

A WEB-BASED KNOWLEDGE MANAGEMENT ENVIRONMENT FOR CONSULTING AND RESEARCH ORGANIZATIONS

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ABSTRACT

Consulting and research organizations are characterized by a project orientation, teamwork, a flat organizational structure, and a dynamically changing set of personnel roles and objectives. These organizations develop information content in the form of reports, various graphics, presentations, documents, and sometimes video and audio files that can be broadly defined as project artifacts. Knowledge is often defined by "best practices," formalized procedures, and external connections. Although many organizations possess characteristics common to those of consulting and research organizations, the unique focus of consulting and research firms on knowledge, as one of the primary products offered to clients requires a knowledge management effort and technological infrastructure that support this unique focus. In this paper we present a Web portal-based knowledge management architecture designed to support the specific knowledge management activities prevalent in consulting and research firms. The architecture is composed of advanced computational techniques consisting of an XML-based repository of organizational artifacts, a software bus, groupware, a multimedia repository, and ontological reasoning. The Web portal is a view into groupware, search, and multimedia applications as well as normal Web functionality. The architecture is three tiered with the client tier consisting of a Web browser, a middle tier consisting of the support applications encapsulated in a portal, and a back tier containing the repositories and databases. An index/repository engine is used in the back tier to manage the contents of a separate index repository and an ontology repository. An ontology repository is used to store expressions that are a form of knowledge representation that can be queried. An index repository contains indexes to HTML and XML based Web pages containing organizational artifacts. The architecture represents a unified use of various technology components that, in concert, provide the functionality and integration of technology required by consulting and research firms to harvest and leverage the combined knowledge of their knowledge workers to provide better service to their clients.

INTRODUCTION

Among the many definitions of knowledge management that exist in the literature there is a common theme that knowledge management involves a combination of social and technological systems. Bhatt (8) posits that overemphasizing one over the other engenders a bias that can prevent the benefits of knowledge management from being fully realized. Often the greatest hurdle for many firms attempting to implement a

knowledge management strategy is the culture change required, i.e., a switch from a culture of knowledge hoarding to one of knowledge sharing. Consulting and research organizations, in contrast, often promote and encourage knowledge sharing since knowledge in and of itself is commonly the "product" offered to clients. This is not to say that such firms always and entirely operate within a knowledge-sharing culture, but in general, the preponderance of a knowledge-sharing paradigm among "knowledge workers" is one way of differentiating such firms from other more hierarchical organizational structures (9). Hewlett Packard is an example of a firm that has prided itself as a knowledge-sharing organization (15, 32). Because of this distinction between traditional hierarchical organizations and consulting organizations, the culture change efforts required by many traditional organizations trying to foster knowledge sharing demand as much, if not more, attention to the social components of knowledge management than to the technological components. In contrast, knowledge management efforts within consulting and research firms often can place more emphasis on the technological component of knowledge management than other types of organizations. The unique characteristics of the work performed by such firms which often revolve around projects rather than transactions requires a technological support structure that permits the creation and sharing of knowledge that is both tacit (deep, experiential knowledge that is often difficult to replicate and imitate) and explicit (routine, functional knowledge that is much easier to capture, codify, and imitate than tacit knowledge). It is the intensity of the symbiotic relationship between explicit and tacit knowledge that forms the core-competencies of an organization and offers sustainable advantages to the company (16, 18). All organizations benefit from leveraging both their tacit and explicit knowledge; however, consulting and research firms by their nature benefit more from an ability to disseminate tacit knowledge. According to Fry (21), tacit knowledge is the key to what corporate clients pay for and what knowledge management's ultimate focus should be, especially for consulting and research firms whose objective is often to harness, harvest, and disseminate the tacit knowledge that exists among its knowledge workers.

In this paper we outline the characteristics of consulting and research firms that differentiate them for traditional transaction processing businesses to underscore the unique knowledge management technological requirements for such firms. We then discuss a sample of frameworks for knowledge management provided in the literature and synthesize the key characteristics essential for the development of a knowledge management technology architecture that can address the specific demands of managing knowledge in consulting and

research firms. Finally, we present a Web portal-based knowledge management architecture and discuss its components and their impact on supporting the management of knowledge within consulting and research organizations.

