The Co-Evolution of Design and User Requirements in Knowledge Management Systems: The Case of Patent Management Systems

Tony R. Briggs
Department of Information Systems, Boston University School of Management
595 Commonwealth Avenue, Boston, MA 02215
Phone: 617 595-3305; Fax: 617 353 5003
Email: tbriggs@bu.edu

Bala Iyer
Technology Operations and Information Management Division
F. W. Olin Graduate School of Business, Babson College
231 Forest Street, Babson Park, MA 02457
Phone: 617 353 4402; Fax: 617 353 5003
Email: biyer@babson.edu

Paul R. Carlile
Department of Information Systems, Boston University School of Management
595 Commonwealth Avenue, Boston, MA 02215
Phone: 617 353 4287; Fax: 617 353 5003
Email: carlile@bu.edu

Revised on July 31, 2006

The Co-Evolution of Design and User Requirements in Knowledge Management Systems:

The Case of Patent Management Systems

Tony R. Briggs is a doctoral student in Information Systems at Boston University's Graduate School of Management. He holds an M.S. from MIT, where he researched the impact of patent constraints on innovation, and also assisted in the design of the Intellectual Property Owners Association and the Licensing Executives Society surveys. He also holds an MBA from University of British Columbia, and a B.Sc. Hons. in Biochemistry from the University of Alberta. He was a patents licensing officer in Canada and the US, most recently at Harvard Medical School, and has consulted with numerous U.S. SBIR grant companies on patents licensing and technology strategy. His research examines how information is shared and assessed under highly novel conditions. He conducts related work on the patent system as a knowledge system.

Bala Iyer is an Associate Professor of Management Technology Operations and Information Management Division, Babson College. He received his Ph.D. from New York University with a minor in computer science. His research interests include exploring the role of IT architectures in delivering business capabilities, designing knowledge management systems, querying complex dynamic systems, and designing model management systems. Recently, he has begun to analyze the software industry to understand the logic and patterns of emergence of architecture. He has published papers in JMIS, California Management Review, CACM, CAIS, Decision Support Systems, Annals of Operations Research, Journal of the Operational Research Society and in several proceedings of the Hawaii International Conference of Systems Sciences.

Paul R. Carlile is an Associate Professor of Management and Information Systems at Boston University's School of Management. His research has focused on how work "practices" structure knowledge differently and the characteristics of boundary objects that allow for the effective joint
construction of knowledge across specialized domains. Currently he is focusing on explaining the characteristics of the social and technical infrastructures required to mobilize and transform knowledge that leads to organizational and industrial change. His research has appeared in such journals as Administrative Science Quarterly, Management Science, Organizations Science and The Information Society. He received his Ph.D. in Organization Behavior from the University of Michigan.

The Co-Evolution of Design and User Requirements in Knowledge Management Systems: The Case of Patent Management Systems

Abstract:

Do the design requirements of a knowledge management system change over time? If so, how do these changes affect the users of the system? In this paper we explore the case of patent management systems (PAMS) to identify changes in knowledge management system design and user requirements over a 200 year period. Using a design science approach, we study 30 different implementations of PAMS across theoretically derived knowledge management (KM) problems. We find that while primitive forms of PAMS persist as modern system implementations, new design configurations co-evolved with new knowledge management problems and new user requirements. We conclude by suggesting that this co-evolutionary path is not unique to PAMS and suggest that a similar co-evolution is driving the development of new World Wide Web technologies.

Keywords: Knowledge Management Systems (KMS), Knowledge Management (KM), Design Science, Patent Systems, Decision Support Systems (DSS), Design, User Requirements, Evolution

The Co-Evolution of Design and User Requirements in Knowledge Management Systems: The Case of Patent Management Systems

INTRODUCTION

The knowledge-based view of the firm posits that knowledge resources allow organizations to achieve dynamic capabilities and competitive advantage (Kogut et al. 1992; Nonaka 1994; Nonaka et al. 1995). Organizations have invested in knowledge management systems (KMS) to capitalize on enhanced knowledge capabilities and many information systems suppliers serve this large industry (Alavi et al. 2001; Iyer et al. 2006). Increasingly, firms are developing their information systems to support more than just localized exploitation and internal integration, as firms are realizing that their competitive advantage can be realized through effective knowledge management (Carlile 2004; Orlikowski 1996; Venkatraman 1994). As KMS change over time, the question we explore is if changes in KMS design simply reflect an increasing information capacity of KMS, or are the designs and user requirements of the KMS reflecting requirement differences for different knowledge management (KM) problems?

In this paper we explore the role of patent management systems (PAMS) as a mechanism for managing knowledge claims across different theoretically derived KM problems. We do not address questions of the economic utility of patents, but rather consider how patent information is managed and used. Because patents can act as boundary objects (Carlile 2002; Star 1989), we propose that PAMS are designed to improve capabilities to access the information the patent describes, and improve the ability to use patent knowledge across knowledge boundaries. Using a design science approach (Hevner et al. 2004; March et al. 1995) we examine 30 historically important cases of PAMS across a theoretically derived KM problem space. We evaluate these 30 implemented PAMS artifacts using a simple decisions support system architecture analysis supplemented by historical case study and user scenarios. We find that PAMS design configurations addresses patent KM problems that co-evolve with specific user requirements. We demonstrate that these design configurations address new KM problems coincident with the increased size and complexity of patent system knowledge. We also demonstrate that these design configurations and user requirements have counterparts in other evolving knowledge systems like the World Wide Web.

This paper is organized in several sections. The paper begins in Section 2 with a review of the theoretical literature on knowledge and proposes a framework considering the role of information access and knowledge boundaries in KMS. In Section 3 we consider the use of the design science approach to examine PAMS and why the patent system affords a rich opportunity to understand how human agents have historically developed technologies and practices to understand knowledge claims. In Section 4 we examine PAMS artifacts, KM problems and users across four general knowledge management problems: (1) detailed retrieval, (2) clustering and combining, (3) searching and querying, and (4) abstracting and theorizing. We find that PAMS artifacts are developed in a co-evolutionary fashion with user requirements that are driven by increases in the size and complexity of the knowledge system. In Section 5 we consider if the framework proposed is generalizable to other KMS designs and consider the case of the World Wide Web. Finally, we conclude with implications for KMS and PAMS design, the design science approach, and theories of knowledge management.

LITERATURE REVIEW

The emphasis on innovation and technology in developing competitive advantage has stressed the importance of knowledge as a key driver of firm competitiveness (Brown et al. 2001 ; Teece 1998; Teece et al. 1997). The use of knowledge has been posed as both a challenge and as an opportunity in the study of organizational success, particularly in how knowledge is codified, shared, and used (Brown et al. 1995; Hargadon et al. 1997b; Leonard-Barton 1995). Knowledge differences in firms occur because knowledge is imperfectly shared over time, as well as across people, organizations, and industries (Hargadon et al. 1997b). It has also been shown that firms differ in their abilities to overcome local search, rigidities and competency traps (Leonard-Barton 1995; March 1991; March et al. 1958; Nelson et al. 1982) and that developing new knowledge across organizational boundaries can be very difficult (Cohen et al. 1990; Rosenkopf et al. 2001). These challenges are confounded by the apparent paradox of knowledge, that knowledge can be both easily transferred, or leaky (Arrow 1969; Rosenberg 1990), but also can be very local and sticky (Brown et al. 1998; von Hippel 1994).

Two Dimensions of Knowledge – State and Relational

We can attempt to understand this paradox of knowledge by separating confounding dimensions of how knowledge is studied. While six different perspectives of knowledge have been identified (Alavi et al. 2001), for our purposes they will be simplified to two dimensions: (1) knowledge as a state property, and (2) knowledge as a relational property. When we view knowledge as (1) data and information, (2) as objects, or (3) as a condition of access to information (Alavi et al. 2001), we are treating knowledge primarily as a state property. The theoretical use of knowledge as a state property is fairly prevalent in economic views of knowledge (Arrow 1969; Rosenberg 1990; Shapiro et al. 1998). When we view knowledge as (4) a state of mind, (5) process, or (6) capability (Alavi et al. 2001) we consider knowledge more as a relational property. This relational view is more prevalent in organizational theories of knowledge (Carlile 2002), and can, for example, explain why knowledge can be very local and sticky (Brown et al. 1998; von Hippel 1994). While there are differences within these six categories that are interesting to explore, this simplification is sufficient for our analysis.

Unfortunately, theories on knowledge and theories on information are confounded. Rather than distract ourselves with this debate, we will define "knowledge" as information enacted by an agent, and define "information" as processed data that is independent of an agent (Alavi et al. 2001). Following this view, a knowledge management system, enabled through information technology, would be defined by combining (1) the state properties of information with agents and (2) the relational properties of information with agents.

The State View of Knowledge and Information Access

For an agent to use state properties of knowledge that agent must be able to access information. Four of the six perspectives of knowledge management make this simple implication explicit suggesting that the role of KMS may be to (1) provide source access, (2) gather, store, and transfer, (3) provide effective search and retrieval, and (4) extend assimilation of information (Alavi et al. 2001). However, information technology theory rarely considers even a subset of the many barriers that exist for information access in practice (Table 1). Because of these access barriers, KM systems are highly dependent on the ability of an agent to practically get access to information.

