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Reaching for the Moon: Expanding transactive memory's reach with wikis and tagging

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Table of Contents

Research Articles

Book Review

Reaching for the Moon:
Expanding Transactive Memory's Reach with Wikis and Tagging

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ABSTRACT

Transactive memory systems (TMS) support knowledge sharing and coordination in groups. TMS are enabled by the encoding, storage, retrieval, and communication of knowledge by domain experts—knowing who knows what. The NASA Ames Intelligent Robotics Group provides an example of how TMS theoretical boundaries are stretched in actual use. This group is characterized as being highly innovative as they routinely engage in field studies that are inherently difficult due to time and technology resource constraints. We provide an expanded view of TMS that includes the technology support system available to this group, and possible further extensions to NASA's or other such dynamic groups' practice. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: *Groups; Knowledge Management; Robotics; Teams; Transactive Memory Systems*

INTRODUCTION

The United States National Aeronautics and Space Administration (NASA) is pushing to return astronauts to the Moon by 2020, and then on to Mars (Lawler, 2007). Robots will play a crucial role in this vision by performing time consuming, repetitive tasks that have little to gain from high-level human reasoning. The Intelligent Robotics Group (IRG) at NASA Ames Research Center develops software enabling space exploration robots of the future to carry out their tasks in unstructured environments without requiring human guidance at every step.

The dynamics of innovative, research-oriented groups such as IRG present a considerable challenge to capturing and reusing knowledge. In their discussion of knowledge management in research and development, Armbrecht et al. (2001) note that managing knowledge is not literally possible in R&D environments, and that facilitating knowledge flows is a more productive approach. Support for the development, maintenance, and augmentation of cognitive

Transactive Memory Systems is one way to facilitate these knowledge flows.

Transactive Memory System (TMS) theory provides a framework based on group-level cognition describing how individuals in a group can cooperatively learn, store, use, and coordinate their knowledge to increase the group's effectiveness (Brandon & Hollingshead, 2004; Lewis, Belliveau, Herndon, & Keller, 2007; Moreland, Argote, & Krishnan, 1998; Wegner, 1987). TMS are the cognitive memory systems through which teams know who knows what, who needs what knowledge, and how to coordinate given the distribution of this knowledge. Much of the research on TMS has focused on small, stable groups. However, simulation models suggest that TMS may be of even more value to larger groups, groups in a dynamic task environment, and groups that deal with volatile knowledge environments (Ren, Carley, & Argote, 2006). At the same time, more dynamic and emergent environments present difficulties around the boundaries of TMS mechanisms (Majchrzak, Jarvenpaa, & Hollingshead, 2007; Nevo & Wand, 2005).

Just as returning to the Moon and sending humans to Mars push our technical capabilities, the demands of the required tight time horizons, technical integration, and fluid teams push our understanding of team dynamics and support as well. In the sections of this article, we extend the concept and application of TMS to focus on fluid teams that interact with technology. We review the TMS literature with a specific focus of highlighting areas where knowledge management systems and practices can augment the TMS. We see knowledge management as intertwined technical systems and organizational practices supporting knowledge coordination, transfer, and reuse (e.g., Sambamurthy & Subramani, 2005).

Whereas most TMS research focuses on TMS development through teams working face to face on the task, we focus on how to extend TMS development in settings where computer mediated communication is prevalent and technology augmentation is part of the general task environment. We use IRG as an exhibit for this discussion, and conclude with further design ideas to generalize from this setting to organizational settings more broadly.

TRANSACTIVE MEMORY: A FOUNDATION FOR SUCCESSFUL TEAM WORK

Organizational knowledge is useful to the extent that knowledge is high quality, transfers across users, and is used in a coordinated fashion—for example, when team process knowledge supports the link between task knowledge and performance outcomes (Griffith & Sawyer, 2007; Griffith, Sawyer, & Neale, 2003; Haas & Hansen, 2007; Reagans, Argote, & Brooks, 2005). In this context, task knowledge is knowledge about the task at hand while process knowledge is about how to apply that task knowledge toward performance. Transactive memory, a type of process knowledge, is a team's way of knowing who knows what and how to coordinate as a result (Wegner, 1987). Transactive memory is a powerful force in team performance and provides our focus here (Kanawattanachai & Yoo, 2007; Lewis, 2004).