AN OVERVIEW OF CONSULTING AND RESEARCH ORGANIZATIONS

A consulting and research based organization could be defined as one whose primary objective is the answering of questions. The question may take many forms consisting of "how" or "why" or "what" but they are questions nonetheless. Examples range from management and technical consulting to scientific research. These organizations are peopled by the classic "knowledge worker" and rely on levels of creativity, innovation, and expertise not seen in other organizations. An important element of organizational success is intellectual capital, which consists of such elements as skills, organizational culture, client relationships, and organizational processes. In addition, these organizations contain intellectual property consisting of patents, copyrights, trade secrets, and brands.

Typically, consulting and research organizations are given projects or problems in which one or more questions are embedded. A typical scenario is as follows.

1. A research or consulting problem is posed internally or by a client in the form of a request for proposal (RFP) or a similar document.
2. Negotiations commence to establish feasibility, cost, and deliverables and a proposal is created.
3. Upon proposal acceptance, a team is formed and a leader is appointed.
4. A detailed budget is produced and resources authorized.
5. A plan is created containing a timeline, milestones, a completion date, a set of objectives, and a monitoring process.
6. Team members carry out specific tasks, collaborate with other team members, and report interim results.
7. A product consisting of a report, prototype, patent, or a discovery is released.

The scenario follows a project life cycle consisting of initial customer contact, proposal creation, proposal acceptance, assignment and completion of tasks, and the creation of the final deliverable.

These organizations have varying levels of hierarchical control but are usually less hierarchical than most other

organizations. Team members and even team leaders may be pulled from other areas and their participation may only be on a part-time basis. The client often has intimate contact with the team and may exert final authority over the direction of the effort. Some organizations have become "virtual" by outsourcing much of the effort and using technology such as collaboration and videoconferencing tools to link all participants (17, 24, 31, 34). Essential characteristics of consulting and research organizations include the following:

- Personnel are the primary asset;
- Wisdom, expertise, teamwork, collaboration, and creativity are valued;
- The product is a solution, discovery, patent, or recommendation;
- To be effective, the organization must be adaptive and be able to learn;
- Projects are the focus of all effort and are usually time sensitive;
- There is extensive use of research tools.

Knowledge within these organizations consists of four elements as summarized in Table 1: internal knowledge, external knowledge, human resource knowledge, and project knowledge. Internal knowledge encompasses both knowledge of the internal processes and workings of the particular firm as well as both tacit and explicit knowledge accrued by workers through project experience and the collection of artifacts that document knowledge acquired and created through experience (10, 14). External knowledge includes information required to satisfy stakeholders such as governmental agencies as well as knowledge about market and other external forces on the firm's domain. Knowledge generated through client interaction also contributes to the firm's external knowledge base. In a consulting or research environment, human resource knowledge such as knowledge of the skill sets and experiences of workers is critical to optimizing project team formation. Knowledge of past project components, outcomes, lessons learned, etc., is very important in consulting and research organizations for a variety of reasons, not the least of which is to avoid reinventing the wheel every time a new project is undertaken. Access to project knowledge in varying degrees of granularity can expedite project completion, free the knowledge worker to focus more on innovation and less on "data collection and interpretation," and promote the kind of learning organization that is essential for successful knowledge management (3).

TABLE 1
The Knowledge Environment in Consulting and Research Organizations

<u>Internal Knowledge</u>	<u>External Knowledge</u>	<u>Human Resource Knowledge</u>	<u>Project Knowledge</u>
Formalized procedures	Client relationships	Personnel skills	Sponsorship
Informal personal relationships	Market and environmental factors	Current & past project membership	Project time factors
Organization structure and related information	Governmental relationships	Interests	Best practices for a project type
Specific skills	Outsourcing relationships	Funding	Budget management, monitoring
Past "Best Practices"		Publications	Security
Legacy data, information, reports, models, patents, and other artifacts		External relationships	Project management techniques, policies, procedures
		Workload, commitment	Financial audit practice
			Feedback mechanisms

Regardless of the nature of work within different organizational structures, the ability to adapt to change has

remained foremost as a critical success factor for modern organizations. The changes organizations have undergone are

mirrored in the evolution of technology, especially information technology. To address many of the issues facing organizations, especially consulting and research firms in which the knowledge that resides within individuals and teams is the primary organizational asset, technology has evolved to support the need for workers to transform data into information and information into knowledge, across time and space, among remote teams, and outside the traditional boundaries of an organization (23). Knowledge management could not be very successful without a universally accepted network such as the Internet which has created an opportunity for firms to establish collaborative networks of teams and partners with whom they can exchange

knowledge to achieve mutually beneficial objectives. These "e-knowledge networks" (27) could not have existed a few years ago. The technology of the Internet has become the greatest enabler of knowledge exchange within and between companies (25, 28, 29). The increase in inter- and intra-organizational knowledge sharing capabilities has been brought about by the Internet-driven "new economy" technologies (35). Table 2 shows a chronology of the movement from a data-centric, IT orientation, to the present Web-based information infrastructure environment that is necessary to support and enable knowledge management.