The Relational View of Knowledge and Information Novelty

Overcoming information access barriers do not necessarily improve how individuals share and use knowledge (Ackoff 1967). The challenge of knowledge transfer from other sources, and across organizational boundaries, is core to the performance of technology intensive firms and a core mission of knowledge management systems. The critical function of this transfer is dependent on more than just how information is distributed. When agents are highly differentiated and heterogeneous, and they interpret different meanings in communication, the process of knowledge transfer can be difficult to acheive. To address the challenges of distributed intelligence across multiple actors, metaphors relating to individual use of information does not inform the social phenomena of how communities create common understanding (Star 1989; Star et al. 1989). Instead, barriers to knowledge integration across boundaries are best addressed by considering how knowledge transfer limits the achievement of community goals such as organizational problem solving, or the development of complex technologies (Carlile 2002).

The sharing and accessing of knowledge across boundaries can be examined using an integrative framework based on syntactic, semantic and pragmatic boundary categories (Carlile 2004; Shannon et al. 1949). These categories are represented by the increasing scale of effort necessary to effectively communicate over domains. Syntactic information processing boundaries are the most commonly discussed in product development (Brown et al. 1995) and describe “knowledge transfer.” Knowledge transfer occurs in cases where there is a shared syntax between the knowledge sender and the receiver. When this type of boundary is addressed, the context of the knowledge is understood and the key challenge is in processing, storage, and retrieval. Semantic boundaries are more challenging than syntactic boundaries as increased novelty in the knowledge can create interpretive differences across the domain. In semantic boundaries, the sender and receiver must develop a common language so that knowledge sent across the domain is translated, either in meaning (Dougherty 1992) or in interest (Brown et al. 1995), for the receiver. Mechanisms for overcoming semantic boundaries in technology development include using knowledge brokers or technological gatekeepers (Allen 1977; Hargadon et al. 1997a), co-location, or cross-functional teams. More complex than semantic boundaries, pragmatic boundaries are the most challenging to overcome and require the most investment (Carlile 2004). Pragmatic boundaries require the transformation of knowledge under conditions where novelty introduces different incentives, potential outcomes, or 'stakes' for the actors involved. For example, the same data can mean different things to a prosecuting lawyer that to a defending lawyer. Similarly, different organizations will necessarily react differently to similar information. Pragmatic boundary spanning includes all the challenges faced at the other boundaries, but the political process of transforming knowledge across a pragmatic boundary can benefit some actors at the expense of others.

A Framework for Examining Knowledge Management Systems

In this paper we explicitly consider the degree of novelty encountered, a measure sensitive to the user's relational use of the information, with the cost of information access, a measure sensitive to a state view of information. We suggest four workflow problems for different types of knowledge practices: 1) When information access costs are low and information is not contested across relational boundaries, an agents knowledge practice is oriented towards the detailed retrieval of information; (2) when information access costs are low, but novelty causes information contests across relational boundaries, knowledge practice is oriented towards overcoming differences in knowledge boundaries through the clustering or combining of information; (3) when information access costs are high and information is not contested across relational boundaries, an agents knowledge practice is oriented towards searching and querying difficult to access information, and (4) when information access costs are high and novelty causes contests across relational boundaries, an agents knowledge practice is oriented towards both simultaneous searching and clustering knowledge practices.

To simplify the above framework, we could create an analogous framework by considering information as data (state) and models (relational). Some data is easy to access, some very difficult. Similarly, some models are shared, while some models are contested. When data to solve a KMS problem is easy to access, KMS can support either the detailed retrieval of data when the model is shared, or to combine the data to identify knowledge differences across models. When data is difficult to access but models are shared, KMS can support search and querying for shared models. When data is difficult to access and models are contested, KMS can support the abstraction and theorizing about contested model boundaries. In this paper we examine KMS artifacts and their use across this theoretically derived problem space to inform both KMS design and theories of knowledge management.

RESEARCH APPROACH

Our approach will be to examine general knowledge management problems comparing multiple artifacts, some implemented in different temporal contexts. Using a simple KM problem framework (Figure 1) and design science approach (Hevner et al. 2004; March et al. 1995) we choose to examine primitive and modern knowledge management artifacts to identify the use of fundamental KMS design elements. Similarly, we choose to examine KMS that address persistent, and often wicked (Hevner et al. 2004), KM problems, including conditions of low and high information access, and low and high novelty. A setting which satisfies these requirements is the use of PAMS for US Patent information, a setting where technologies are employed to address one of the most established systems of knowledge claims (September 17, 1787, Article I, Section 8, US Constitution). We address our research approach and setting below.

Integrating Design Science and Natural Science Research

Information technology researchers have identified distinctions between design science and natural science research activities. Whereas design science research is oriented towards building and evaluating artifacts, and natural science research is oriented towards discovery and justification of theories, '*IT research should be concerned both with utility, as in design science, and with theory, as a natural science'* (March et al. 1995). In this paper, we consider the building and utility of artifacts using a broad theoretical KM problem framework.

We begin with a foundational theory of a KM design problems and develop our paper along design science guidelines (Hevner et al. 2004). We are explicitly oriented toward the design elements of artifacts, in both their "*instantiations… not as independent of people or the organizational and social contexts in which they are used, but as interdependent and coequal with them in meeting business needs*" (Hevner et al. 2004). We examine 30 cases of instantiated artifacts, in a natural experiment, that solves KM problems for end-users. For each theoretically derived KM problem we identify which design elements of the instantiated KMS are used, and which design elements are peripheral to different end-users. We choose the case of KMS artifacts in the US Patent System, because a wide variety of artifacts that have been used to manage patent knowledge over the last 200 years (see Section 4 and Appendix 1), and because of the broad nature of the end-users (inventors, technologists, lawyers, patent examiners, entrepreneurs, business development and others). Because we study both current and historical Patent Management System (PAMS) artifacts in a historical context, it is not practical to build multiple instantiations of the artifact in different patent system contexts. However, as we will demonstrate in our analysis, only certain design elements of the instantiations are used given particular context of KM problems and end-user requirements. Because certain PAMS design elements are latent, or even absent, in different use cases, we are able to demonstrate variance across different PAMS architectures. As we describe below, changes in the patent system have over time resulted in several significant new KM problems.

The Case of Patent Systems as Knowledge Systems

For over 400 years a key argument towards the need for national patent systems was that economic protections provided by patents create the necessary incentives to induce inventors to disclose their new inventions and not keep them secret (Machlup 1950). It was argued that patents, regardless of their ability to induce new inventive activity, served to fund society's common technological knowledge. Thus, instead of inventors keeping their invention as a technical secret, the patent was seen as a contract between the inventor and society around the disclosure of new knowledge.

It is not the purpose of the paper to criticize the patent system, despite the fact that patent bashing has been well in fashion for at least the last 150 years (Machlup 1950). And while patents are not used well as knowledge artifacts, many knowledge artifacts are not used well (Carlile 2002). Given the significant cost of procuring a patent, a patent has a far greater chance of making an important knowledge claim than for example, a blog entry or a given email. Similarly, regardless of how poor the knowledge claims are constructed, these knowledge claims exist in vast quantity and complexity, with potentially highly significant implications to economic actors. Patent management systems are particularly interesting to study from a KMS perspective because PAMS are specifically designed to help agents make sense of knowledge claims.

The size of the current patent-base is enormous. In the US there are 6.5 million patents (the international Patent Cooperation Treaty (PCT) system, offers approximately 8,500,000 additional active international patents), which, unlike most texts, do have a minimum novelty, and non-obviousness requirement. This compares with other technical sources, for example, the US Patent and Trademark Office's 120,000 physical volumes of scientific and technical books in various languages, as well as 90,000 bound volumes of periodicals devoted to science and technology. Again, to consider scope conditions, the Library of Congress has 115 million items, the US Copyright Office has 41 million items, the National Library of Medicine has 5 million items, and the National Library of Agriculture has 3.3 million items. We consider the patent system a significant and important source of knowledge claims and examine how agents have historically developed technologies and practices to understand it.

THE ARCHITECTURE AND CO-EVOLUTION OF PATENT KNOWLEDGE MANAGEMENT SYSTEMS

In the following analysis we will examine a brief history of the patent system in relation to each of the theoretically derived KM problem space. We examine the design elements of the information technologies, or PAMS being applied, and the agents using those technologies. For each KM problem we consider the design implications for the PAMS artifact using common architecture of a decision support system (DSS). As we identify each different problem we will specifically address which of these components is affected by each KM problem and use case. In the last part of our analysis we compare the four KM problems over time and demonstrate that while different KM problems have very different PAMS architectures, the design of PAMS follow a path dependency related to the increasing complexity of the patent system. Interestingly as the patent system changes, new PAMS artifacts and KM problems co-evolve with relatively independent workflows and user requirements.

