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Knowledge Management has been a recent focus in the Information Systems literature. However, there is little consensus on what this term really means or how to operationalize it, and there is even less clarity regarding how those sharing common scientific research interests should manage knowledge. Interest in this idea is often driven by the arrival of new technology, e.g. that which is increasingly available for rapid dissemination of information or storage of large masses of data in various formats. This is obviously a backward approach to solving the problem of truly *managing* knowledge as a critical resource. Knowledge Management is facilitated by the technology, but knowledge must be organized, stored, cataloged, accessed, leveraged, and protected regardless of the technology. This presentation deals with definitions of Knowledge Management and the application of key concepts to the management of the knowledge base that has accumulated during decades of space exploration.

In the 1970's a concept called *The Invisible College* became a hot topic of discussion. This *college* was not something that anyone set out to create. Rather, there was a loosely linked web of scientists, researchers, and scholars who were exploring ideas in various specific scholarly domains. An "Invisible College" united a web of scholars, all interested in some specific topic or academic discipline. Prior to electronic mail, researchers and scholars formed interacting communities, linked through telephone, fax machines, conference presentations and attendance, and old fashioned land mail. Through these often-inconvenient channels, these researchers shared experiences and knowledge gained pursuing their individual research efforts. Some never met, but all who were involved in a particular body of research were aware of the players in this exchange of niche knowledge. While there was a sense of friendly competitiveness among researchers, there was also the ability to quickly learn from and build upon their shared experiences and discoveries. Often there were collaborative projects that involved several members of a given group and these project teams benefited by the synergy that was created. Various roles, such as 'boundary spanners' and 'gatekeepers' evolved. Boundary spanners were those who had a foot in more than one of the research domains. For example, an engineer who is also an astronaut would serve as a liaison, transporting information across the boundaries of specialization. In contrast, 'gatekeepers' often performed the role of assessing the potential value of the knowledge that someone wanted to bring to a particular effort. This "Invisible College" approach (augmented by the world wide web) is, of course, still very much the way academia operates and its informal framework and conceptual approach can be seen as foundational to formalized, structured efforts to define and apply Knowledge Management principles and ideals in modern organizational contexts.

Knowledge Management is an effort to capitalize on already established data and information in a given setting. The goal is to capture and leverage the intellectual capital of the knowledge workers in that setting (Lee, 2000). Most Knowledge Management theory and research addresses knowledge within a specific organization, rather than an area of academic specialization or of scientific interest. But focusing on a wider context is different in that the knowledge transcends organizational and even specialization boundaries. Knowledge is different from data or even information. Data is merely a string of numbers and characters, bits with little inherent meaning. Information is an attempt to place the data within a context and to define a relationship between the unfocused data and its intended use. Knowledge is data in context, *and with meaning,* that refines and directs the data's intended use. It is a broader concept and it resides within the social and cultural framework of the domain of interest. The concept of knowledge is deeply imbedded within the frames of reference employed by the individuals who interpret it to construct knowledge in a given domain. Any data, organized into information, may clearly have different meanings for different people. Accordingly, there are complex interpretive, filtering, and translation issues that must be addressed when one wants to store, access, modify, or make use of knowledge.

What is the relevance of Knowledge Management to the business of space exploration? The study of space is accumulating a vast repository of data, information, and knowledge resulting from research and exploration activities focusing on many aspects of the universe. But, we are beginning to lose the first generation of space explorers, and with them we face the loss of a wealth of implicit knowledge about these many and diverse activities. We do not even know how to categorize the various types of knowledge that are possessed by those who have worked in these endeavors. This does not call for interviews with the older generation, 'picking their brains' for their knowledge. That is not the point of this discussion. Rather, it is time to begin a systematic process of documenting experiences and findings from all levels of the multitude of projects in this domain. This knowledge needs to be tied together and accessible by what will become a newly focused "Invisible College," a community of practice of those interested in all aspects of space exploration linked by technology. We are already all members of this "Invisible College" but we do not have standards and protocols for adequate collection, storage, and dissemination of the knowledge we each carry around within us.

At this point we have isolated islands, an archipelago, of knowledge. We have exploration of, for example, planets, happening from different perspectives and different parts of the world. Who at NASA is in charge of collecting, filtering, storing and even applying the knowledge gained through the activities of the European Space Agency? How can we learn from these efforts and apply them to future activities? Certainly, attending a conference and listening to a paper presentation of three-year-old facts is not going to be very helpful in our rapidly paced, fast changing world.

Knowledge Management involves knowledge generation which includes processes involved in acquiring, collecting, and developing information and knowledge (Grover and Davenport, 2001). Knowledge codification includes converting information and knowledge from individually based units into formats that are easily accessible by others interested in the topic. And, knowledge transfer involves moving information and knowledge from the point of creation to the point where it can be applied. We can see that the field of Knowledge Management crosses many disciplines and requires broad knowledge of data processing, data base management, systems engineering, plus the softer sciences of psychology and sociology. This is further complicated by the fact that the various types of knowledge in the space community also cross multiple boundaries where different and conflicting objectives may be considered paramount at a particular time. This clearly will further complicate knowledge capture, maintenance, and sharing.

We are at a point in the business of space exploration where we can no longer afford to ignore those who have gone before and the knowledge that has been gained. This is true of knowledge about how to manage complex projects, or that gleaned from scientific research or from engineering success and failures, or knowledge from any of the other areas related to space. What are the best practices and how do we know that they are best? Where does this knowledge come from and what does a particular bit of knowledge mean for the various diverse stakeholders in the space science community? These are important issues requiring a serious effort to develop a global plan for managing past, current, and future knowledge as humans continue to explore their universe.

References:

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