More specifically, a TMS describes how individuals in a group learn, store, use, and coordinate their knowledge to increase the group's effectiveness (Wegner, 1987). One of the main advantages of the TMS is that it provides individuals with more extensive and higher quality knowledge than they have access to in their individual memories (Moreland & Myaskovsky, 2000). TMS theory builds upon what is known about individual memory functions. There are three stages in individual memory systems: (1) knowledge enters the system during the encoding stage, (2) it is retained in the individual's memory in the storage stage, and (3) it is accessed for use during the retrieval stage (Wegner, 1987). The TMS is a network of individual memory systems with communication links that have been established. These communication links are not created arbitrarily, but can be facilitated by design of the organization or information technology tools that exist within the environment. These links rely on the creation of metamemories (or memories about the memories of others) by individuals in the group. A "TMS is a shared division of cognitive labor" (Lewis et al., 2007, p. 160) in terms of a group managing the three memory stages noted above.

The structure of these systems includes an awareness of knowledge specialization amongst the team members, a level of credibility related to the specialized knowledge, and the ability to coordinate given this specialization (for recent summaries, please see, Kanawattanachai & Yoo, 2007; Lewis, 2003). The literature has established a variety of benefits for groups with TMS. First, the cognitive load on the individual is decreased, thus allowing people to focus on their domain expertise instead of redundantly storing knowledge (Wegner, 1987). Second, individuals have access to more knowledge than they would through their own individual memories (Wegner, 1987). Third, the best qualified person (domain expert) for a given problem will be assigned, thereby increasing group efficiency. Fourth, knowledge coordination should allow members to be proactive rather than reactive in their work (Murnighan & Conlon, 1991). Thus, TMS also refers to the group's ability to coordinate given the knowledge of where the knowledge resides and who should have access to what (Liang, Moreland, & Argote, 1995; Wegner, 1987). Finally, problems should be able to be solved more quickly and with higher quality knowledge since problems will be aligned with domain expertise (Moreland & Levine, 1992).

Wegner (1987) discussed three issues with TMS which are especially important to the features of technology-enabled systems: directory updating, information allocation, and retrieval coordination. Directory updating is the process of keeping meta-memories current to enable efficient retrieval within the system. That is, if domain experts change or new knowledge emerges, the directory must be updated in a timely manner. One of the solutions to this problem is to create directory structures that enable more efficient searching. Information allocation is the process of routing incoming knowledge to the correct location in the directory structure. This is especially important in technology-enabled solutions and the rules for knowledge routing must be established at the system onset, but remain adaptable as the knowledge evolves. When new knowledge enters the system, it should be allocated to the member who is perceived as the domain expert (Nevo & Wand, 2005). In certain cases, an individual retainer is elected based on circumstantial knowledge responsibility (Wegner, 1987). That person may not be the knowledge expert, but they fill the role because they had initial contact with the knowledge. Retrieval coordination is the process of deciding where to look for a memory item. During retrieval, there is an evaluation of perceived expertise before the knowledge is accessed (Nevo & Wand, 2005). An effective TMS also requires a common language for tasks, assignments, roles, and locations of expertise (e.g., Faraj & Sproull, 2000). These issues have implications for technology tools in the areas of user interface design and search algorithms.

Prior research has considered the role knowledge technology plays regarding TMS. Moreland and Myaskovsky (2000) provide one of the most primitive, yet effective versions. They used hardcopy handouts summarizing each team member's skills (based on an earlier performance period). The results indicated that this knowledge was used to form the TMS. Teams that were given the handouts performed significantly better than those that did not have prior knowledge of teammates' skills, and on a par with teams that had been trained as a group. Using a more technically sophisticated approach, Nevo and Wand (2005) designed "meta memory" support via information technology. We note that their work focused on being able to extend the mechanisms of TMS to communities, not teams, and that theirs is a presentation of a design, not a test. Nevertheless, they argue effectively that information technology can support TMS via directories of who knows what, and metaknowledge including the quality of the knowledge held by the person, the cost of obtaining that knowledge, and so forth.