PAMS Design Considerations Following a Common DSS Architecture

Our analysis will examine PAMS by considering typical DSS design configurations at a level of abstraction slightly higher than a typical design science paper. We make this choice because, as we will demonstrate, different PAMS designs deemphasize or omit different DSS components. Our DSS analysis will consider the following common DSS components (Marakas 1999): (1) a database management system (DBMS) comprising of internal and external databases, potentially from other computer-based systems (Bonczek et al. 1981; Sprague et al. 1982), (2) a model management system (MMS) including internal and external models, internet, intranets, extranets, (Keen et al. 1978; Kottemann et al. 1992; Sprague et al. 1982), (3) a knowledge engine comprising of an organizational knowledge base, including data, model, and knowledge-base subsystems (Keen et al. 1978; Marakas 1999), (4) the user-interfaces (5) and the user (Marakas 1999).

In the context of PAMS, we are concerned with DSS design components that address patent information. PAMS DBMS components for example could manage either internal patent data (e.g. internal patent filings, technical notes, disclosure dates, internal evaluations, fees, legal costs, marketing efforts, licensing information), or external data (i.e. competitor patent information, product infringements, legal and technical opinions), or both. PAMS MMS components could manage internal models (e.g. preferred embodiments, cost and product projections, patent platform strategies, market claims, customer strategies, development or legal strategies), external models (e.g. estimates of competitor roadmaps, external patent claims, competitor intelligence, new market opportunities, new legal challenges), or both. The knowledge engine is impacted by the organizational use of the PAMS, namely what kind of decisions are informed by the PAMS within the context of the organization (e.g. is the organization examining patents, litigating patents, licensing patents, or getting patents?). The user-interface and user requirements are also key components of PAMS. Some PAMS offer extremely simple user interfaces (e.g. simple document retrieval) and others sophisticated visual interfaces (e.g. patent citation or landscape maps). Finally, PAMS are used by different users with different technical expertise and interests (e.g. inventors, patent examiners, patent agents, litigators, business development, and strategists). The question we address in this paper is given that all of these elements are salient with the introduction of patent information 200 odd years ago, do the design requirements and users of the PAMS artifact change over time?

Detailing/Retrieving

The introduction of the patent system in 1790 preceded the first set of complex patent claims by a just a few months. From its introduction, the patent system created a complex set of interests and knowledge claims across inventors, entrepreneurs, attorneys, organizations and governments. In 1790, technologies for writing, copying, and dissemination of patents were difficult to procure, However, in the broad sense, technologies to access patent information such as recording claim detail necessarily goes back to the very beginnings of the patent system. In the early years of the patent office, beginning in 1802 (Dobyns 1994), written records of patents were kept and each patent was recorded as a document with a unique single number identifier.

Storage and retrieval of patents was not trivial as the copying cost was quite high. Indeed, many patents have been lost forever. Some 34 years after the patent office was established, and after this ‘patent office’ underwent several moves from private home to private home, most early patents we lost in a huge fire (Dobyns 1994). Two fires later, the patent office began publishing summary patent information (number, name, abstract, and first claim) in an annual bound book called the Official Gazette. Information in the Official Gazette was organized by patent number which had no technical meaning. For this type of information storage, the practice of identifying a competitors patent was hard unless you sorted through all the active patents (there were only about 10,000 in 1830 so this was a formidable but not impossible task). Presumably patent search was not done frequently, and patent claims information was not readily accessible, leading to cases where, for example, Edison sued over 600 firms for using his core telegraph patent (Brooks 1975).

In the early history of the patent office, patent detailing and retrieving would have been the primary use of any PAMS when the knowledge system was small. We note that PAMS were not sufficient for patent retrieval for at least a few decades after patents were introduced. Knowledge management systems in the 1830 did not provide either clustering and combining technologies, or flexible search and querying technologies, to identify the presence of user relevant information. Nobody knew whether a lawyer, an entrepreneur, a competitor, or some other agent was going to use the patent information, or how they would use it, so the system was not designed to cater to any specific need. And while this probably seems like a strange way to discuss KMS, unfortunately many modern PAMS have very similar design characteristics.

Today many current technologies are hardly more sophisticated in their design that than the initial 1830 storage of documents in a house. Patents prior to 1975 are stored by the US patent office as unsearchable (but now partially categorized), untagged, very large, highly TIFF picture files that can only be read a page at a time. Like early patents, these files are only identifiable by the patent number. Until 2001, the USPTO still published the Official Gazette, before updating to another detailing/retrieving PAMS called the Electronic Gazette. The Electronic Gazette is a collection of image files comprising some 200+ DVD’s. As with online TIFF files, the DVDs are ordered by number, but are not text searchable or categorized. The Electronic Gazette is clearly a modern instantiation of a PAMS, comprising approximately of

130GB of past and current US patents stored at the Boston Public library. However, having been acquired Boston Public Library a year before we examined this collection, only 2 of 200 DVDs had ever been removed from their cellophane. Provided one had the patent number of interest it took about 4-5 minutes, to load the appropriate DVD (after removing the cellophane!) to view the patent image.

Relative to a decision support system framework, (Figure 2A) PAMS that are designed simply for retrieval and detailed information can be used by anyone, though not necessarily well. They are designed to retrieve detailed information that has a wide ranging audience. The design of these systems does not assume to assist the agent in either identifying new information, or in overcoming knowledge boundaries. Necessarily, design considerations do not address integrating external data, external systems infrastructure, and external models. Similarly, because the user context is unknown, or perhaps unknowable, the quality of the user interface does not address specific user requirements. For the most part, today's publicly available PAMS primarily consider only internal data, data management, internal model management, DSS components (Figure 2B).

Combining and Clustering

In 1879 the US Patent Office purchased some shoe drawers to organize patents that would later be referred to as the "patent shoes." By 1879 there were approximately 211,078 issued patents and because of this increase in the patent system size, it was getting increasingly difficult for patent examiners to examine new patent applications. The patent shoes were used by the examiners to sort the patents into similar technical categories so it would be faster to identify similarities and differences between issued patents and new applications. For example this lead to such famous categorizations schemes toothpaste container patents and manure spreader patents winding up in the same shoe (Schmookler et al. 1962). This PAMS example, while seemingly trivial, has the characteristics of a very long lived artifact (Hevner et al. 2004). Shoes have been used by patent examiners as a primary PAMS up until 2002, and have been effective for over 120 years. Indeed, certain consulting firms that are technical specialized, like Global Prior Art (personal communication with Dr. Bruce Rubinger, Global Prior Art, 2001), and technical attorneys that draft new patents, often find it faster to search through the shoes than through any existing computerized system.

However, while the shoes and other classification systems have been good for highly trained experts in one domain, they are very difficult to use across domains and knowledge boundaries. The USPTO's categories suit the USPTO's examiners KM practices, but hardly relate to how companies manage their knowledge. Toothpaste is not sold by the same companies that sell manure spreaders, and the patents clusters at the USPTO aren't how companies cluster their patents. While certain companies like Delphion provide PAMS that, for example, are collections that contain just biotechnology patents categorized by market application, they would still not be suitable for individuals inventing semiconductors with biotechnology applications. We suggest this can lead to a well known KM problem in patents popularized by Kevin Rivette and David Kline (Rivette et al. 1999) called the 'Rembrandts in the Attic' problem. The Rembrandts problem proposes that even in cases where companies have created the patents, a company may not have the appropriate models to sufficiently understand the value of their patents, and therefore some Rembrants can be found in certain patent portfolios.

Relative to our DSS framework, PAMS that are designed for combining and clustering information are best suited to highly expert technologists within a specific domain. They have specialized tools oriented to the particular type of expert use, and they help apply internal information to external models, thought the knowledge may not relate more broadly to the organizational knowledge base. The architecture of the US PTO's categorization technology allows internal data to be organized across different models of categorization (Figure 2B). While historically patent classification has been accomplished internally by just using USPTO shoes, external models have been introduced allowing for concordances with international classification patent schemes, or classification by firm. These PAMS allowing differences in pragmatics to limit the search space by clustering or combining internal information across internal and external models.

Searching and Querying

Patent thickets, or the anti-commons, present a knowledge management problem that is very different from the Rembrandt's problem. Patent thickets occur when too many patents assume priority to the same knowledge claim (Shapiro 2001). At some point, clustering and categorizing technologies are not sufficient to manage the scope or overlap of the knowledge claims, or the knowledge claims may be so fragmented that the categories become too narrow for a particular area of inquiry. For example, the US patent office has created a hierarchical technology categorization system that contains over 170,000 subclasses. When a user is looking for a technology that could be reasonably categorized in 10 different subclasses per patent, depending of different component choices, but is also described across 100 different patents, you could have an absurdly large search space across subclasses. Beginning in the 1980s, but more broadly available in the early 1990s, IBM created a free text searchable patent database so that people doing searching and querying could more easily span across category definitions. Other similar PAMS are offered by Derwent, Thomson, NERAC, and US PTO text database. More recently, genetic sequence mapping databases, which can be huge sequences of A, T, G, and C's, have aided in the searching and querying over extremely large and overlapping category domains.

Users of patent querying and searching technologies tend to be predominantly expert information gathering professionals. Interaction with these different databases can be challenging as they offer different types of information, with different information structures and unique information access challenges. The emergence of technologies and specialized expertise in this area has led to the formation of PIUG, the Patent Information Users Group in 1988. While free text searching allows for different groups of patents to be linked together based on semantic and syntactic similarities, it is difficult for information gathering professionals to also be expert on the use of the and strategic implications of the information. To this extent it is helpful for the KMS to help the expert information gatherer identify information that is more relevant to the organization.

