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A Methodology For Capturing Tacit Knowledge Within The Defense Industry

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A METHODOLOGY FOR CAPTURING TACIT KNOWLEDGE WITHIN THE DEFENSE INDUSTRY

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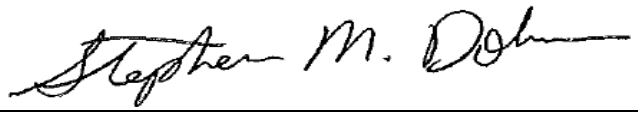

Stephen M. Dokus

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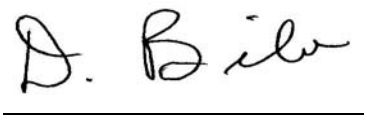

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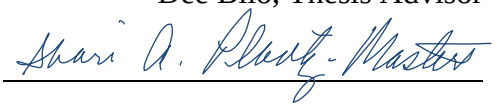

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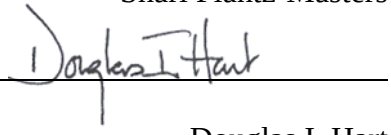

Douglas I. Hart

Abstract

This study looks at the knowledge management practices used by study participants from the defense industry and offers a methodology for capturing tacit knowledge. Interviews were conducted with stakeholders involved in work teams focused on the development and acquisition of defense systems. Those interviewed held various staff and management positions in Program Management (PM), Enterprise Architecture (EA), and system safety auditing. This researcher conducted primary research in the form of a Case Study. Interviewees in the defense industry supporting the Army, Marine Corps and Military aeronautics were interviewed and asked to provide feedback on their experiences and knowledge of tacit knowledge capture. Through a series of questions this researcher was then able to derive a methodology to better capture tacit knowledge in the industry in question. It became evident during the primary research that further studies should be conducted within the defense industry regarding the capture of knowledge from those who have clearances above and beyond "public knowledge". The discoveries in this primary research brought light to the fact that classified tacit knowledge may not be captured, because it is sensitive in nature. Further studies may include research to provide a means of capturing classified tacit knowledge while still maintaining its security.

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Chapter 1–Introduction

Knowledge can be divided in to two types: explicit and implicit (or tacit). Smuts et. al. (2009) define these types of knowledge by stating "Explicit knowledge is defined as knowledge that has been articulated in the form of text, diagrams, and product specifications. Implicit (tacit) knowledge is far less tangible than explicit knowledge and refers to knowledge deeply embedded in an organization's operating practices" (p. 71). For example, Enterprise Architecture (EA) products (such as an Operational View 1 (OV-1))[1] depicting the operational elements of how a system works are explicit, while the knowledge held by a Subject Matter Expert (SME) of the system is tacit. The SME must express the knowledge to a system architect to capture and diagram as an OV or other architecture product. Both support the organization's goals, but only the explicit diagram can be openly understood, depicted, and captured, whereas the tacit knowledge cannot be easily captured by the organization.

The focus of this study is to address the problem of how organizations within the dynamic field of the defense industry can capture tacit knowledge. Best Practices including a formal process involving technology in the form of Information Technology (IT) Knowledge Management Systems (KMSs) is a viable means of capturing tacit knowledge within an organization. The researcher will propose a methodology for capturing tacit knowledge by providing Best Practices of how tacit knowledge is captured on different work teams as well as what organizations do with the tacit knowledge they capture. To do so, the researcher will answer the following questions:

1. Do teams use a formal process for capturing tacit knowledge?
2. What role does Information Technology (IT) play in capturing tacit knowledge?

[1] An OV describes the tasks and activities, operational elements, and information exchanges required to conduct operations. A pure OV is materiel independent. However, operations and their relationships may be influenced by new technologies such as collaboration technology, where process improvements are in practice before policy can reflect the new procedures.(DODAF 1.5, April 23, 2007, p. 4–1)

3. Does tacit knowledge capture pose challenges to teams?
4. If so, what processes are used?
5. Is tacit knowledge captured on every project?

It is clear that tacit knowledge is seen as extremely valuable to an organization, and also difficult to capture. Both processes and systems are necessities for the capture of tacit knowledge. Technology as well as processes can allow for tacit knowledge to be accurately accounted for in the KM process. Answers to questions in the preceding paragraph will support such a conclusion.

The flow of knowledge through an organization is just as important as its use. If knowledge does not flow, it cannot be captured and conveyed to a knowledge user. The following figure depicts the General Knowledge Model introduced by Newman and Conrad.