TABLE 2
A Brief Chronology of Knowledge Management Efforts

<u>Period</u>	<u>Orientation</u>
1960s	Data-centric, IT orientation Knowledge captured in forms, reports and databases
1970s	Information-centric, MIS orientation Data converted to information via ad hoc database queries, graphics, and presentations
1980s	Decision Support DSS Orientation Knowledge encapsulated in models and simulations; more sophisticated statistical applications
1990s	Web-based knowledge support Capture, organization, and dissemination of knowledge using the Web
2000s	Advanced Computation Techniques Convert information to knowledge using concept clustering, linking, and searching, ontologies, multimedia, AI, and others

The Internet alone, however, is not sufficient to enable knowledge management within consulting and research organizations. The objective of this research is to provide an architecture that demonstrates the integration of software, hardware, and network connectivity that will provide consulting and research firms with the ability to capture, store, access, disseminate, and apply organizational knowledge.

FRAMEWORKS FOR KNOWLEDGE MANAGEMENT

A number of frameworks have been proposed to classify the processes and components of knowledge management. Figure 1 (20) is a framework that classifies knowledge management tools in terms of five essential management processes. Each process can be satisfied by a software application or an organizational redesign. For example, the need for communication that entails sharing and collaboration might be satisfied by groupware products such as LotusNotes®, synthesis might be satisfied by data mining technology, and dissemination might be satisfied by Web push technology that provides a continuous stream of real-time information (26).

Another framework, developed by Nonaka and Takeuchi (29) and illustrated in Figure 2, consists of three component layers. The first layer (Project-team) at the top of the model facilitates team interaction. The model is based on the use of hypertext as a means of connecting team members to each other, to the next layer (Businesses-system), and to the bottom (Knowledge-base) layer.

Since their approach uses hypertext, it is applicable to a Web implementation as well as the addition of other advanced

computational tools. A Web portal approach would be a particularly suitable implementation of the top "Project-team" layer since a portal aggregates diverse applications with a uniform user presentation. The knowledge-base layer, composed of corporate culture artifacts, is particularly amenable to the use of tools used to capture, categorize, and display knowledge. Both of these frameworks are helpful in understanding the practical and theoretical considerations necessary to design a knowledge management system. Our proposed architecture incorporates elements of both frameworks. For example, it contains a search engine for gathering knowledge and components and tools that support knowledge storage, synthesis, and dissemination as well as providing a means for communicating knowledge among knowledge workers (Figure 1). Our three-tiered architecture also includes technology components that mimic the three-layered organizational model proposed by Nonaka and Takeuchi (Figure 2). In the following sections we present and describe the components of our proposed architecture to support the knowledge requirements of consulting and research firms.

Proposed Architecture

The advent of the Internet and the Web has created an opportunity to create an environment that will support the management of knowledge found in consulting and research organizations. Previously in Table 1, we proposed a framework for viewing knowledge requirements within these organizations from four separate but integrated perspectives: internal, external, human resource, and project perspectives. Consideration of

these perspectives must be part of a knowledge management architecture to support the work performed in such firms. Figure

3 represents these four knowledge requirement perspectives as input to such an architecture.