Nontechnical sources can also support TMS development. Baumann (2001) (cited in Lewis et al., 2007) found that role structures from prior groups facilitated TMS in new groups even when group members had not worked together before—if the new task had a similar role structure. Brandon and Hollingshead (2004) suggest that the basics of TMS are created from a variety of sources (memories, overheard conversations, memos, handbooks, etc.). Over time and with interaction, the TMS is refined. Additionally, ongoing maintenance is important. Individuals have an ongoing process of encoding, storing, and retrieving knowledge that serves to update the TMS and keep it aligned with the reality of the group. TMS is “not just any static association of task, expertise, and person information” (Brandon & Hollingshead, 2004, p. 637). We believe that TMS can be supported either by ongoing direct interaction with others, or generalized exchange via communal repositories (e.g., Yuan, Fulk, & Monge, 2007).

The literature has also identified several difficulties in the design of information systems that support knowledge management and transactive memory. First, the often contextualized nature of knowledge presents difficulties, especially during the encoding stage. Second, a considerable amount of knowledge is tacit. Tacit knowledge first exists within individual memories and is difficult to codify and retain, especially in large organizations. Third, the different knowledge locations present problems in a TMS. For example, in the IRG system, individuals retain knowledge in their individual memories; machines or robots contain structured data; organizational procedures and rules exist with embedded knowledge; organizational structure and roles can be captured, but are changing. These various retainer memories may be difficult to combine in a technology tool. Fourth, the volatility of organizational knowledge presents problems. Finally, all of this assumes that the needed information has gotten into the repository—a difficult assumption if people must actively enter this information versus it being collected more passively (Goodman & Darr, 1998; Griffith & Sawyer, 2006).

Several other factors have been identified in the literature as affecting TMS function. Ren et al. (2006) note that larger groups, groups with higher task volatility (the frequency with which the group changes its tasks), and groups with higher knowledge volatility (cases where knowledge quickly becomes irrelevant—that is, decays) are likely to benefit more from TMS than other teams. The key is to maintain an up-to-date view of the expertise distribution. The role of the TMS is to provide access to knowledge when it is needed. This role is more valuable to the extent that there are more places to look (i.e., larger groups), and to the extent that the task and or knowledge is likely to change (requiring new searches).

Dynamic teams are receiving increasing attention. Brandon and Hollingshead (2004) note that it is more difficult to achieve optimal TMS in dynamic contexts (ill-structured problems, uncertain environments, or settings with shifting goals). Lewis et al. (2007) focus specifically on group membership change and note that a key issue is to trigger the reevaluation of the TMS given new members—attempting to put a round peg in a square hole just because that is the vacant hole is not effective. Majchrzak et al. (2007) examined the teams at work during the response to Hurricanes Katrina and Rita. They considered TMS in the context of teams with: sense of great urgency, high levels of interdependence, and constantly changing environments and resources. Moreover, these teams had to manage unstable task definitions, flexible task assignments, fleeting membership, differing purposes (firefighting, security, animal care). However, they also note that these “teams” often violated the boundaries around which TMS was developed, namely, known membership, members perceiving interdependence, and shared goals—the boundaries of the definition for a true team (Hackman, 2002).

THE INTELLIGENT ROBOTICS GROUP

The Intelligent Robotics Group (IRG) at NASA Ames Research Center is comprised of 24 permanent staff members with a diverse skill set and little overlap of these skills within the group. Space robotics is a broad field, spanning the areas of mechanical engineering, controls theory, computer engineering, computer science, through to the nascent social science of human-robotic interaction. The vast scope of developing a robotic space mission requires closely coordinated efforts across many organizations and suborganizations. IRG's research approach is to develop systems-level software and concepts for supervisory control of robotic activities, then validate those concepts in field test scenarios.

The group's core development spans several technical areas, including applied computer vision, robot software architectures, interactive 3D visualization, science instrument integration, and frameworks to support human-robot interaction. Staff members frequently rotate between teams as project requirements evolve, and every project involves external collaborations. Virtual teaming is common and necessary, and the teams are comprised of people from diverse organizational cultures: other NASA centers, academia, large corporations, and small technology start-ups. Virtual teams are assembled from several organizations to develop an innovative technology within a fixed timeframe, then disbanded at the end of the project. Personnel may come and go over the lifetime of each project, and members participate in these fluid virtual teams on a part-time basis.

