Issues Involved in the Structure and Development of Intellectual Capital

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Abstract

This paper contains a survey of issues concerning the structure and development of intellectual capital systems and electronic performance support systems. Some issues involve human incentives and motivations, while others are of a technical nature regarding the structure of information capture and retrieval. Additionally, several terms and concepts used in intellectual capital systems are defined and discussed.

A mechanic went to a surgeon to remove a small growth from his arm. Because it was minor, the surgeon performed the surgery in his office and the mechanic was able to go home within minutes. When the mechanic got the bill for $5500.00, he went back to the surgeon for an explanation why it was so much money for a few minutes work. The doctor said that the charge was justified because of his extensive training and knowing exactly where to cut. A few months later, the surgeon took his car to that same mechanic because it was running rough and had a loud knock. The mechanic listened to the motor for a minute, took out a hammer, tapped once on the engine and the car purred like a kitten. The surgeon was astounded and pleased until he got the bill for $5500.00. He went to the mechanic, demanded an explanation and an itemized list of the charges. The mechanic calmly pulled out a note pad and wrote the following:
Hitting engine with hammer........$1.50
Knowing where to hit.............$5498.50

This exemplifies intellectual capital as it presently operates in our society. People are rewarded for using the knowledge they possess. The more scarce and consequential the knowledge, the greater the value of the service. We perceive a surgeon's knowledge as being more valuable than a mechanic's, partly because fewer people possess that kind of medical knowledge, and partly because the consequences of performance, based on that knowledge, is greater.

Today's business environment is complex and companies are increasingly dependant on the knowledge and intellectual resources developed and maintained by employees. Even large corporations are caught unawares by just how much they depend on their employee's intellectual capital, and it is not at all uncommon for an employee to quit, retire or be laid-off only to be rehired as a consultant—at a much higher cost to the company. It is therefore to companies' benefit to capture this knowledge and make it available to other employees who might need it.

Intellectual capital consists of the information, knowledge, know-how, methods, procedures, insights and experience that has real or potential commercial value to a person or organization. And unlike physical forms of capital (such as gold that has a relatively finite total quantity) intellectual capital operates more freely under the rules of the non-zero sum game. The total sum of knowledge can grow and expand without bounds, and as information concerning specific bits of knowledge becomes more widely distributed, that sum total can expand even more rapidly. It was Gutenberg's introduction of printing in 1450 that provided the spark to the information explosion. Thoughts and ideas which had been captured in writing could be duplicated and distributed much faster than they could previously by producing individual copies "by hand." Now with the Internet, an idea can literally be available to anyone in the world within seconds of its origin. The question, however, remains as to why anyone would want to give away valuable information and possibly lower her personal earning power. Some way must be found for intellectual capital to be converted into financial capital so that individual rewards are balanced with the overall progress and growth of the knowledge base.

Incentives and Compensation

Capital in any form has value to a person or organization only as long as it is possessed or can be controlled, and establishing who owns an idea or insight can be difficult indeed. Intellectual capital is obviously under the control of a person as long as s/he is able to hoard the knowledge and keep it a secret from others. The violin maker, Stradivarius, maintained the value of his intellectual capital by protecting his special knowledge of violin making and keeping it to himself. The luthier's traditional wisdom was that violin wood should be cured in a very dry climate and never be allowed to get wet. Stradivarius' secret of soaking the wood in a brine solution before drying was not discovered until the late 1980s. Sharing that information would have drastically lowered the value of his violins by increasing the supply of top quality violins from other competent—though less innovative—luthiers.

The risk is even more substantial for the person who works as an employee. Whenever an employee documents knowledge, s/he runs the risk that the employer will lay legal claim to that knowledge as trade for wages rendered. Any future earning power of the knowledge would then be under the control and benefit of the company owner and any additional value assigned to the employee because of the knowledge could be eliminated. It is rumored that Edwin Land chose to not receive his Ph.D. because it meant that he would have to relinquish all patent rights for the Polaroid process to the university. In essence, the customary way of dealing with intellectual assets is "largely in the context of rigid legal definitions of intellectual property, which focus on restricting the use, sale and transfer of intellectual capital in forms such as patents and copyrights" (Klein, 1998).

