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Integrated Analysis and Design of Knowledge Systems and Processes

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Although knowledge management has been investigated in the context of decision support and expert systems for over a decade, interest in and attention to this topic have exploded recently. But integration of knowledge process design with knowledge system design is strangely missing from the knowledge management literature and practice. The research described in this chapter focuses on knowledge management and system design from three integrated perspectives: 1) reengineering process innovation, 2) expert systems knowledge acquisition and representation, and 3) information systems analysis and design. Through careful analysis and discussion, we integrate these three perspectives in a systematic manner, beginning with analysis and design of the enterprise process of interest, progressively moving into knowledge capture and formalization, and then system design and implementation. Thus, we develop an integrated approach that covers the gamut of design considerations from the enterprise process in the large, through alternative classes of knowledge in the middle, and on to specific systems in the detail. We show how this integrated methodology is more complete than existing developmental approaches and illustrate the use and utility of the approach through a specific enterprise example, which addresses many factors widely considered important in the knowledge management environment. Using the integrated methodology that we develop and illustrate in this article, the reader can see how to identify, select, compose and integrate the many component applications and technologies required for effective knowledge system and process design.

KNOWLEDGE MANAGEMENT AND SYSTEM DESIGN

The power of knowledge has long been ascribed to successful individuals in the organization, but today it is recognized and pursued at the enterprise level through a practice known as knowledge management (Davenport and Prusak, 1998). Although knowledge management has been investigated in the context of decision support systems (DSS) and expert systems (ES) for over a decade (Shen, 1987), interest in and attention to this topic have exploded recently. For example, knowledge capital is commonly discussed as a factor of no less importance than the traditional economic inputs of labor and finance (Forbes, 1997), and the concept *knowledge equity* is now receiving theoretical treatment through research (Glazer, 1998).

Many prominent technology firms now depend upon knowledge-work processes to compete through innovation more than production and service (McCartney, 1998), and Drucker (1995, p. 271) writes, "knowledge has become the key economic resource and the dominant—and perhaps even the only—source of comparative advantage." This follows his assertion that increasing knowledge-work productivity represents the great management task of this century, on par with the innovation and productivity improvements made through industrialization of manual-work processes (Drucker, 1978). Brown and Duguid (1998, p. 90) add, "organizational knowledge provides synergistic advantage not replicable in the marketplace." Indeed, some forecasts suggest knowledge work (e.g., performed by professionals and managers) will account for nearly 25% of the workforce soon after the 21st century begins (Labor, 1991). And partly in anticipation, fully 40% of Fortune 1000 companies claim to have established the role of Chief Knowledge Officer (CKO) in their companies (Roberts, 1996). Miles et al. (1998, p. 281) caution, however, "knowledge, despite its increasing abundance,

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may elude managerial approaches created in 20th century mindsets and methods."

In fact, knowledge is proving difficult to manage, and knowledge work has been stubbornly resistant to reengineering and process innovation (Davenport, 1995). For one thing, Nonaka (1994) describes knowledge-creation as primarily an individual activity, performed by knowledge workers that are mostly professional, well-educated and relatively autonomous, often with substantial responsibility in the organization. They tend to seek and value their relative autonomy and often resist perceived interference by management in knowledge-work activities (Davenport et al., 1996). Moreover, substantial, important knowledge is tacit, unstructured (Nonaka, 1994) and external to the organization (Frappaolo, 1998). This can greatly impede the identification, acquisition, interpretation and application of such knowledge. Also, corporate knowledge has historically been stored on paper and in the minds of people (O'Leary, 1998). Paper is notoriously difficult to access in quantity and keep current on a distributed basis, and knowledge kept in the minds of workers is vulnerable to loss through employee turnover and attrition. Vulnerability to such loss of knowledge is exacerbated by recent waves of downsizing associated with reengineering (McCartney, 1998) and the constrained labor markets affecting many professions (especially information technology and software engineering).

Moreover, most information technology (IT) employed to enable knowledge work appears to target data and information, as opposed to knowledge itself (Ruggles, 1997). We feel this contributes to difficulties experienced with knowledge management to date. Knowledge, almost by definition, lies at the center of knowledge work, yet it is noted as being quite distinct from data and information (Davenport et al., 1998; Nonaka 1994; Teece, 1998). Drawing from Arrow (1962) and others, we understand that even information economics has many important differences from standard economic theory (e.g., negligible marginal costs, network externalities, consumption without loss of use), but our understanding of *knowledge economics* is entirely "primitive" (Teece, 1998).

Further, extant IT used to support knowledge management is limited primarily to conventional database management systems (DBMS), data warehouses and mining tools (DW/DM), intranets/extranets and groupware (O'Leary, 1998). Arguably, just looking at the word "data" in the names of many "knowledge management tools" (e.g., DBMS, DW/DM), we are not even working at the level of information, much less knowledge. And (especially Web-based) Internet tools applied within and between organizations provide a common, machine-independent medium for the distribution and linkage of multimedia documents, but extant intranet and extranet applications focus principally on the management and distribution of information, not knowledge per se. Although a great improvement over previous stove-piped systems, islands of automation and other information systems maladies, as Nonaka (1994, p. 15) states, such "information is [just] a flow of messages," not knowledge.

Groupware offers infrastructural support for knowledge work and enhances the environment in which knowledge artifacts are created and managed, but the management of knowledge itself remains indirect. For instance, groupware is widely noted as helpful in the virtual office environment (e.g., when geographically-dispersed knowledge workers must collaborate remotely) and provides networked tools such as shared, indexed and replicated document databases and discussion threads (e.g., Lotus Notes applications), as well as shared "white boards," joint document editing capabilities and full-duplex, multimedia communication features. These tools serve to mitigate collaborative losses that can arise when rich, face-to-face joint work is not practical or feasible, and groupware can facilitate the reuse of knowledge-work artifacts (e.g., successful consultant proposals, presentations and analyses).

However, as we learned through the painful, expensive and failure-prone "first wave" of reengineering (see Cypress 1994), simply inserting IT into a process in no way guarantees performance improvement. Indeed, many otherwise successful and effective firms experienced process *degradation* as the result of reengineering (Caron et al., 1994; Hammer and Champy, 1993). This point is underscored by Hammer (1990), who colorfully refers to such practice as "paving the cowpaths" and "automating the mess" (e.g., making a broken process simply operate broken faster).

Drawing all the way back to Leavitt (1965) and others (Davenport, 1993; Nissen, 1998), new IT needs to be integrated with the design of the *process* it supports, which includes consideration of the organization, people, procedures, culture and other key factors, in addition to technology. Such integration of knowledge process design with knowledge system design is strangely missing from the knowledge management literature and practice. And what about the information systems (IS) methodologies, techniques and tools used to design and implement knowledge systems? Are they the same, familiar ones employed over the decades for databases, transaction process systems, expert systems, groupware and other applications? Should they be? These are some of the critical knowledge management questions addressed through this article.

The research described in this article is focused on knowledge management and system design from three integrated perspectives: 1) reengineering and process innovation, 2) expert systems knowledge acquisition and representation, and 3) information systems analysis and design. We integrate these three perspectives in a systematic manner, beginning with analysis and design of the enterprise process of interest, progressively moving into knowledge capture and formalization, and then system design and implementation. Thus, we offer an integrated approach that covers the gamut of design considerations from the enterprise process in the large, through