Relative to a DSS framework, (Figure 2C) PAMS that are designed for searching and querying information are best suited to highly expert information gathering professionals across domains. User interfaces may vary across domains, so the information gathering expert is less sensitive to the interface, but must be aware of the organizational context for the PAMS to support the knowledge work. In this sense, PAMS that aid in search look to supplement internal, organizational knowledge with external, and hard to access information. An example of a technology from Derwent's patent service allows search experts to identify and extract very precise information across all patents quickly, and while avoiding the burden of acquiring all category patent information.

Abstracting and Strategizing

In the last ten or so years, new PAMS have emerged that enable very different perspectives of patent knowledge. Information challenges such as poor patents, diverse technical knowledge, overlapping markets, hidden ownership of patents, and other business challenges have made it very difficult for companies to sort through the volumes of data to identify emergent trends. Recently certain PAMS have emerged that help to simplify this problem such a patent networks, graph and landscape diagrams can be used to identify emergent, but otherwise hidden trends. These technologies are typically used by individuals with more general technology understanding, such as consultants or academics, and are less useful for technical specialists or attorneys that require detailed knowledge about specific technical domains.

Relative to a DSS framework, (Figure 2D) new PAMS have been designed to abstract and theorize from difficult to access information across knowledge domains. For these types of PAMS, the user interface is extremely important to help the user recognized new patterns that derive from poorly accessible information and across knowledge domains. The user, typically a consultant, entrepreneur, or academic will not be able to glean much from internal data, or models because this information will help to understand other models using unfamiliar information. In this sense, PAMS that aid in abstraction and theorizing assist KM problems where the details are far less meaningful than the total data and model landscape. An example of this type of technology would be Aurigin's (now Delphion's) patent service that allowed generalists to visualize emergent trends using a text-based multi-dimensional scaling technology. For this technology, the model emerges from other's patenting behavior rather than the user organization. IPVision offers another visualization technology which uses externally driven patent citation data to visualize between patent relationships.

While these PAMS are not designed to efficiently provide detailed information from a particular patent, they support important knowledge functions by identifying new competitor positions, emerging technological trends, firm complementarities, network influences and other abstract knowledge claims. These technologies tend to focus primarily on developing intuitive user interfaces, and often have models that emerge from patterns from external data sources.

Summary of PAMS Design and User Need Co-Evolution

A comparison of the 30 PAMS (Appendix 1) reveals significant differences in underlying architecture of the artifacts, and as described above, significant differences in the types of users. The PAMS artifacts also have a very different look and feel (Figure 4). For example, considering the simpler case of internal and external data, and internal and external models respectively, the earliest PAMS that emerge are primarily data repositories (circa. 1790) that seem to offer much in the way of raw data, but very little in the way of synthesis. The next PAMS that emerge (circa. 1879) are classification systems that offer a lot of synthesis, though only to highly trained technical users that understand the categories. As complexity overwhelms these PAMS, querying tools emerge (circa 1980s) that, can identify specific knowledge at low cost across, for example distributed data repositories and categories. However, these users tend to be highly trained search specialists. Finally, and more recently (circa. 1995), we see the emergence of PAMS that are designed to use external data and external, or emergent models. These PAMS enable generalist users, like consultants, strategists, or academics, to understand system wide knowledge at the expense of specific and detailed knowledge.

Returning to the more general framework with information access and information novelty challenges, PAMS offer some very interesting design insights.

First, the different PAMS architectures do not emerge simultaneously but instead in a path dependent manner. By examining historical and modern PAMS, PAMS technologies co-evolve with new user requirements arising from the complexity and scope of the patent system. By examining early PAMS systems, this result is clear. Category technologies, originally just simple boxes, now suites of software tools in some cases, arose only with the increasing complexity of the patent system. Similarly, abstraction technologies, such as citation maps, could have been drawn decades ago on paper, or even retrospectively introduced into patent repository PAMS today, but neither has happened.

The resistance of old technologies to incorporate the new technologies leads to our second insight, that the different PAMS architectures are remarkably persistent. Despite tremendous increases in our capacity to product, store, create and retrieve patents over the last 200 years, the PAMS repository artifacts, including the modern DVD versions of them, persist. New PAMS tend more complement existing PAMS than replace them, but interestingly new PAMS attract different end-users.

Our last insight is that the PAMS appear to co-evolve with end-users and their rather independent KM problem requirements. At the patent system gets larger end-users get increasingly specialized across different knowledge management problems requiring different PAMS functionalities and architectures (Figure 4). In firms that are highly sophisticated in patent knowledge management, patent KM problems are addressed by inventors, technologies with domain expertise, information searchers, and strategists, all of whom use different supporting PAMS.

Indeed, certain PAMS artifacts are more natural to different user communities. Technical specialists, like patent examiners, use categorization technologies and rarely patent maps.

Strategy consultants use patent maps, but infrequently use the distributed querying tools used by PIUG professionals and librarians. Patent agents use patent categories, whereas litigants tend to use specific patent claims. Commercially (Appendix 1), PAMS offerings are typically only designed to address one or two of the four identified KM problems, with the exception of Thomson Scientific which offers segmented products for different categories of end-users.

PAMS AND WORLD WIDE WEB EVOLUTION

While studying PAMS and patent system may seem like an unusual starting place to examine design opportunities for KMS, we believe that our findings are generalizable. For example, the early developments of World Wide Web (WWW) technologies were explicitly developed to solve the syntactic transfer problem. While early histories of the WWW identify it's origins in von Neumann's EDVAC Report of 1945, or Vannevar Bush's seminal 1945 essay 'As We May Think', early pre-instantiations of the WWW are considered to be Douglas Englebart's information retrieval system demonstrated in 1968 Fall Joint Computer Conference, and Ted Nelson's Xanadu system (Ceruzzi 2000). For these systems to function, protocols and addresses were manually linked and these links were used to find very specific information that was known to reside at particular locations. Beginning with Tim Berners-Lee, the WWW was born in late 1990 at CERN with the intent of detailed information retrieval. This intent was oriented to first retrieve information across computers and software of different types, through the use of Universal and Uniform Resource Locators (URL), Hypertext Transfer Protocol (HTTP), and Hypertext Markup Language (HTML), and second across text, image and other content, through early browsers like Lynx, Viola, Mosaic and Netscape (Ceruzzi 2000). These early WWW technologies were not designed to query, categorize, or analyze WWW information, but rather to retrieve detailed stored content at known addresses. Modern forms of these technologies persist. For example, many file hosting services, like rapidshare.de, putfile.com, and megaupload.com, explicitly have no content querying, categorizing, or analysis tools available to the user, but do offer a capacity to manage extremely large volumes of content (for example 360 Tb of storage and, 45Gb up/down transfer capabilities from rapidshare.de, July 26, 2006).

As address information became more available, and information itself became easier to access, hierarchical structures were used to group and organize information within a limited number of categories. Early portal technology did not start with distributed search technologies, but rather firms like Yahoo, helped make sense of the web by manually categorizing addresses. Yahoo’s website offers a description of this process:

“The two founders of Yahoo!, David Filo and Jerry Yang, Ph.D. candidates in Electrical Engineering at Stanford University, started their guide in a campus trailer in February 1994 as a way to keep track of their personal interests on the Internet. Before long they were spending more time on their home-brewed lists of favorite links than on their doctoral dissertations. Eventually, Jerry and David's lists became too long and unwieldy, and they broke them out into categories. When the categories became too full, they developed subcategories ... and the core concept behind Yahoo! was born….The name Yahoo! is an acronym for "Yet Another Hierarchical Officious Oracle..."” (http://docs.yahoo.com/info/misc/history.html, July 23, 2006)

Content providers like America Online and CompuServe also began by structuring categories of content to help users navigate WWW content. In the mid-1990s this technology was extremely important first because information in the WWW was so new and changing that often a user wouldn’t know *a priori* if an entity even had a web presence, and second because conventions for using the WWW were still evolving. We caution that our discussion is limited in that we are describing a history so near our own time, but we continue to see modern technologies that promise to offer increased capacity to cluster and categorize WWW information. Modern artifacts that orient towards clustering and categorizing include XML, meta-tags and the Semantic Web, and technologies like Really Simple Syndication (RSS) that allow users to choose categories of information without knowing specifically what information they are retrieving. As we describe elsewhere, while many technologies do combine for querying and categorizing functions together, there is a distinction between architectures that search by querying across the universe of WWW information, and technologies like Yahoo directories and RSS that use clustering and categorization to vastly reduce the search space of WWW information.

For a short period of time, technologies used for clustering and categorizing had their commercial advantages. However, as the WWW grew, like we discussed in the patent system, the scope of information increased the cost of using categories. Beginning with Lycos, launched in mid-1994 by Dr. Michael L. Mauldin and others at Carnegie Mellon University Center for Machine Translation , and later firms like DEC (Altavista), AskJeeves, Yahoo, and Google, have shifted to employ technologies that reduced the cost of the search and transfer problem. Spider and crawler technologies, which had in Lycos' case indexed 60 million pages by early 1996, allowed for highly syntactic search across a substantial amount of the existing WWW universe. However, these indexing tools, similar to library tools like card-catalogs, keyword bibliography searches and on-line document retrieval (Licklider 1965), are '*wonderfully helpful when you already know what documents you want, but if you're not sure where to look… the classic search techniques won't help much at all*' (Waldrop 2002).