Mark Salisbury (1998) proposes that companies modify their knowledge management structure to include mechanisms for documenting and distributing knowledge that employees conceive and develop in the course of performing their jobs. After the description above, this might seem foolhardy or even a little communistic, but as authors who publish the myriad of self-help and how-to books can testify, there is already in place a capitalistic method of making money from providing knowledge to others.

The author of a how-to-book can potentially earn a lot of money for recording and dispensing information. If s/he has a good idea, and a well defined plan to show others how to do it, it is possible to earn more by writing a book which is used by many people than by personally providing the service to just a few. It should be noted that an author typically receives royalties only for the books that get sold, not for writing the book. This puts in place natural checks and balances to insure that authors are rewarded only for good (or at least popular) work.

To be sure, money and compensation are not the only incentives that motivate people on the job. Factors that directly influence employee satisfaction (Hodgetts, 1989) are; (a) challenging or interesting work, (b) a chance to have ideas adopted, (c) a sense of accomplishment, and (d) a feeling of being treated with respect. Money didn't even make the list though probably because that need was already being met and job security was not threatened.

In Dr. Salisbury's model, employers would modify their incentives structure to make it attractive for employees to contribute to the corporate knowledge base. And like the professional author, employees would be rewarded, not for providing knowledge that is tucked away in a database, but rather, for contributed knowledge that coworkers retrieve *from* the database and actually use. Incentives (such as pay, job security, and recognition) must be established so that the rewards for contributing intellectual capital would be greater than the rewards for maintaining personal control of the knowledge. Also, adjustments would have to be included to balance the motivations to save job time by using someone else's existing material with the motivations to produce new or better material that could possibly be more profitable to the employee in the long run. By applying Vroom's expectancy theory, (Motivation = Valence X Expectancy) (Hodgetts, 1989) the valence that the employee has for the outcome of providing the company with intellectual capital must be high and the expectancy of the outcome is likely.

Assuming that this substantial logistical problem in social engineering can be solved, computer programs and knowledge systems must be devised to efficiently capture, organize, package, and redistribute the right knowledge, at the right time, to the right people, in a usable fashion. Klein (1998) has identified three general characteristics that should be included in a workable infrastructure. First, it should connect all those with similar interests, second, it should facilitate capture of know-how in context, and finally, it should deliver this know-how directly to the point of execution.

Instructional Design

Before we can effectively discuss the design and management of a knowledge base, we must operationally define exactly what is "knowledge," how it differs from "information," and how these terms interact to form a comprehensive learning paradigm. The following list of definitions may be used to construct a framework on which we can build a foundation.

Data are the symbols, metaphors and icons that encode real or abstract thoughts, ideas and facts. They are the basic elements, or building blocks, that combine to make up information.

Information, as recited by Grabowski (1997), is a process or flow of information with many functions, only one of which is to instruct. I only partially agree with this definition. I prefer to think of information as data that have meaningful coherence, or in some way "make sense." The process or flow of information might be described better as the presentation of information. A book on a library shelf contains information but no flow or transfer takes place until that information is presented to the reader through the action of reading.

Instruction is the process, external to the learner, by which information is selected, structured, organized, and sequenced with the deliberate intent that the consumer of the information will remember, apply or act upon it now or in the future.

Learning is the process, internal to the learner, by which information is selected, structured, organized, and sequenced with the deliberate intent that the consumer of the information will remember, apply or act upon it now or in the future. How learning is perceived, observed or measured will depend on which philosophical and educational paradigms are used.

Knowledge is the ability to use or act on information with some kind of strategy and skill. A person may possess all the available information on how to hit a golf ball or fly an airplane but without a strategy to apply the information and the skill to implement it, knowledge is not present.

Wisdom includes the ability to decide when knowledge should (or should not) be applied. It is the quality that links action to purpose (Fitchett, 1998).