IRG frequently supplements its workforce by employing interns through various educational outreach programs. Interns will work for the group for anywhere between 2 to 12 months, and at peak times the number of interns may match the number of permanent staff. The level of education of the interns covers a wide range, from high school to doctoral students. Similarly, there is a wide variation in the amount and quality of work accomplished through intern labor. All of the students are bright and motivated, and most make valuable contributions over the course of their employment. Although there are usually a few students that never quite hit stride, every year there are one or two "star" interns that surpass all expectations and make contributions at the level of permanent staff. The departure of star interns often has a disruptive effect on the group's effectiveness. High performing interns acquire trust through action (e.g., Majchrzak et al., 2007) and rapidly become first class participants in their team's TMS. Loss of the intern fractures the stable interdependence of the team as the intern's knowledge role has to be reassigned and relearned.

Paradoxically, the more capable the intern, the less the knowledge transfer to the permanent team. Whereas most interns receive sustained mentoring from a permanent staff member, high performing interns are often trusted to perform their roles with little supervision. Under current methods, this provides little opportunity for knowledge to transfer from the intern to the team.

The dynamics in this setting push the boundaries of TMS development, maintenance, and augmentation. The transient nature of the intern workforce affords them limited time to work on specific projects, and it is critical that the group effectively integrate the knowledge of the intern population before their departure. Additionally, the research focus of the IRG's work is at odds with traditional TMS in that roles and tasks are dynamic, with permanent staff often rotating between projects.

Managing TMS in Dynamic Teams: Quick Start TMS

We will present a sociotechnical approach to "Quick Start" TMS. Our approach focuses on training for team assimilation and systems assimilation via a Wiki[1] platform. Additionally, we will highlight the sociotechnical hurdles imposed for such teams when largely voluntary "Web 2.0" tools are utilized. For example, while everyone in each team should be contributing to the Wiki, the temporary members may be reluctant to do so if they equate temporary with lower status and do not feel it is their place.

We define a "Quick Start" TMS as an approach that provides everything a newcomer to the group needs to rapidly form a mental map of the group as a whole. It goes beyond simply mapping knowledge roles to individuals in the group; it is a mapping of how those knowledge roles apply to the group's projects, how those projects have evolved, how the projects interrelate, and how external organizations and individuals fit into the group's "big picture." It provides high level connective meta-information between projects and existing applied knowledge, as well as conduits to concrete work products as examples, and insertion points for contributing new work products to the knowledge base.

Two mechanisms for achieving these goals follow from the discussion of public goods theory (Fulk, Flanagin, Kalman, Monge, & Ryan, 1996) in communication systems. Yuan et al. (2007) build from this theory to distinguish between two types of TMS information access. The first, connective access, is the direct exchange of information through social interaction. Effective connective information exchange depends on individuals having well developed expertise directories of "who knows what" in order to coordinate knowledge at the team level. Information system support for the development and maintenance of these individual expertise directories has taken the form of online expertise directories, which map areas of expertise to people.

The second type of information access is through communal sources. Communal sources are broadly defined as external information repositories where knowledge can be contributed and consumed by multiple people. Yuan et al. (2007) argue that communal repositories such as corporate intranets, Wikis, blogs, and e-mail lists not only complement connective information sources, they may serve as effective substitutes. One significant advantage of communal sources is that they permit asynchronous access to information, which is a crucial aspect to consider in the context of virtual teams and fluid teams where the information holder may no longer be with the organization.

We draw our confidence in Wikis and other communal sources from experiences across a wide range of organizational settings. Majchrzak et al. (2007), for example, note that Wikis can be used to coordinate within and across emergent groups in disaster relief settings. Rech, Bogner, and Haas (2007) document effective application for software reuse. Cress and Kimmerle (2008) effectively differentiate between the information sharing capabilities of blogs and file sharing systems, and the knowledge development and learning supported by the more collaborative/interactive Wiki process.

We believe the Quick Start TMS approach supports traditional TMS development, and may substitute for access to a particular individual's knowledge. We outline two technology mechanisms that can be foundational Quick Start TMS. The first, a Wiki, is in use in the IRG. The second, tagging information within the Wiki, is under development.