Increasingly, as the WWW begins to address information problems that go beyond targeted search and move more towards pragmatic computing, we predict, as in the case of PAMS, the emergence of new abstraction tools that orient much more to the user interface. In the last few years, we have seen the emergence of early recommender systems that begin to identify information that the user did not know to look for. Recommender systems offered in DVD rental sites like netflix.com, consumer sites like amazon.com, and insurance sites like progressive.com, are designed to match difficult to access information, like user demographics and behaviors, with models of different interests, like user preferences. In these cases, KMS are offering increasingly customized user interfaces to reduce the sensitivity of system performance to either user querying capabilities or to fixed categorization technologies. Increasingly these interfaces are oriented less to specific querying or categorization technologies, and oriented more towards sophisticated visualization tools that increase the users ability to navigate information. More recently, in the last two years, we are beginning to see the emergence of mash-ups and other visualization tools that aid in pragmatic computing. On webMD.com, users looking to identify causes of health symptoms are directed to a diagram of a human that then links to searchable categories of content. Similarly, early visualizations tools like www.zillow.com, or mash-ups like housingmaps.com use both query and category search technologies to represent real estate opportunities and information dynamics in a given geographic area. It is important to note that zillow.com or housingmaps.com do not control the quality or type of data that they use, which are derived from external sources, nor do they impose inflexible models of the housing opportunities, which can be adjusted by the user to a certain degree. As with PAMS, we do not suggest that abstraction and visualization technologies ubiquitously perform better than others (e.g. compare google.com search to kartoo.com visual search), but rather that they are designed to meet new user requirements that co-evolve with the emergence of different types KM problems.

DISCUSSION

Our research findings have several important contributions for knowledge management theory, design science, and knowledge management systems.

First, we develop a simple KM problem framework that addresses two different views of knowledge: the state view where information access is paramount, and the relational view where information novelty and knowledge boundaries are paramount. We relate this framework to a historically important KMS, patent management systems, and demonstrate that different KM problems can emerge from a single knowledge system, requiring significantly different KMS architectures.

Second, we demonstrate that new PAMS design configurations co-evolve with new user requirements in a path dependent manner. We find that PAMS architectures that co-evolve complement existing PAMS architectures by addressing (1) different KM problems and (2) by appealing to different end-users. We find that once instantiated, general PAMS architectures are persistent in both design and use. As new macro-design elements are introduced in newer PAMS, they are not incorporated in older PAMS.

Finally, we consider the generalizability of our approach by comparing our results to a brief history of the WWW. We propose that KMS co-evolve across four general KM problems (1) detailed retrieval, (2) clustering and combining, (3) searching and querying, and (4) abstracting and theorizing, the last KMS of which is only beginning to emerge in the WWW.

There are several avenues for future research. First, while instantiations of PAMS are typically not fully integrated KMS systems, we are not in a position to know if this is strategically important. It may be KMS should be disaggregated for particular KM problems and so we see this in our PAMS case. However, it may also be that there are economies to fully integrated KMS that are unrealized because of path dependencies that are yet unexplored. Second, within each KM problem domain some PAMS are much more successful than others even thought they have similar architectures at our level of analysis. This is a classic design science problem that we have not yet addressed. Finally, while our research suggests how PAMS changed over a long historical period, systems like the WWW are evolving far quicker. As information generally becomes more available, it is still unclear it if (1) information is becoming more accessible (or if more junk web pages reduce information access), and (2) if novelty is becoming more assessable. An interesting direction would be to examine how these different categories and end-user requirements are changing over time.

REFERENCES

Ackoff, R.L. "Management Misinformation Systems," *Management Science* (14:4) 1967, pp 147-156.

Alavi, M., and Leidner, D.E. "Knowledge management and knowledge management systems: Conceptual foundations and research issues," *MIS Quarterly* (25:1) 2001, pp 107-136.

Allen, T.J. *Managing the Flow of Technology*, (1993 ed.) MIT Press, Cambridge (MA), 1977.

Arrow, K. "Classificatory Notes on the Production and Transmission of Technological Knowledge," *American Economic Review, Papers and Proceedings* (59) 1969, pp 29-35.

Bonczek, R.H., Holsapple, C.W., and Whinstonm, A. *Foundations of Decision Support Systems* Academic Press, 1981.

Brooks, J. *Telephone: The First Hundred Years* Harper and Row, New York, NY, 1975, p. 369.

Brown, J.S., and Duguid, P. "Organizing knowledge," *California Management Review* (40:3), Spr 1998, pp 90-108.

Brown, J.S., and Duguid, P. "Knowledge and organization: A social-practice perspective," *Organization Science* (12:2), Mar-Apr 2001, pp 198-213.

Brown, S.L., and Eisenhardt, K.M. "Product Development - Past Research, Present Findings, and Future-Directions," *Academy of Management Review* (20:2), Apr 1995, pp 343-378.

Carlile, P.R. "A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development," *Organization Science* (13:4) 2002, pp 442-455.

Carlile, P.R. "Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries," *Organization Science* (15:5), Sep-Oct 2004, pp 555-568.

Ceruzzi, P.E. *A History of Modern Computing* MIT Press, Cambridge, MA, 2000, p. 398.

Cohen, W.M., and Levinthal, D.A. "Absorptive-Capacity - a New Perspective on Learning and Innovation," *Administrative Science Quarterly* (35:1), Mar 1990, pp 128-152.

Dobyns, K.W. *The Patent Office Pony: A History of the Early Patent Office* Sergeant Kirklands Museum, Fredericksburg, VA, 1994, p. 249.

Dougherty, D. " Interpretive barriers to successful product innovation in large firms.," *Organization Science* (3:2) 1992, p 179–202.

Hargadon, A., and Sutton, R.I. "Technology brokering and innovation in a product development firm," *Administrative Science Quarterly* (42:4), Dec 1997a, pp 716-749.

Hevner, A.R., March, S.T., Park, J., and Ram, S. "Design science in Information Systems research," *Mis Quarterly* (28:1), Mar 2004, pp 75-105.

Iyer, B., Shankaranarayan, G., and Wyner, G.M. "Process coordination requirements: Implications for the design of knowledge management systems," *Journal of Computer Information Systems* (Forthcoming) 2006, pp 1-51.
Keen, P.G.W., and Scott Morton, M.S. *Decision Support Systems: An Organizational Perspective* Addison-Wesley, Inc., Reading, MA, 1978.
Kogut, B., and Zander, U. "Knowledge of the firm, combinative capabilities, and the replication of technology," *Organization Science* (3:3) 1992, pp 383-397.
Kottemann, J., and Dolk, D. "Model Integration and Modeling
Languages: A Process Perspective," *Information Systems Research* (3:1) 1992, pp 1-16.
Leonard-Barton, D. *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation* Harvard Business School Press, Boston (MA), 1995.
Licklider, J.C.R. *Libraries of the Future.* MIT Press, Cambridge, MA, 1965.
Machlup, F.a.E.P. "The Patent Controversy in the Nineteenth Century," *The Journal of Economic History* (X:1), May 1950, pp 1-29.
Marakas, G.M. *Decision support systems in the twenty-first century* Prentice Hall, Upper Saddle River, N.J., 1999.
March, J.G. "Exploration and Exploitation in Organizational Learning," *Organization Science* (2:1), February 1991, pp 71-87.
March, J.G., and Simon, H.A. *Organizations* Wiley, New York, 1958, p. 262.
March, S.T., and Smith, G.F. "Design and Natural-Science Research on Information Technology," *Decision Support Systems* (15:4), Dec 1995, pp 251-266.
Nelson, R., and Winter, S. *An Evolutionary Theory of Economic Change* Harvard University Press, Cambridge (MA), 1982, pp. 1-136.
Nonaka, I. "A dynamic theory of organizational knowledge creation," *Organization Science* (5:14-37) 1994.
Nonaka, I., and Takeuchi, H. *The Knowledge-Creating Organization.* Oxford Press, Oxford, U.K, 1995.
Orlikowski, W.J. "Improvising Organizational Transformation Over Time: A Situated Change Perspective," *Information Systems Research* (7:1) 1996, pp 63-92.
Rivette, K.G., and Kline, D. *Rembrandts in the Attic: Unlocking the Hidden Value of Patents* Harvard Business School Press, Cambridge, MA, 1999.
Rosenberg, N. "Why Do Firms Do Basic Research (With Their Own Money)?," *Research Policy* (19:2) 1990, pp 165-174.
Rosenkopf, L., and Nekar, A. "Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disk Industry," *Strategic Management Journal* (22) 2001, pp 287-306.
Schmookler, J., and Brownlee, O. "The Economics of Research and Development: Determinants of Inventive Activity," *American Economic Review Papers and Proceedings* (52:2) 1962, pp 165-176.
Shannon, C., and Weaver, W. "The Mathematical Theory of Communications.," University of Illinois Press, Urbana, IL., 1949.
Shapiro, C. "Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting," in: *Innovation Policy and the Economy,* A. Jaffe, J. Lerner and S. Stern (eds.), MIT Press, Cambridge, MA, 2001, p. 32.
Shapiro, C., and Varian, H.R. *Information Rules: A Strategic Guide to the Network Economy* Harvard Business School Press, Cambridge, 1998, p. 352.