FIGURE 1
A Framework for Knowledge Management Processes [Fayyad, 1996 (20)]

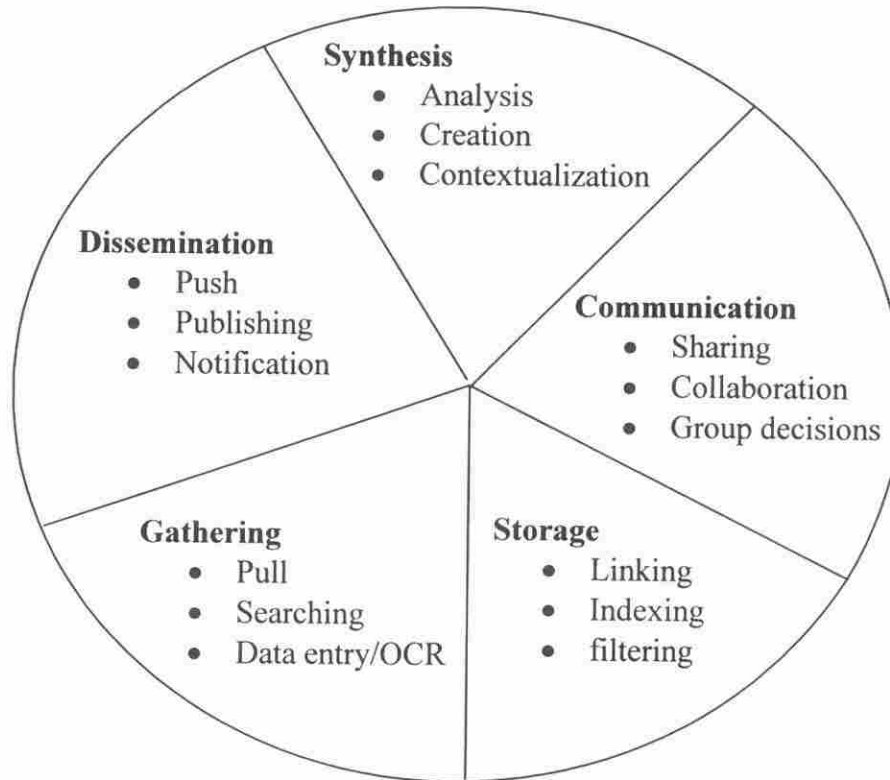


FIGURE 2
Hypertext Organization [Nonaka & Takeuchi, 1995 (29)]