THE WIKI

The IRG has a base system through which they can implement an approach for Quick Start TMS, which will benefit both new and permanent team members. IRG began using an integrated Wiki/Software Configuration Management (SCM)/bug tracking system in 2006. The historical logs maintained by SCM tools and bug tracking systems allow new developers to re-experience the step-by-step evolution of a software code base. Re-experience of the development process through the combination of SCM commit logs, bug tracking logs, code comments, and archived forum discussions constitutes the fundamental mechanism for learning in collaborative open-source communities (Hemetsberger & Reinhardt, 2006) and we think it has application here.

Some of the teams in the group, primarily those that were software development intensive, rapidly adopted the system. Many of the group members have a history of contributing to open source software efforts and were familiar with the potential benefits of the system. Management sponsored use of the system and the group was encouraged to consolidate information that had been spread out among disparate repositories into the Wiki system. The deployment found several champions who promoted Wiki use, created foundation pages, and imported existing documentation into the system.

An informal practice evolved during early adoption of the system wherein if a team member asked a question regarding a project relevant task and the answer required more than two sentences, the information holder was asked, “Is it on the Wiki?” If the answer was “no,” the information holder was asked to create a summary information page. However, during the summer of 2007, IRG encountered operational realities that pushed them to formalize the “is it on the Wiki” process for mission-critical operations. The group carried out a field test of simulated lunar operations involving two planetary robot rovers performing a systematic site survey to map local topography and surface substructure. The robots carried out their survey at a lunar analog site located at the rim of an ancient meteor impact crater in the Arctic Circle (Fong et al., 2008). Operations involved teams at three locations: local operations located at a simulated lunar outpost in the Arctic, a ground-operations team located at NASA Johnson Space Center in Houston, Texas, and a remote monitoring team located at NASA Ames Research Center in Mountain View, California. All three teams shared the same tool chain, but experts for the individual tools were distributed amongst the three teams. All exercise participants had well developed knowledge of who knew what, and operational readiness tests preceding the field exercise had gone smoothly. However, communication barriers and time constraints significantly impeded knowledge coordination during the exercise. Network bandwidth constraints prohibited voice communication to the field site, e-mail turn-around was too slow, and instant messaging did not provide sufficiently rich communication.

Following the field test, IRG developed a cross-training procedure mediated by the Wiki to mitigate future coordination problems. The process begins with the subject matter expert training another group member face to face. Following the training, the trainee summarizes their experience on the Wiki. The trainer then reviews the Wiki page, corrects any miscommunications, and provides supplementary information. Later, a third member of the group is assigned to the knowledge role in question during a test exercise, using the Wiki as their only source of information. During testing, the third party makes note of any questions or operational issues directly into the Wiki. The subject matter expert amends the document, and this process iterates as the document is refined. This process has low overhead as the trainee’s notes are augmented, refined, and validated by collaborative Wiki-mediated exchanges between the subject matter expert and other group members. By artificially inserting the Wiki as a communication medium following the initial face to face transactive information exchange, the information is effectively encoded into the knowledge repository for future asynchronous retrieval, and the iterative validation process assists in transforming the subject matter expert’s knowledge from tacit to explicit.

The Wiki is used in a similar fashion across all areas of IRG’s workflow. During meetings, notes are typed into the Wiki in real time. The Wiki is used for software development discussions and requirements gathering; links between the Wiki, bug tracking system, and SCM commit notes provides a comprehensive view of current software status as well as historical context. Test plans are created in the Wiki for operational exercises and results are noted in the Wiki in real time by participants during the test. At the test debrief sessions which are held upon completion, the test director enters a detailed recap of the day’s events and begins a skeleton test plan for the next iteration.

The Wiki system is a rich communal repository that retains information about virtually every aspect of IRG’s workflow and knowledge products, and as such, provides a solid foundation for a Quick Start TMS. Information is available for asynchronous access from the repository, and it also provides a level of connective support as all information entered into the system can be traced to the individual who entered it. However, as the amount of information in the system grows, access and retrieval become more challenging.