Sprague, R.H., and Carlson, E.D. *Building Effective Decision Support Systems* Prentice-Hall, Inc., Englewood Clifts, N.J, 1982.

Star, S.L. "The structure of ill-structured solutions: boundary objects and heterogeneous distributed problem solving," in: *Distributed artificial intelligence,* G. L. and M.N. Huhns (eds.), Pitman, London, 1989, pp. p. 37-54.

Star, S.L., and Griesemer, J.R. "Institutional Ecology, Translations and Boundary Objects - Amateurs and Professionals in Berkeleys-Museum-of-Vertebrate-Zoology, 1907-39," *Social Studies of Science* (19:3), Aug 1989, pp 387-420.

Teece, D.J. "Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets," *California Management Review* (40:3), Spr 1998, pp 55-+.

Teece, D.J., Pisano, G., and Shuen, A. "Dynamic capabilities and strategic management," *Strategic Management Journal* (18:7) 1997, pp 509-533.

Venkatraman , N. "IT-enabled business transformation: From automation to business scope redefinition," *Sloan Management Review* (35:2) 1994, pp 73-87.

von Hippel, E. ""Sticky Information" and the Locus of Problem Solving: Implications for Innovation," *Management Science* (40:4) 1994, pp 429-439.

Waldrop, M.M. *The Dream Machine. J. C. R. Licklider and the Revolution that Made Computing Personal.* Penguin Books, New York, NY, 2002, p. 502.

Table 1. Barriers to Information Access
Information access barriers can be created if the information is: • Proprietary or owned by someone else • Sensitive, secret, or confidential • Highly complex, hidden, or difficult to parse • Difficult to coordinate or match • Highly distributed • Incomplete or unable to know if complete • Of poor quality or confidence • Imprecise or inaccurate • Short lived or extinguishable • Too expensive to collect or maintain

