>Maximum</th>
<th>Skew</th>
<th>Kurtosis</th>
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As can be seen from the table above, the mean and standard deviation of the questions proposed clearly reveal the strong, positive outcome of the survey. In addition to this a skewness and Kurtosis test was also done. The skewness "returns the skewness of a distribution". Skewness characterizes the degree of asymmetry of a distribution around its mean. Positive skewness indicates a distribution with an asymmetric tail extending towards more positive values. Negative skewness indicates a distribution with an asymmetric tail extending towards more negative values". The "kurtosis characterizes the relative peakness or flatness of a distribution compared to the normal distribution.

Comment [C&BE12]: I have seen the data in the pdf version, but a reviewer might find it unhelpful not to say what the questions were.

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Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution.

It can be seen that almost all respondents felt that the portal met all objectives stated in phase 1 of the portal development. The developed portal was judged to be aesthetically good and was very easy to navigate.

5. Portal as Knowledge Repositories

A knowledge repository as the name suggests is a depot for storing tacit and articulated knowledge from the experts. In section 4, the reader was introduced to a framework on developing a portal that can provide an ideal infrastructure for a knowledge repository. In this section the reader will be introduced to a practical mechanism of creating, storing and transferring knowledge within a project consortium. Working on the VIZCon project has shown us that Portal technology offers the best solution for creating, storing and transferring with added advantages of flexibility, customization and relevance. The mechanism for creating, storing and transferring knowledge is shown in figure 3 below.

Project knowledge resides in the minds of the project consortium experts. This tacit knowledge can be represented in various forms using texts, diagrams, movies etc and stored on the portal knowledge base. The VIZCon portal provides the user a mechanism to upload this tacit knowledge using a variety of forms. For example, documents representing a certain situation using IDEF diagrams can be uploaded to the VIZCon knowledge base. On the other hand representing problem solving methods using Alexandrian patterns can also be uploaded to the VIZCon knowledge base. The VIZCon knowledge base is a database created using the open source database system MySQL. All users can access this knowledge base via web browsers on any operating system. Using a series of simple navigation buttons the user can ‘shop’ for this tacit knowledge using the developed ‘publication cart’.

The developed portal also provides a mechanism to capture the knowledge generated via interaction between the experts, users and the general community. An open source
The forum module allows all users to interact and discuss details about relevant topics. A chronological log of this interaction is captured and stored within the VIZCon knowledge base, which can be accessed by users at any latter time.

In addition to this, users, community and experts can have real-time chat sessions on topics of mutual interest or can contact each other via SMS. Again all this is stored in the portal knowledge base, which can be archived and transferred to the user or non-expert community.

The VIZCon portal also has a news module. Users can update ‘critical knowledge updates’ using a simple news upload button. The portal in addition to this sources out and filters relevant news from sources like Reuters etc using an intelligent search logic.

It can be seen clearly from the above discussion that VIZCon portal offers a mechanism for capturing, sorting and transferring knowledge using portal technology.

6. Conclusion

As described in the case of VIZCon project, there is little denying that portals can offer an excellent mechanism for knowledge repository and transfer. From our methodology it can be seen that using a structured method is important for a successful portal development activity. The methodology proposed in this paper provides companies a good starting point for managing complex projects, where knowledge storage and transfer is critical. Using the latest open source portal technology, communities can create, store and transfer knowledge within the business domain with limited cost.

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