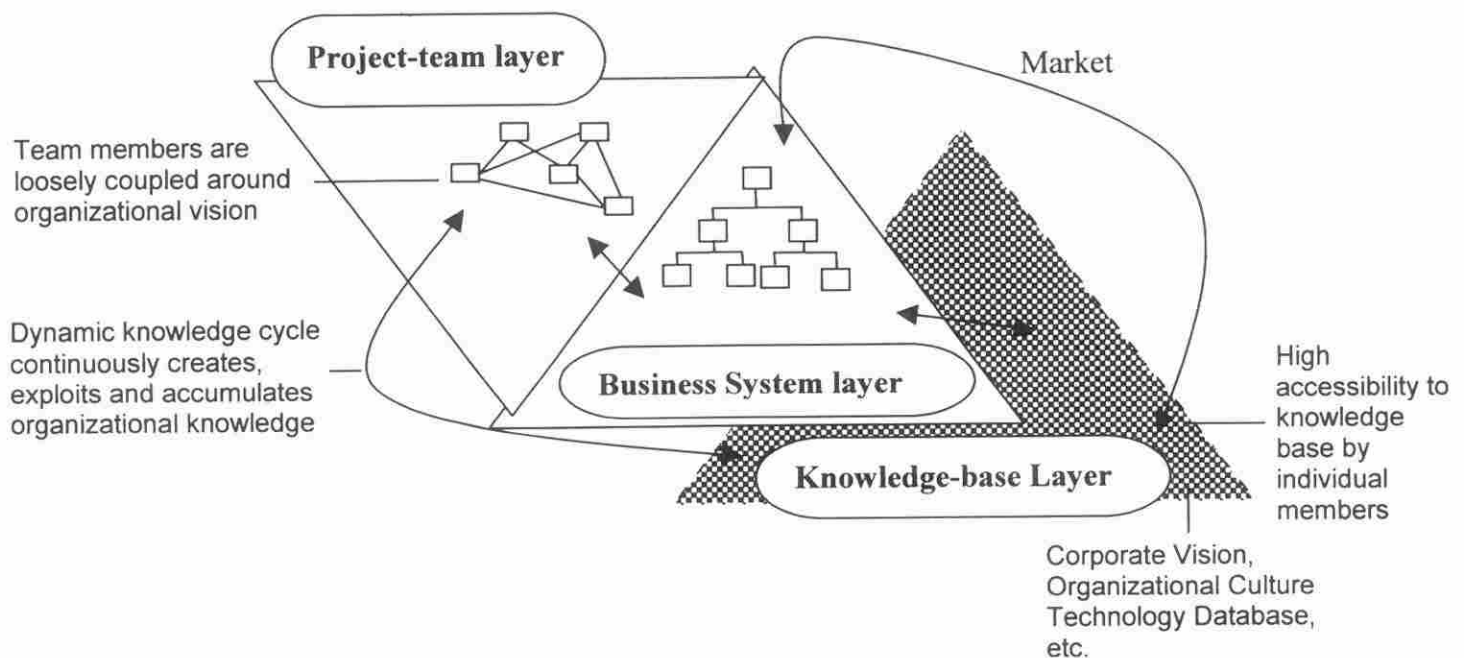
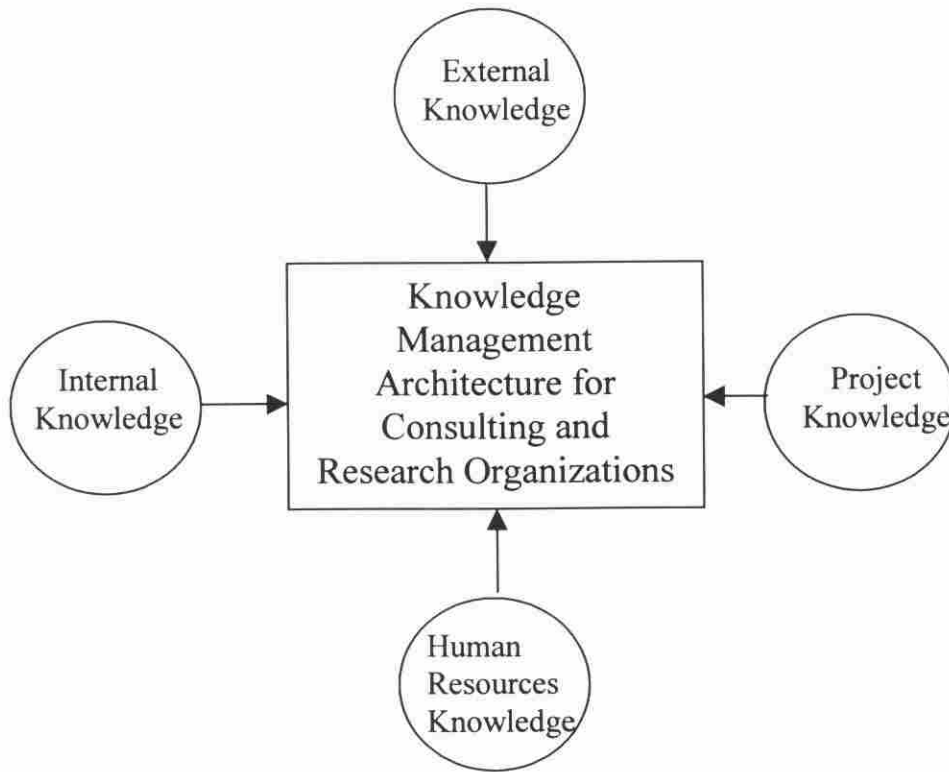


FIGURE 3
Inputs to Knowledge Management Architecture for Consulting and Research Organizations



The knowledge perspective inputs of Figure 3 and the knowledge management processes represented in Figure 1 are used as a basis for a knowledge management system employing advanced computational techniques used to capture and process the types of knowledge typical in consulting and research organizations. Figure 4 is a depiction of the technology components that make up the architecture.

This architecture is based on the concept of a "knowledge portal," a "knowledge server," and a software bus that integrates a variety of internal and external knowledge sources.

Knowledge Portal

The knowledge portal is the application that integrates and presents content from the knowledge server. It is the interface to the knowledge environment and it is the main entry point to the system presenting the user with a set of services, resources and tools required as part of the knowledge management process. A knowledge management Web portal incorporates the existing data and information centric approach found in traditional Web portals and adds knowledge management functionality. Examples of recent implementations of the concept can be found in such products as "AskMe Enterprise" from AskMe Corporation that focuses on employee knowledge sharing (4) and Portal-in-a-Box with IDOL (Intelligent Data Operating Layer) which is a knowledge content and capture portal from Autonomy, Inc. (5). The portal architecture proposed in this paper is a composite of some existing product approaches with some additional components.

