THE NEED FOR KNOWLEDGE MANAGEMENT IN THE MULTIFACETED WORLD OF ROBOTICS. Katherine A. Davis[1] and Charlene A. Dykman[2], ([1]Texas Academy of Math and Science, 344 McConnell, University of North Texas, Denton, Texas 76203, katherine@unt.edu, [2]Cameron School of Business, University of St. Thomas, 3800 Montrose Boulevard, Houston, TX 77006, dykmanc@aol.com)

Introduction: Developments in information technology have made it possible to create massive repositories of data, information, and knowledge that can be retrieved and applied as required. Such developments enable the capture, management, and sharing of knowledge to increase the efficiency and effectiveness of work processes. No longer do we need to 'reinvent the wheel.' This paper addresses the need for deployment of a knowledge management system in the realm of robotics research and development to facilitate more rapid transfer of knowledge gained in independent areas of robotics research and application.

Knowledge Framework: Knowledge Management has always involved discovery, documentation, storage, and retrieval of knowledge acquired through experience. As scientists, engineers, doctors, astronauts and even creative filmmakers conduct their research and work, they are consistently learning and achieving a new understanding based on their experiences with particular methods, technologies, and their environments. Some of this understanding is easy to capture and document. The results of scientific experiments are an example of this type of understanding, which is also known as explicit knowledge. Documented procedures for work activities, commonly accepted and well-understood standards of interaction between chemicals, and understanding of cause and effect relationships between moving objects all represent explicit knowledge.

There is one other type of knowledge, known as tacit knowledge, which represents the insights of specific individuals. The insights and understandings derive from a multitude of factors. These factors are things such as the background of the individual, the prior experience of the individual with similar work or research, the understanding of qualitative phenomena in the environment, etc. A good example would be a physician's insight into a patient's health based as much on observation and instinct as on blood tests and similar diagnostic measurements. Tacit knowledge is much more difficult to identify and capture than explicit knowledge. It is carried in the heads of individual researchers, who may not even be able to articulate or recognize the knowledge that they have. Both explicit and tacit knowledge are important in the ongoing development and evolution of a body of research.

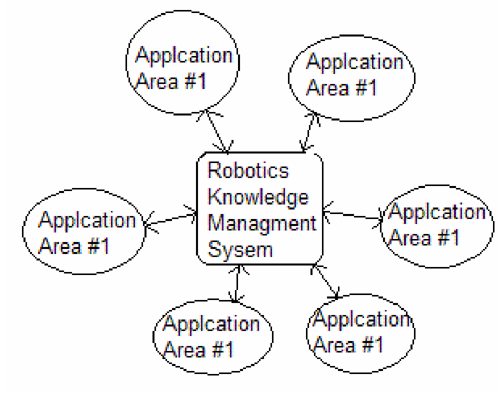
One could argue that there is, in fact, a temporal relationship between these types of knowledge, that explicit knowledge in a particular arena will precede the tacit knowledge. We may explicitly know the expected chemical composition of a Mars meteorite. However, tacit knowledge held by those with meteorite research experience makes it possible for them to recognize plausible meteorite origins before the chemical composition is assessed. Political correctness aside, think how advances in information technology have allowed us to use surveillance cameras to perform facial recognition and identification of individuals [1]. This would previously have required the tacit knowledge of a human, usually even of an acquaintance, to perform. Previous fingerprint recognition and identification would compare to the chemical composition of meteorites. Today's facial recognition and identification systems would compare to the tacit knowledge of the meteorite researchers. It is easy to see how the same technology can have a major impact in two very dissimilar areas of application.

Application to Robotics: Robotics is an important area of research and development in the space industry. Witness the importance of the robotic arms in space shuttle repairs while in space. Consider also the great successes of the various planetary rovers. The authors would submit that even greater success in the development and deployment of robotics technology in the space industry could be realized through an aggressive knowledge management program. A knowledge management program within the space industry itself is already underway at NASA. A world-wide working group within the International Academy of Astronautics has also concluded that there is a very real need to seriously focus on identifying, capturing, and using the knowledge gained about mission –based successes and failures through decades of space activities [2]. Most documents, insights, results, and general information about our work in space has been retained in mission specific memory. It has only recently been recognized that this impedes the sharing of this knowledge across missions. This is even more complicated since the exploration of space has taken on a serious international dimension [3].

Knowledge management was first recognized as beneficial within the boundaries of a particular organization or company. The oft-repeated mantra was that an organization could gain competitive advantage through use of a good knowledge management system within the firm. We are now extending this, in the realm of space activities, to an entire industry. The belief is that everyone within the industry can benefit from this management of knowledge across the governmental organizations, companies, professional societies, etc. that make up a particular industry. However, the area of robotics research is multifaceted and crosses the boundaries of many different organizations and industries and /or professional specializations. Because this research is being conducted within each of several different realms, there is often a "stovepipe" effect. This means there is little sharing of the knowledge gained outside of the particular professional specialization in which the research took place. As a result, the new understanding or knowledge becomes confined by the ultimate application of the knowledge. Medical robotics discoveries are not shared with those working in manufacturing and industrial robotics, and basic discoveries in artificial intelligence often remain in the laboratory looking for a place to be applied. At times, even the space industry is guilty of taking what has been learned from missions and only feeding it back into the space industry itself. A knowledge management process that would transcend scientific, industry, and application boundaries would allow more rapid development and application of robotic knowledge across all of the professional specializations in which robotics technology is developed and used.

Certainly there is a sharing of knowledge and discovery through traditional outlets, such as peer-reviewed scientific journals, conferences, etc. But the audiences are, by definition, limited to those who are participating and are, by their very nature, specialization focused. Would it not be wonderful to have this knowledge vetted, catalogued, stored, and made available across these specialized disciplines? (See Figure 1.) How many in the space industry are really keeping up with the robotics discoveries and knowledge coming out of the current film, toy, or gaming industries, for example. It may seem unconnected and frivolous to those in the "hard" sciences; however the technological developments in the "Imagineering" industry are highly sophisticated. Think also about the medical area and the vast developments in that arena. We have all seen documentaries about telesurgery and current research involves a "surgical cockpit" system to allow greater precision in the location and positioning of the robotic surgical instruments [4]. Such research and knowledge can easily be useful in the business of planetary exploration. Until we really develop a sense of the "meta" nature of robotics, the pace of development is limited to the knowledge acquired within each industry, application area, or specialized professional discipline.

Figure 1: Robotics KMS Model



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