TAGS

There is an additional dynamic quality to the Quick Start TMS approach: tagging, where users freely assign keywords to objects in the information repository using their own understanding of the information. Tagging is nonhierarchical and inclusive, as the group members themselves form the directory structure with their input (Golder & Huberman, 2006). Tagging has been applied in several practical Web 2.0 solutions, including Del.ico.us, a social bookmarking site; Flickr, a photo sharing and cataloging site; and Technorati, a blog search engine. The metadata generated by this activity is shared with the other members and forms the directory structure. The collective metadata has three components: (i) the person doing the tagging, (ii) the information object being tagged, and (iii) the tag data itself.

These processes are closely tied to Wegner's (1987) discussion of directory updating and information allocation in transactive memory systems. Directory updating is fundamentally learning who knows what in the group. It often contains the metamemory or information about the memory. Tagging supports directory updating in that the tag contains information about the contributor, the information object and the descriptive tag information itself. Furthermore, information allocation is the process of assigning memory items to group members. Tagging further supports information allocation in that tags contain information on the person doing the tagging. Generally, the first person to receive any information is assigned to keep it in personal memory and could be the subject expert. In performing a tag-based keyword search, the pointer to this domain expert is thus created.

Tags also add to the Quick Start process via their relationship to sensemaking. Sensemaking is supported as team members process labels, categorize information, and the information's meaning becomes apparent to the individual or the group. Tagging provides "triggers for sensemaking" as taggers and readers of tags are confronted with requests to make sense and/or situations where an other's sensemaking may not match their own (Louis & Sutton, 1991). In their study of tagging using the Del.ico.us social network, Golder and Huberman (2006) found the vocabulary formed quickly, a consensus was formed and it was not significantly affected by the addition of more tags. Even though a stable language emerges, minority opinions can still exist without disturbing the established vocabulary. This flexibility allows tagging systems to change over time with shifts in group membership or the sensemaking patterns of the group.

Tagging has been identified as an alternative to the structured taxonomy or ontology-based approach. Tagging relies on people to contribute to the directory structure to classify information objects (Titus, Subrahmanian, & Ramani, 2007). Taxonomies are hierarchical and exclusive, with regard to the participants' input. Tagging, as noted above, is non-hierarchical and inclusive (Golder & Huberman, 2006). In practice, users freely assign keywords to objects in the information repository using their own understanding of the information. The metadata generated by this activity is shared with the other members and forms the directory structure. In taxonomies, a subset of the user population designs the keywords used in the system. In the NASA IRG environment, an informal tagging approach was favored rather than a top-down ontology as this supports the features needed for Quick Start TMS.

Presently, the IRG Wiki does not use tags. The loosely organized Wiki information causes much of the sensemaking in the group to occur outside the domain of IT tools and through shared experiences. We submit that the Wiki environment is an ideal candidate for asynchronous sensemaking, especially for the transient interns. The interns have not had the benefit of shared experiences and can instead rely on stored knowledge to enable sensemaking.

Current Situation in the IRG and Generalizing Beyond

Dynamic groups need Quick Start TMS. NASA's IRG provides an example where one component exists, the Wiki, but there is room for improvement in the social implementation of the Wiki, and in the use of tags. However, even in this limited form, we offer that there is evidence of success. The Intelligent Robotics Group holds a yearly, off-site retreat in order to reflect on the past year's work, stimulate ideas for future areas of research, and discuss ways to make the group more effective. Two comments were made during the 2007 retreat that had direct relevance to TMS. The first was made by the principal investigator for a recently completed project that had only a few dedicated staff, but involved many of the group members on an as-needed, part-time basis. He thanked those involved, adding:

robotics covers so many areas, and it was really great this year, with all the people in the group - knowing what person to go to to get the necessary bits and pieces, and pulling it all together to make the magic happen.

The second comment came from a new permanent staff member who had been with the group for only a few months. During a discussion on how the Wiki could be improved, he said that it would be helpful for him to have a list of past projects, what software components were reused and developed for those projects, who had worked on the projects, and in what role. Despite being familiar with the individual group members and their core competencies, he was having a difficult time developing a cohesive view of the organization and where his expertise would be most valuable. It became apparent in the discussion that followed that the evolution of projects within IRG—previous projects, technology offshoots, funding sources, project collaborators, and so forth—provided valuable connective information about the group's diverse application areas that mapped organizational goals to technology development. This prompted the creation of a current and historical project directory to provide organizational context for development efforts.