Knowledge Server

The knowledge server is the application that supports the synthesis, communication, dissemination, gathering and storage of knowledge. It is contained in the middle tier and it communicates with other system components in the back tier via the software bus. It integrates the search engine, multimedia and groupware processors such that responses and requests for these functions can be handled uniformly. Typical interactions would include interactions such as requests to create a groupware session or requests for streaming media connections, or a request for an advanced natural language search.

Software Bus

The software bus is a common gateway used to pass messages and data among all software components found in the middle and back tiers. It provides a common centralized resource for locating software components and routing communication and control through well-regulated channels (1). Typically a software bus consists of a protocol and a set of libraries that allow applications to broadcast information through text messages. Like a hardware bus, message traffic is continuous but applications can only understand those messages directed at them. The technique is useful when an application consists of a "federation" of distributed applications that must communicate with one another. The approach is sometimes known as "publish-subscribe notification service" or "message-oriented middleware" (12).

created from the terms in the vocabulary and knowledge is encapsulated in the expressions. Ontologies provide a shared and common understanding of a domain that can be communicated among people and across application systems (33). An "ontology engine" is used to translate project information into a set of expressions, which can be queried, checked for logical consistency, and used to create additional knowledge.

These activities are part of an emerging technique known as "ontological reasoning." An example of the use of this technique is the creation of a project. As project resources are allocated they can be checked against knowledge about the project and its required resources. A human resource might have an associated expression such as "Fred Jones IS-ASSIGNED 20 HOURS-PER-MONTH to PROJECT-ID D451." The expression is matched against existing expressions describing Fred Jones' workload and the project requirements. If Fred Jones' workload has been exceeded or there is a skills mismatch with the project, then a logical discrepancy is created. Extensible Markup Language (XML) is used to store the expressions (IS-ASSIGNED, HOURS-PER-MONTH, and PROJECT-ID), which consist of a set of XML tags. Indexes act as pointers to a variety of resources including XML pages, key fields in databases, and meta data.

Index Repository. The index repository holds the result of indexing the contents of the multimedia, organizational artifacts, and human resources databases/repositories. Some indexes will represent meta data in the sense that the index only reveals the location of the data category. This location will have to be further searched to get the specific information.

Ontology Repository. This repository contains a set of expressions that are used to form organizational knowledge. The expressions are created using a lexicon developed for specific aspects of the knowledge environment. In the consulting and research environment, this would consist of such elements as project facts, procedures, constraints, and other knowledge components pertinent to project development and management.

Multimedia Repository. Much of the work of consulting and research organizations consists of meetings, conferences, and discussions. Ideally, these events can be captured and stored in a multimedia repository. The concept has been proposed as an attractive method for knowledge capture (11, 19, 30). Entries in the repository would be indexed by the index engine and processed by the multimedia processor.

Human Resources Database. The HR database contains information about all people in the organization. The components needed to form project teams include employee skills, prior project membership, employee photographs, etc.

Organizational Artifact Repository. The purpose of the organizational artifact repository is to record all relevant data created within the organization. Essentially, it would be an XML based collection of such elements as documents, timetables, budgets, images, etc. It would be a form of organizational memory that would be indexable and searchable, from which knowledge could be extracted and shared.

Middle Tier

The middle tier represents a Web tier that connects the portal to the Internet and the Web. The portal application is part of the Web tier and manages interaction with the following

components.

Groupware Engine. The groupware engine is responsible for providing collaboration facilities to the client tier via the portal. Services provided by the groupware engine consist of application sharing, a common whiteboard, a real-time chat facility, audio/video integration (via the multimedia processor), a group outliner, and a voting facility. The use of groupware to capture organizational memory has been well documented in the literature (2, 6, 13).

Multimedia Processor. The multimedia processor provides a set of services to handle typical digital video and audio functions. This includes handling a variety of protocols and media sources. Input to the processor would come from external sources on the Web as well as internal sources such as the multimedia repository.

Search Engine. A customized search engine is required to provide a set of services to search both internal and external text and multimedia sources. Its primary function is to shape queries to conform to the product of the index/ontology engine. Thus client input to the search engine could consist of either keywords or questions. Keywords searches are run against the index repository and questions against the ontology repository.

Client Tier

The client tier consists only of a standard browser. In an actual implementation additional client software would be required to handle multimedia protocols, a firewall, and other implementation specific functions.