Knowledge Engineering

In many ways the motivations to develop computer based knowledge systems are the same ones that launched the time & motion studies back in the 30s and 40s. Employers are always looking for ways to increase productivity, improve efficiency and reduce waste. Even though the focus may now include the management of intellectual capital (rather than assembling components on a production line) the same issues of productivity, waste, and efficiency remain. In earlier times, job tasks were more straight forward and usually easy to learn, so productivity issues involved the efficiency of motions required to perform tasks, the organization of the work space, and the time required to complete each task; hence "time & motion." Now that jobs are becoming increasingly complex, extensive training programs are often required to enable employees to perform properly. "As the work environment becomes more dynamic, the possibility of adequately training the worker before he or she starts a job is increasingly challenging" (Hudzina, Rowley, Wager, 1997). Therefore, productivity and efficiency issues must also include the time required for an employee to acquire up-to-date information about the job and the efficiency of knowledge transfer between employees and sources. Knowledge management and information support systems must then include two major functions. First, there must be an efficient way for employees to acquire new concepts and skills, and second, there must be a way for information, insights and techniques to be cycled back and included into the pool of common knowledge.

Organization of Instruction

Many current technical training programs can be criticized for being too abstract oriented. (Johnson, 1988) Training classes often begin with theoretical or mathematical models followed by attempts to apply these equations to specific examples. Research by Simon, Larkin, McDermott, however, indicate that experts do not rely primarily on abstract theory and quantitative equations but prefer instead to create a qualitative understanding of the problem space as a starting place. With this in mind, training programs should begin by providing concept maps, overviews, etc. (You know, the usual education theory stuff.) before introducing the quantitative material. This idea might also be incorporated in the search engine and database structure to more efficiently navigate the database. Information must be available so that it can be quickly located and assimilated by the employees, and efficient method of capturing knowledge is required as new ideas and procedures are developed.

Barry Raybould (1997) developed a model he called the Organizational Performance/Learning Cycle. This five-phased framework calls for development in the various components needed to establish employee performance and learning, and in the mechanism for knowledge capture and dissemination.

Phase One addresses the interface used to present knowledge to the performer so that learning occurs as fast as possible and with the least amount of support from other people. Phase Two discusses the use of the knowledge database as a facilitation tool to be used as a just-in-time resource. Phase Three addresses the idea that an individual's learning may come before, during, or after competent performance by that individual has been established. Phase Four of the model explores the phenomenon that new techniques, processes, etc. (not part of the original knowledge base) emerge and evolve. And finally, Phase Five looks to capturing this new knowledge which can then be used by others in the organization.

User Friendly Access

Regular, as well as novice, users of on-line help files know that finding the information you want can be extremely frustrating. If you are trying to find out how to perform a certain function but you are using the wrong key words in your search, the information remains hidden to you. A novice user is often unfamiliar with all the category groupings and cognates used in the information retrieval system to locate what they are trying to find. If there is a knowledgeable person nearby, we often ask that person rather than hunt around in the help files. Jaffey (1997) identifies several reasons for this. Novice users are simply unaware of what they don't know, whereas, experienced people are much more familiar with the information and knowledge bases, and can find their way around more quickly. They know when information becomes dated and should be discarded or updated. In addition, human agents often give suggestions, warnings and advice that go well beyond the original question. Finding the information we want is always expedited when we ask the right questions. Human agents are very good at hearing a naive question in context and extrapolating to a more appropriate question.

At root, we want to know how to "do something," not just "know something." By interacting with a person we have access to an experience base as well as a knowledge base. But, because corporate knowledge bases can be so vast that no one person can possibly know everything, finding the right expert becomes a chancy exercise, and even if the right expert can be found, s/he may be far too busy "being" an expert to teach expertise. If some of the burden of the human expert can be transferred to an electronic performance support system, many of these difficulties should be reduced.

Electronic Performance Support Systems

A performance support system is the collection of all the things we use to become successful and productive in our work (Laffey, 1997). It may include telephone lists, trade journals, colleagues, mentors, computers, day timers, and anything else we use to accomplish our jobs. And it seems that everyday, the amount and variety of things we need increase. As we become inundated with information, it is imperative that we learn how to quickly organize and consolidate information. Electronic Performance Support Systems (EPSS) might be thought of as "one stop shopping" for information support.