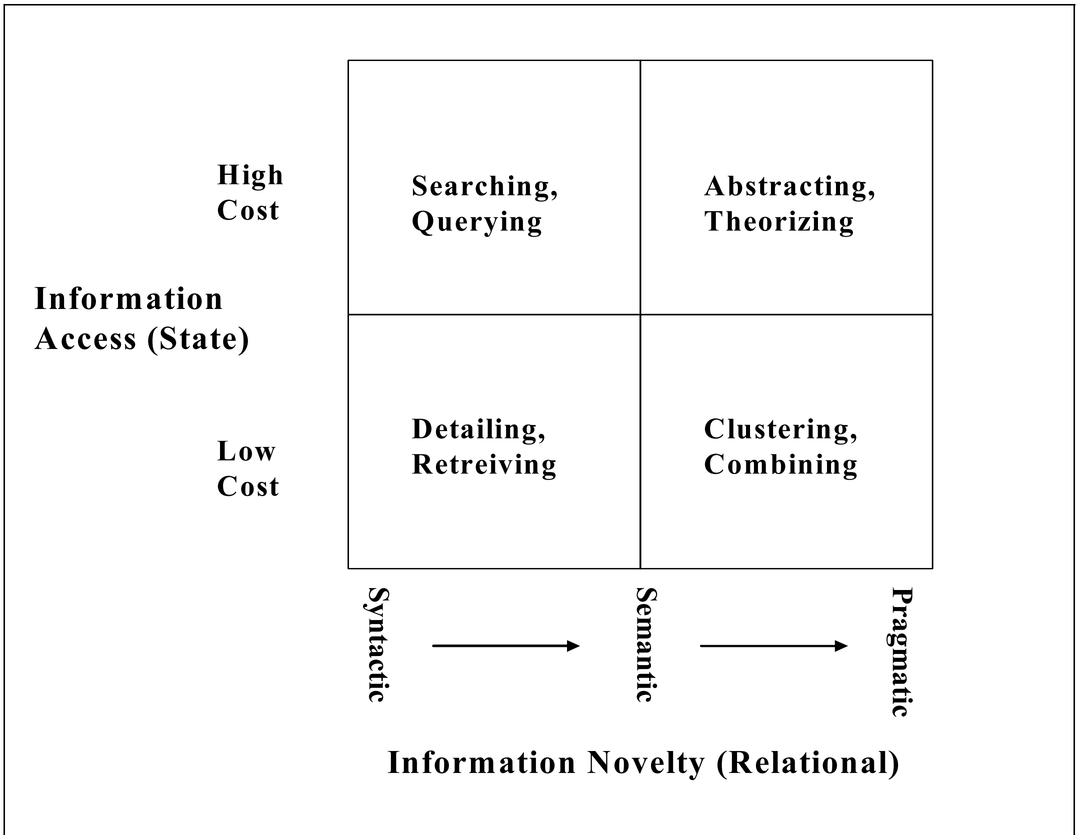

Figure 1. A Framework for Analyzing KMS User Requirements

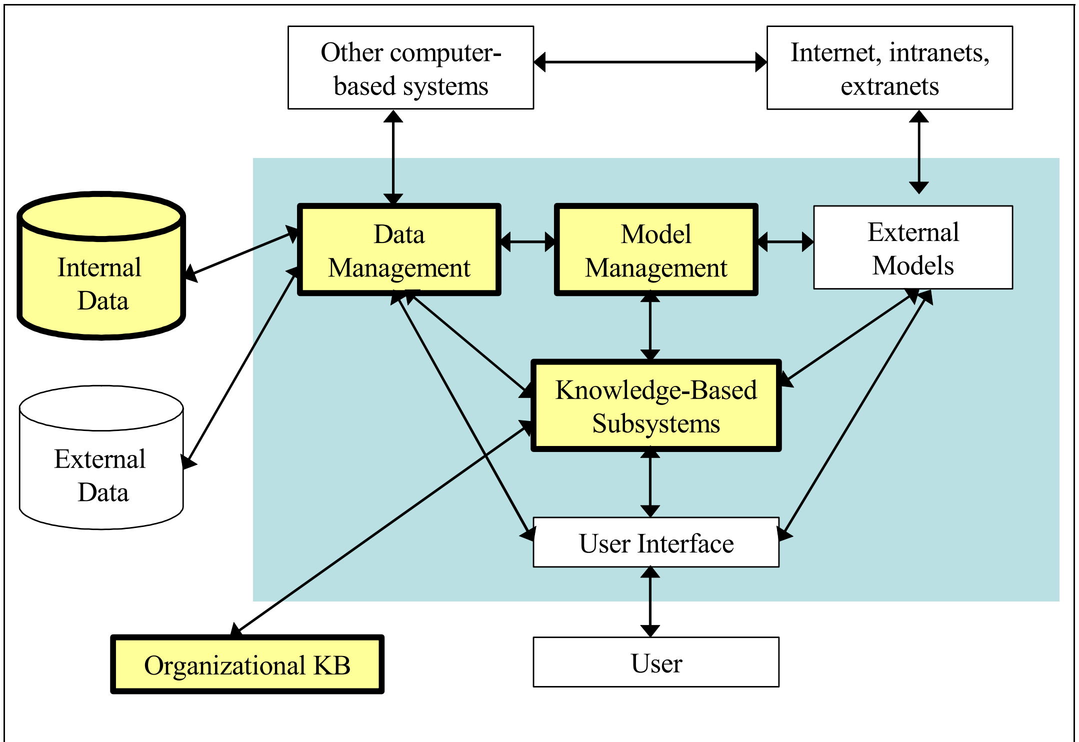

Figure 2A. Low Information Cost, Low Novelty

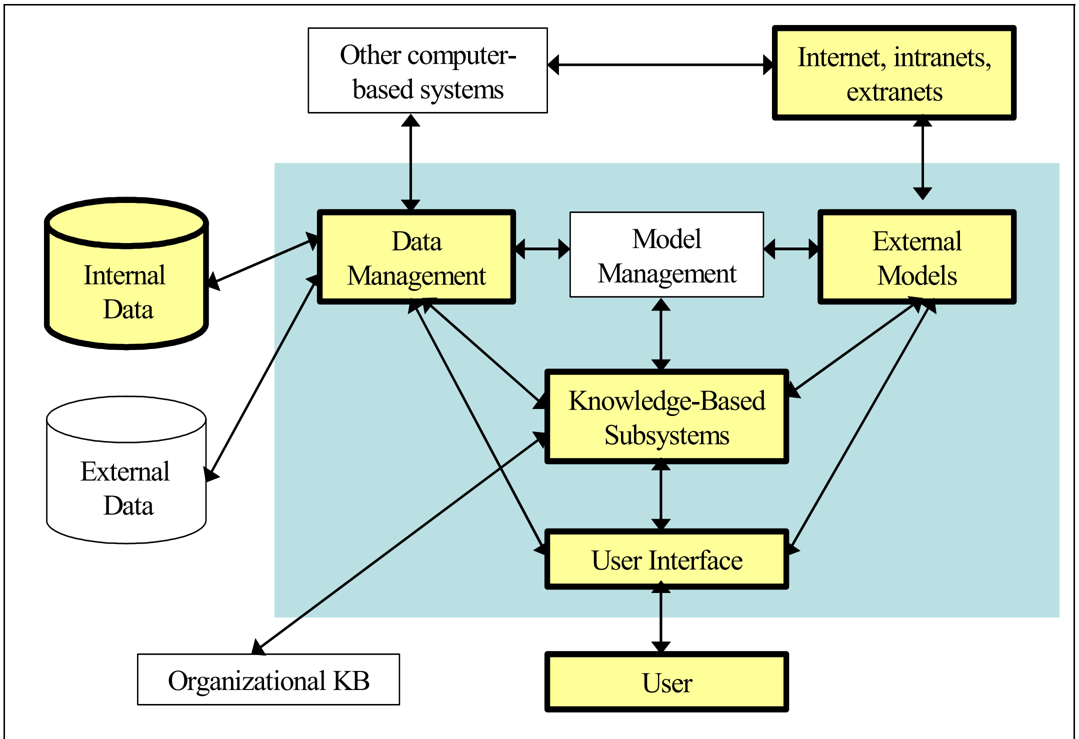

Figure 2B. Low Information Cost, High Novelty

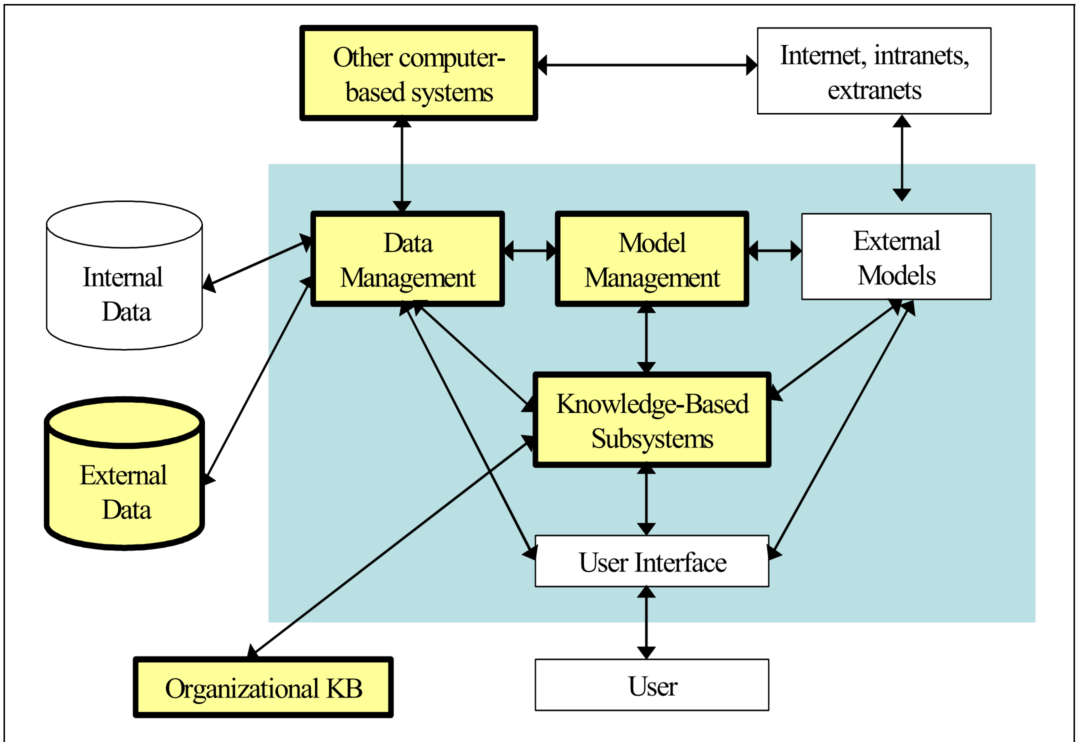

Figure 2C. High Information Cost, Low Novelty

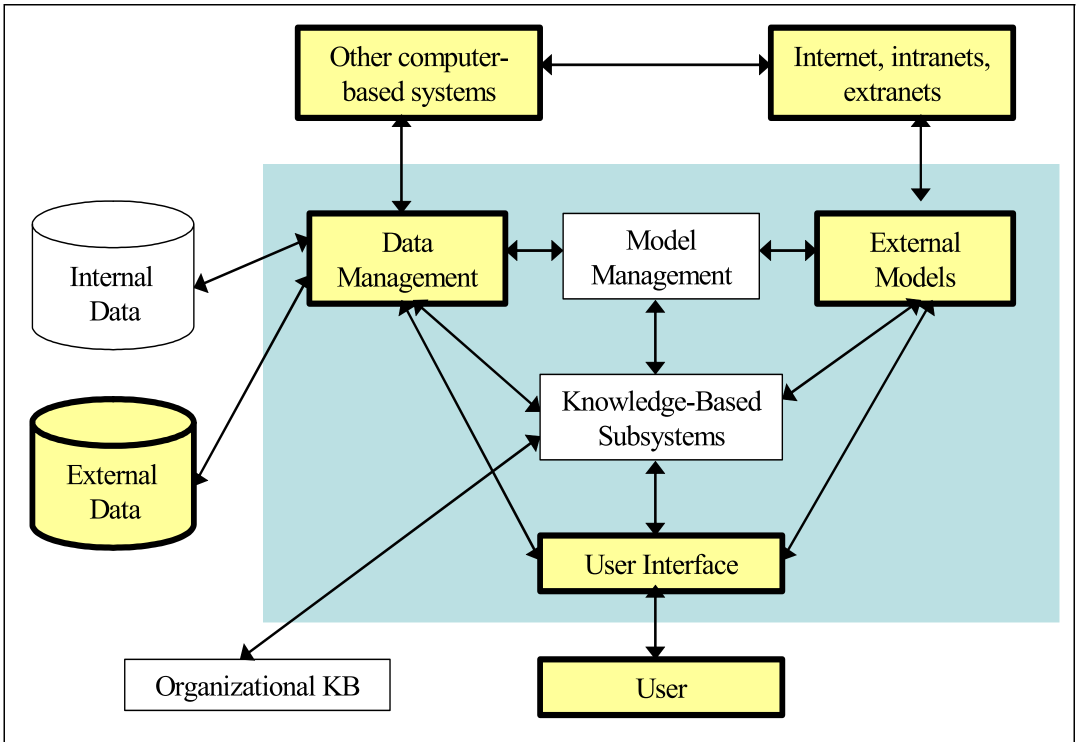

Figure 2D. High Information Cost, High Novelty

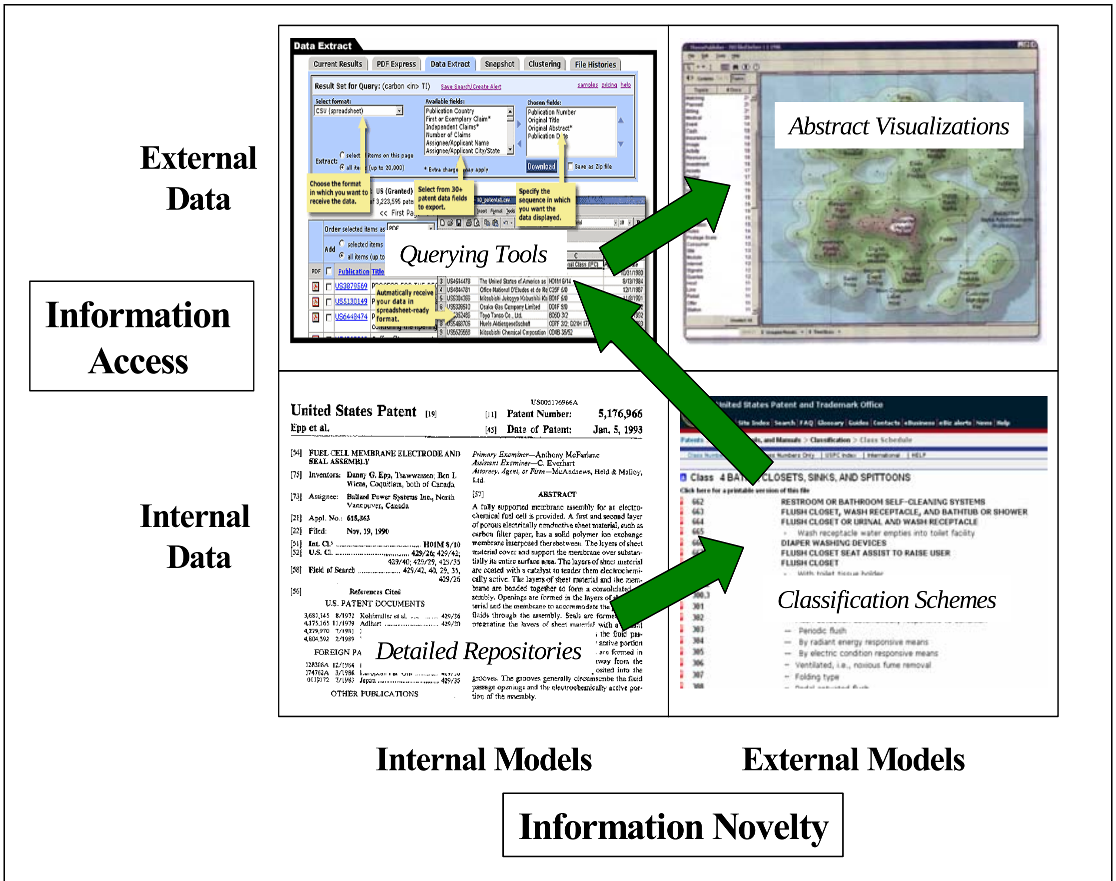

Figure 3. Design Evolution of US Patent Management Systems

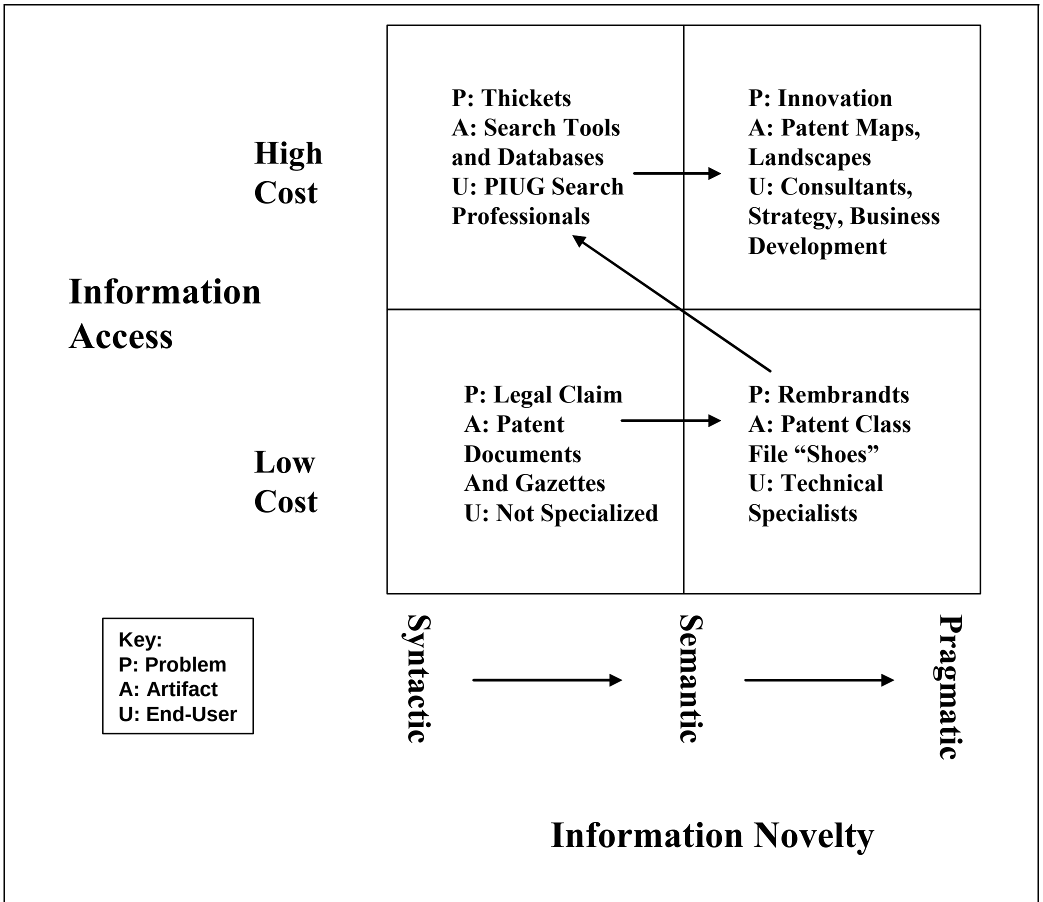

Figure 4. Design Evolution of US Patent Management Systems

Appendix 1: U.S. Patent Management Systems and PAMS Supported Services

Legend: ● → Core technology offering
○ → Secondary technology offering

Name	Description	1. Detailing, Retrieving	2. Clustering, Combining	3. Searching, Querying	4. Abstracting,
Anaqua	Collaborative enterprise patent management system with competitive intelligence capability.	●		○	●
BizInt	BizInt Smart Chart for Patents creates tabular reports from patent databases.	●		○	
Bustpatents	Consulting service for prior art search in emergent categories of technology. Unique patent categories.	○	●		
Chemical Abstracts Service (CAS)	STN current and archival information from over 200 scientific, technical, business, and patent databases covering a broad range of scientific fields, including chemistry, engineering, life sciences, pharmaceutics, biotechnology, regulatory compliance, patents, business, and more.	●		●	
CHI Research	Consulting service for the analysis and visualization of patent and academic paper metrics.				●
Dialog	Search software with enhanced post-processing capabilities. Also, Derwent WPI First View for an early look at published patent documents.	●		●	
FIZ Karlsruhe	European STN partner, similar functions to Chemical Abstract Services (see above)	●		●	
Gene-IT	Large-scale sequence searching solutions for the life science industry. Provides GenomeQuest an intranet-based solution that enables functional investigators to rapidly search the entire sequence world quickly and easily. With its patent search module for corporate bio-sequences.	○		●	
Gen-Eric	News Source for the Latest Patent Information	●			
Global Prior Art	Technical consulting service for detailed analysis of patent information. Uses patent categories to search for prior art.	○	●		
i2 ChoicePoint	Anacubis Desktop displays visual research and analysis of patent and other structured data from multiple sources.				●

IFI Claims	IFI CLAIMS Patent Databases, represents the most reliable, text-searchable, and value-added databases of U.S. patents in the world. Legal status information, company name standardization, competitive intelligence tools, indexing services.	●	●	●	
Intralogics/Patent Vision (ILPV)	Comprehensive source for USPTO data in digital form. USPTO patents and applications replicated on DVD. US patents in compressed PDF form.	●			
IPValue	Business consulting service for strategic assertion of high-value intellectual property.	○			●
IPVision	Business and product consulting service. Generation of interactive patent landscape maps and charts. Identifies relationships and facilitates scenario modeling revealing overall IP market context.	○			●
Knowligent	Commercial software for managing inventions, patenting process, and licensing.	●			
MicroPatent	Full-service intellectual property information, software, and consulting-services company with large commercial collection of searchable full-text patent information. Several distinct products including: (1) PatentWeb for online patent searching and document delivery, (2) Aureka for online patent analysis and collaboration, (3) industry specific patent products, and a (4) File Histories service. Acquired SmartPatents.	●	●	●	●