A SCENARIO

The proposed architecture might best be described in a scenario based on its use in an engineering consulting firm. Typically, most contracts at such firms are the result of repeat business derived from a particular expertise. The proposed architecture supports each stage of the project life cycle through the access to internal and external knowledge contained in the following components.

1. A portal, which integrates the underlying application, provides a common view and is the interface to all functions. It is used throughout the project cycle.
2. An organizational artifact repository which contains documentary information about past customer relationships, contracts, and memoranda is used throughout the project cycle but is initially used to research the history of the organization's contact with the customer.
3. The HR Database contains information on personnel who have worked on previous contracts with the customer but is used throughout the project cycle. The initial team is constructed based on skill sets found within the HR database. Team members can be added or removed from projects as roles and project orientation changes.
4. The multimedia repository is searched for video or audio material relevant to the customer or the problem. This component is used throughout the project cycle.
5. Natural language questions about the customer and possible tasks can be posed via the search engine and matched against entries in the ontology, the HR database, and index repositories. Thus queries such as "show me all of the contracts involving packaging design for customer X" or "find the person in the organization that can answer questions about packaging problems encountered in the

application in question" can be posed by users and answered by the system.

6. External information sources about the customer, general industry news, etc., are accessible from the Web tier and are used throughout the project cycle.
7. Collaboration with other team members is accomplished via the groupware engine that enables a common whiteboard, application sharing, and interactive multimedia. This function is primarily used during the production phase of the project cycle.
8. Integrated desktop applications are used to create reports and presentations, monitor task progress, and manage project budgets.

CONCLUSIONS

Consulting and research organizations have knowledge management requirements centered on human resources, project artifacts, "lessons learned," formalized processes, collaboration, and external sources. An architecture to capture, store, disseminate and use knowledge is proposed in the paper. The architecture consists of a Web-based portal used to view and manage applications running on a knowledge server, a set of applications to manage and view multimedia, provide internal and external search capability, and support groupware activities. The architecture employs a "software bus" that provides connectivity to a set of repositories and databases which hold organizational artifacts, multimedia data, human resource information, an XML-based index and an ontology repository. An ontology repository is a text database consisting of statements written in a formal lexicon developed for a specific knowledge domain. It is a somewhat experimental knowledge representation technique but shows promise for the requirements of knowledge-intensive organizations. Nevertheless, the proposed architecture provides these organizations a viable means to create the first knowledge management system that is destined to evolve as their organizational learning processes continue. Our future efforts will focus on determining the feasibility of the proposed architecture and researching the organizational and process changes required to introduce the architecture into consulting and research organizations.