Raybould (1997) defines the EPSS as "the electronic infrastructure that captures, stores and distributes individual and corporate knowledge assets throughout an organization, to enable individuals to achieve required levels of performance in the fastest possible time and with a minimum of support from other people."

At first gloss the EPSS may appear to be little more than a glorified electronic reference book where employees can research a problem in the hopes that someone else has worked through the problem before and wrote about it. Laffey sees the power of the EPSS in its ability to change and evolve to fit the ever changing needs of the ones who use it. "EPSS will be grounded in the fluid nature of support in the work environment rather than the static nature of formalized knowledge" (1997).

Types of Agents

A big challenge for any EPSS is to locate and present the right piece of knowledge. Three types of navigation support systems are being developed (Hammond, Burke & Schmitt, 1996) that address the problem of finding or constructing, responses that fit the users needs.

Find-Me systems are browser programs that allow users to search through a database by selecting based on category. For example, if you want to read another book like Mitchner's "Hawaii," the find-me system will assist you by identifying what it is about "Hawaii" you want to repeat. Do you want another book by Mitchner? Do you want another book about the Hawaiian islands? Do you want another book that takes 2 men and a small boy to deliver?

Butlers are information agents that are more active than find-me systems. They are designed to learn about your preferences and habits which are then used to access information more efficiently. For example, a butler system designed to assist you find a restaurant will know your personal taste in food, what your schedule is and where you will be with respect to potential restaurants when you want to eat, where you ate last, who you will be eating with and their food preferences, etc. It might even be able to place the reservation for you and communicate relevant information to other butlers.

Correspondents are fully automated find-me systems that act as agents for news groups or case-based databases. A correspondent's function is to read a request, or problem description, and construct a series of queries that can be directed to a case-based library of solutions, or some other find-me system.

No matter what kind of agent is being employed, some construct of logic must be used to search through the database. We will briefly look at some reasoning structures typically used to navigate large databases.

Rules-Based Reasoning

Rules-Based Reasoning is an approach to problem solving that breaks down problem solutions into a generalized set of rules that are chained together. A duck can be defined as the collection of the following set of rules. It has a bill, quacks, has feathers, lays eggs, and whatever else distinguishes it from all other animals. If you are then presented with an unknown animal, you can decide whether or not it is a duck by satisfying its rules. Does it have a bill? Does it quack? And so forth. If the solution to a problem can be uniquely described as an isomorphic collection of rules, this form of reasoning can be used to simulate the problem solving exercise. This method of distilling knowledge into generalized rules is the one most often use to prepare instruction. It is not always the way we learn.

Case-Based Reasoning

Case-based reasoning is a problem solving strategy differing from rules-based reasoning in that, instead of chaining generalized rules together to arrive at a problem solution, problems are solved by remembering and adapting exemplar solutions to similar problems. Cases take the place of generalized rules as the primary source of knowledge, and case adaptation takes the place of chaining for creating new problem solutions (Leake, 1996). Case-based reasoning is founded on two basic assumptions about the nature of the world. Similar problems have similar solutions and new problems are similar to old problems.

An additional advantage to using the case-based approach is that it can expedite the task of data collection in several ways. Experts are not often willing to take time out of their busy schedules to organize and distill their knowledge in to rules, but they are often more than willing to relate their "war-stories." These case "stories" may provide a more flexible vehicle to relate obscure elements of knowledge like tips, techniques and warnings. And stories also provide a natural instrument to address the affective aspects of knowledge making it easier for others to "buy in" to the lesson.

Scripts

Scripts are problem solving strategies that bridge the gap between rules and cases. They have the "knowledge object" nature of cases, and at the same time, they have the abstract generalization of rules. In fact, the way we naturally construct scripts is by experiencing individual case situations and blending them together into an amalgam of the generalized situation (Schank, 1997). As a result, this script becomes an idealized case which we can access easily and use in a variety of situations.

Scripts, as humans use them, allow us to infer much more information from a statement than the words alone convey. For example, the statement "John ordered sushi but he didn't like it." invokes a script. We know that John is in a restaurant, that he is trying Japanese food, that he will pay for the meal, that what he didn't like about the sushi was the taste.