IRG has enhanced group knowledge sharing and retention by integrating a communal information repository into their workflow and evolving social strategies to capture information adequately. But as they reach for the Moon we think there are further opportunities and that these opportunities can support dynamic groups in general. Below we summarize how groups can support their TMS with technology systems that they may already be using. While this generalization is limited in that our main focus has been a highly technical team, these ideas also build on research spanning a broad variety of teams and TMS literature.

Wiki with Tagging as a "Quick Start" TMS enabler

When used as a main part of team work, Wikis, tagging, and search functionality can be used to support transactive memory in the organization. Directory updating is supported by the tagging components as the tag contains a pointer to the contributor, the content and an indication of the content's significance within the group. Knowledge allocation is supported by the tagging feature as incoming information can be dynamically assigned to various knowledge domains based on the tag. Retrieval coordination is achieved as most open source Wiki software contains search functionality for both the Wiki contents as well as the tags.

An additional feature of the Wiki is an indicator of validation. This feature benefits both the information contributor and the seeker as everyone can view contributions and whether they are still in an experimental phase or are a validated method. However, research and development work is iterative and ongoing and the validity of documentation may change over time. Wikis provide a flexible framework for this scenario allowing users to iteratively add to knowledge and change its level of validation as perceived by the group's contributors.

Expertise Directory for People and Projects

The Wiki environment should contain a directory of the staff which provides visibility to the contributor for all content. This system user name would be linked to other metadata, including: (i) self-reported and peer-nominated expertise domains, (ii) past and current projects, and (iii) technology expertise (e.g., hardware or software products). Linking the Wiki content with individuals invites information seekers to seek out the domain expert for face-to-face knowledge exchange if information retained in the repository is inadequate. For groups with dynamic task environments, a directory of past and current projects provides organizational context to enhance coordination. Cross linking the expertise and project directories allows shared resources to be easily identified and provides links to individuals with project-specific task knowledge.

Encourage Contributions from All, but Especially from Temporary Members

Temporary members face challenges with contribution to a knowledge repository due to their transient status and the training required to use a knowledge repository. We overcome this by recommending the use of technologies which are becoming prevalent with the emergence of Web 2.0 and that require little training. When temporary members join the team, permanent members should encourage contribution as part of their mentoring. The message should be made clear that the temporary members were brought in for specialized skills and their knowledge needs to be captured by the organization's memory before their departure.

Adjust Team Design such that Wiki Contribution is Part of Standard Workflow

Teams have enough to do. Teams also have a lot to gain from better dynamics and stronger TMS. We see benefit to teams if systems such as the Wiki and tagging approach described above are how the team does its work—rather than an extra step. Research results, reports, project management, and the like can be managed via collaborative spaces such as a Wiki. These work products then become searchable and traceable—allowing for newcomers and temporary members to get a head start on understanding the work process of the group.

CONCLUSION

Dynamic teams need extra support to manage who knows what—known as Transactive Memory (e.g., Moreland et al., 1998; Wegner, 1987). NASA's Intelligent Robotics Group provides a setting that highlights how Transactive Memory Systems can be pushed to their boundaries given dynamic tasks and team membership. This group also provides an opportunity to evaluate how technology tools and related organizational practices can support TMS at these boundaries—and how a "Quick Start" approach to TMS may provide value in dynamic team environments. We believe the use of Wikis and tagging provides a rich communal repository that supports Quick Start TMS. There are several sociotechnical design considerations in the implementation of this system, including: (i) creating an expertise directory of people and projects in the Wiki, (ii) encouraging Wiki contributions from temporary workers and (iii) making Wiki contribution an unobtrusive task and part of the standard workflow. These technologies can be an effective tool to assist dynamic groups in knowledge sharing and coordination.

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ENDNOTES

[1] A Wiki is a type of server software that hosts Web sites that allow users to add, edit or remove content collectively. Wikis allow users to edit the organization of content as well as the content itself. These features promote open contribution to the Web site and allow submissions from nontechnical users. For more information, please see Wagner (2004).

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