REFERENCES

1. Altherr, M., M. Erzberger, and S. Maffies. "iBus - A Software Bus Middleware for the Java Platform," **International Workshop on Reliable Middleware Systems**, October 1999, pp. 43-53.
2. Allee, V. "Chevron Maps Key Processes and Transfers Best Practices," April 1997, p. 3.
3. Armistead, C. "Knowledge Management and Process Performance," **Journal of Knowledge Management**, 3:2, 1999.
4. AskMe Corporation, 3290 146th Place SE, Suite D, Bellevue, WA 98007.
5. Autonomy Corp., 301 Howard St., 22nd Floor, San Francisco, CA 94105.
6. Bair, J. "Knowledge Management: The Era of Shared Ideas," **Forbes**, 1:1, (The Future of IT Supplement), September 22, 1997, pp. 28-7.
7. Bannon, L.J. and K. Kuutti. "Shifting Perspectives on Organizational Memory: From Storage to Active Remembering," **Proceedings of the 29th Hawaii International Conference on System Sciences (HICSS-29)**, 3, IEEE Press, 1996.
8. Bhatt, G.D. "Knowledge Management in Organizations: Examining the Interaction Between Technologies, Techniques, and People," **Journal of Knowledge Management**, 5:1, 2001.
9. Bhatt, G.D. "Organizing Knowledge in the Knowledge Development Cycle," **Journal of Business Transformation**, 4:1, 2000.
10. Bruner, J. *Beyond the Information Given: Studies in Psychology of Knowing*. In Arglin, J.M. (Ed.). W.W. Norton, New York, 1973, 12. **Business Week**, the Internet Age (Special Report), October 4, 1999, p. 13.
11. Carroll, J.M., S.R. Alpert, J. Karat, M.S.V. Deussen, and M.B. Rosson. "Raison d'Etre: Capturing Design History and Rationale in Multimedia Narratives," **Proceedings of the ACM CHI'94 Conference on Human Factors in Computing Systems**. New York: ACM, 1994, pp. 192-197.
12. Chatty, S. "The Ivy Software Bus: A White Paper," Centre d'Etudes de la Navigation Aérienne (CENA), Paris, France.
13. Conklin, E.J. "Capturing Organizational Memory," **Proceedings of GroupWare '92**, 1992.
14. Davenport, T. "Knowledge Management Case Study: Knowledge Management at Ernst & Young," Graduate School of Business, University of Texas at Austin, 1997.
15. Davenport, T. "Knowledge Management Case Study: Knowledge Management at Hewlett-Packard, Early 1996," 1997.
16. Davenport, T.H., D.W. DeLong, and M.C. Beers. "Successful Knowledge Management Projects," **Sloan Management Review**, 39:2, 1998, pp. 43-57.
17. Davidow, W.H. and M.S. Malone. **The Virtual Corporation**. New York: Harper Collins, 1992.
18. Dove, R. "A Knowledge Management Framework," **Automotive Manufacturing & Production**, 1998.
19. Dutton, W.H. "The Virtual Organization: Tele-access in Business and Industry." In DeSanctis, G. and J. Fulk (Eds.). **Shaping Organizational Form: Communication, Connection and Community**. Newbury Park, CA: Sage, 1999.
20. Fayaad, et al. "Knowledge Discovery and Data Mining: Towards a Unifying Framework." In Simoudis, E., J. Han, and U. Fayyad (Eds.). **Proceedings of KDD'96 Second International Conference on Knowledge Discovery & Data Mining**. Menlo Park, CA: AAAI Press, 1996, pp. 82-88.
21. Fray, R. "Corporate Knowledge Management," www.elearning.com, 2001.
22. Gruber, T. "A Translation Approach to Portable Ontologies," **Knowledge Acquisition**, 5:2, 1999, pp. 199-220.
23. Hackney, R., J. Burn, and G. Dhillon. "SPECS: A New Approach to Strategic Planning for E-Commerce Systems," **Proceedings of the Americas Conference on Information Systems**, 2000.
24. Hedberg, B., G. Dahlgren, J. Hansson, and N-G. Olve. **Virtual Organizations and Beyond: Discover Imaginary Systems**. New York: Wiley, 1997.
25. Holsapple, C.W. and M. Sawhney. "From E-commerce to E-knowledge," **Proceedings of the Americas Conference on Information Systems**, 2000.
26. Holt, C.C. "Organizations and Organizational Support Systems of the Future: Joint Design of Organizations and Computer-Communication-Information Systems." In Phillips, F.Y. (Ed.). **Thinkwork: Working, Learning and Managing in Computer-Interactive Society**. Westport, CT: Praeger, 1992.

27. Lea, M., T. O'Shea, and P. Fung. "Constructing the Networked Organization: Changing Organizational Forms and Electronic Communications," **Organization Science**, 6:4, 1995, pp. 462-478.
 28. Marshall, C. and D. Novick. "Conversational Effectiveness and Multi-media Communications," **Information Technology and People**, 8:1, 1995, pp. 54-79.
 29. Marshall, P. and J. McKay. "Rethinking Information Systems Planning in Strategic Business Networks," **Proceedings of the Americas Conference on Information Systems**, 2000.
 30. Nonaka, I. And T. Hirotaka. **The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation**. Oxford Reference Book Society, 1995.
 31. Phillips (Ed.). **Thinkwork: Working, Learning and Managing in Computer-Interactive Society**. Westport, CT: Praeger, 1992.
 32. Sietoff, C.G. "If Only HP Knew What HP Knows: The Roots of Knowledge Management at Hewlett-Packard," **Journal of Knowledge Management**, 3:1, 1999.
 33. Uschold, M. "Building Ontologies: Towards a Unified Methodology," **Proc. Expert Systems 96**, Cambridge, December 16-18, 1996.
 34. Venkatraman, N. and J.C. Henderson. "Real Strategies for Virtual Organizing," **Sloan Management Review**, Fall 1998, pp. 33-48.
 35. Warkentin, M., V. Sugumaran, and R. Bapna. "E-knowledge Networks for Interorganizational Collaborative E-business," **Logistics Information Management**, 14:1/2, 2001.
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