Script theory may suggest a method of assimilating new cases into the database in a more parsimonious way while maintaining valuable information.

Automating Knowledge Capture

Fitchett (1998) makes the distinction between tangible knowledge (that which has been captured), and intangible knowledge (that which has not been captured). If a knowledge object is tangible, then it can be preserved, manipulated, accessed, and presented by any of the agents described above. If, on the other hand, the knowledge is intangible, then it exists only in the mind of some "expert" person and its use is limited to the capabilities (and longevity) of that person. Converting intangible knowledge into tangible knowledge is, therefore, a major part of a successful intellectual capital system.

Whenever a person takes time away from doing the job to document techniques and ideas, that person is by definition *not* delivering services based on the knowledge. And the more detailed the knowledge, the more time is required (or wasted depending on your perspective). It is unreasonable to "require professionals to address general questions about their knowledge as a process outside normal work flows" (Klein, 1998). In order to create and update an effective knowledge base, high levels of detail are usually required, so ways to capture knowledge as a direct byproduct, or fallout, of doing the job would be most desirable. In medical diagnosis and treatment, documentation in written form is part and parcel to the exercise. And since this is now usually done with the aid of computer, recording the complaint, diagnosis, and remedy into a knowledge base system could be integrated into standard operating procedures.

Recording knowledge from experts in other areas might require the use of more sophisticated recording devices that are just now becoming available—such as the human performance recording equipment used by real-time cartoon animators and Olympic athletes. In the absence of data capture that is a direct result of doing the job, efforts should be taken to make the capture as quick and simple as possible. Techniques taken from the artificial intelligence field might offer some solutions.

Information Capture modeled after the Active Learner

It seems appropriate, when dealing with automatic (or simi-automatic) knowledge capture, that some version of a learning model could apply to the computer system. In the case of knowledge capture, the "student" would be the machine and the "instructor" would be the person adding information into the database.

Any information input into a computer must be structured so that the machine can receive, remember and manipulate it. Otherwise, the machine just gets filled up with megabytes of garbage which is not useful to anyone. So the machine (as the learner) would need to convey the best way for it to receive the new information. It would then need to make sure that it has received the information correctly and understands what it has learned. This is what a human student does (though often haphazardly) and the computer would in effect become a simulation of an "ideal active learner."

Knowledge capture routines using adult learner transactions might provide guidance for developing more efficient data capture routines. And a number of learning principles we take for granted when dealing with human students become evident as models for designing the system. Capture programs would need to include chunking routines, assimilation routines, test-for-understanding routines, and concept mapping routines, in order to build its knowledge base in a coherent and useful way.

Behaviors of the Ideal Active Learner

To more fully develop this idea, behaviors exhibited by prototypical learners may provide some ideas for developing more effective data capture routines. Active learners acquire new knowledge but also are able to restructure and refine existing knowledge. They do this by using a combination of search & categorization strategies, and cognitive techniques, some of which might be adapted to data capture wizards using simulation techniques.

To navigate through new content, students will employ search decision strategies based on the purpose of the material and its possible uses. They will link relevant information with context cues, mnemonics, analogs, indexes, and hierarchies. And they will collect stories as a convenient tool to incorporate affective elements regarding information.

Other cognitive techniques that may or may not be usable are; conceptual integration, risk taking and degrees of confidence, selection, evaluation and screening, organization and development of problem space parameters, interest and relevance, and accessability.

Summary

In this paper, a number of issues regarding intellectual capital have been explored. Some of the issues are based on human nature and human motivations. These opposing motives of managers and employees are each valid just as they are self-serving. The motivations of the employer are to increase productivity by training more people intricate and involved tasks, whereas the motivations of the employee are to protect hard earned intellectual investment and thereby increase the individual's value. Balancing these opposing forces will be required for any implementation of a knowledge distribution system to work.

Issues concerning the engineering, development and implementation of an EPSS are also complex and inter-related. Elements regarding instruction design, solution cases, data capture, stories, and intelligent agents must all be integrated so that they can function seamlessly to create an efficient artificial knowledge system.

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