Minesoft	Provide PatBase a searchable patent information database developed by Minesoft and RWS. Patents are organized into patent families for ease of search and display.	○	●	○	
NBER Database	Economic database of 20+ years of statistical patent information.		●		○
NERAC	Library consultancy and document recovery services for key word search in patent and non-patent databases.	●	○	●	
OnCloud8	PDF patent retrieval and delivery service.	●			
Patolis	PATOLIS (Patent Online Information System) is the sole database in Japan specializing in intellectual property documents with a complete collection of patents since 1955, including Japanese utility models, trade marks and designs. Legal status information and machine translation.	●			
PIUG Listserve	Online support list-serve for those interested in new patent information system tools.	●		○	
Questel-Orbit	Provide Plus-Pat - international patent database covering over 70 countries and patenting authorities and FamPat including patent family file. Internet	●	●	○	●

	based delivery of patent documents. Also provides PatReader, to visualize fulltext patents, and PatentExaminer - portfolio and project management tool.				
Rusch Consulting Group	Merged Markush Service (MMS) - the structural searchable file for the chemical patents community.	●	○	●	
Technology & Patent Search International	Searches for patentability, freedom-to-operate, prior art, validity, legal status, infringement, etc. Manual searching of non-patent literature as well as non-English language documents.	○		●	
Techno-L	Online support list-serve for strategic patent practices primarily in entrepreneurship, licensing, and new business development.	●		○	
Thomson Scientific	Thomson Scientific businesses include Current Drugs, Delphion Research, Derwent, and ISI ResearchSoft. Deliver patent, industry standards and specifications, scientific and technical information. (see Micropatent above).	●	●	●	●
Search Technology VantagePoint	VantagePoint is a text mining software for discovering knowledge in any structured database. Mapping and analysis of trends. Can be adapted to import data from a number of databases.				●
Univentio	Univentio Patent Information, focuses on patent awareness and data. Provides digital patent data collection comprising full text, bibliographic data, facsimile images and machine translations. Broad product range including alerting services, data licensing, custom solutions and search and retrieval	●		○	
USPTO	US Patent Office public webpage offers Boolean search (from 1975) and image search (pre-1975). Index of technological patent classifications	●	○	○	
Wisdomain	Wisdomain offers analysis of patent information including Patent-Lab II and Focust. Focust consists of the Search Module, the Citation Module and the Analysis Module..	●	○	●	●
World Intellectual Property Services (WIPS)	The World Intellectual Property Search (WIPS) Patent Search database contains uniform format data from world patent offices in an integrated web-based search system. Collection of Korean, Chinese and Japanese English language patent information.	●	○	●	●

Note: In some cases, PAMS listed as doing 'search' (i.e. Bustpatents and Global Prior Art) actually accomplish search by limiting the search space using unique classification technologies, and then searching the entire classification space manually. These firms are distinguished from the more common PAMS designs that embody search and querying tools.