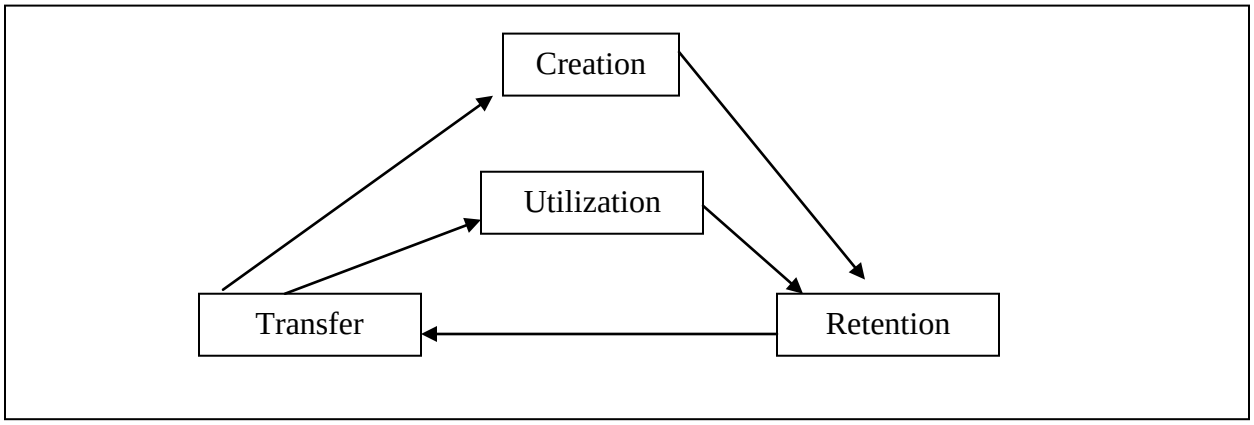

Figure 1–The General Knowledge Model
(Newman and Conrad 2009, p. 16-2)

The authors are visually depicting tacit knowledge as being part of a lifecycle where knowledge is first created, then retained, then transferred, then created as new knowledge by the knowledge recipient. As part of the lifecycle, knowledge is utilized either by the SME or a knowledge recipient. According to Newman and Conrad (2009), "within each activity phase

exists other, smaller knowledge flows and cycles. These layers span a wide range of macro–and micro-behaviors" (p. 16-2). In other words, this model is relevant at any level, be it the work team or the enterprise.

Wagner (1987) defines tacit knowledge as "practical know-how that in general is not openly expressed or stated and must be acquired in the absence of direct instruction" (p. 1236). Only the knowledge owner can convey tacit knowledge to knowledge seekers. Capturing tacit knowledge becomes a problem for organizations worldwide, as this practical know–how cannot be applied unless it is taught or explained to those within the organization.

1.1 Knowledge Management in the Defense Industry Enterprise Level

Many organizations see themselves as knowledge companies. In the defense industry, defense contracting organizations serve a purpose of providing a tangible product or service to the government to support its defense needs. KM is implemented differently in every organization. How KM is implemented is based on the strategic needs of what a particular organization plans to achieve. Organizations often keep methodologies and processes such as KM a tight knit secret. As many organizations are often competing for the same contracts, any competitive advantage may be of benefit to a potential contract bidder. This includes the capturing and holding of knowledge. The following paragraphs provide some insight into organizations that were more forthright with their information. It should be noted that other major defense contractors do not make readily available on their external facing websites information pertaining to their KM. Certain organizations required a lengthy approval processes that did not meet the timelines of this thesis.

Science Applications International Corporation (SAIC), a leader in the defense industry with 45,000 employees, implements an approach that leverages the British Petroleum (BP)

approach to KM. The organization implements a seven phase approach that focuses on learning before doing. According to the organization's external facing website, "Learning before doing" is supported through the Peer Assist process which targets specific challenges, imports knowledge from people outside the team, identifies possible approaches and new lines of inquiry, and promotes sharing of learning with each other through a facilitated meeting" (SAIC, 2011). The key to this is capturing knowledge to ensure that personnel are able to continue supporting the government without facing gaps in knowledge, and therefore gaps in ability. The organization's seven phases, which follow below, demonstrate exactly how the organization leverages knowledge to improve projects in an iterative manner.

- **Phase 0**–Identify and Select Pilot Projects
- **Phase 1**–Customize Pilot Process and Create Stakeholder Alignment
- **Phase 2**–Capture Key Learnings and Good Practices
- **Phase 3**–Establish and Leverage Communities of Practice
- **Phase 4**–Adapt and Apply Best Practices in Pilot Operations
- **Phase 5**–Train and Coach Internal KM Practitioners
- **Phase 6**–Monitor, Review and Optimize Pilot Learning and Impact

(SAIC, 2011)

This methodology listed above equates to success both within SAIC and for BP. According to SAIC, "The business benefits of applying a consistent approach to knowledge management have been significant-BP business managers attributed around $260 million of added value as a direct result of using this approach" (no date). This is a key point, as it addresses the fact that KM practices are not necessarily industry specific. Though knowledge goals may vary, the means of capturing and disseminating knowledge may be identical.

Beyond this, organizations also use KM at the Business Development (BD) level. In order to provide consistency in both the development of proposals as well as conducting project procedures, defense organizations provide knowledge centers that consist of Best Practice procedures in the area of engineering management, Information Assurance (IA), software development, Quality Assurance (QA), testing, as well as system engineering. By doing so, this organization ensures that it maintains the same quality of work regardless of where a project is conducted, or who the customer is. This information can be accessed by any employee as a reference for corporate procedures.

Boeing also implements KM as a means of capturing its employees' knowledge and improving on organizational success. Boeing is a well known defense contractor as well as aircraft developer for industry. Boeing serves as an integrator as well as a weapons systems developer for the Department of Defense (DoD). The enterprise does not serve a niche role, but rather has involvement across hundreds, if not thousands of DoD projects. As with SAIC, Boeing has various tools and techniques to capture knowledge. One of these methods is through video capture. "Video capture has proven to be an excellent way to retain and transfer critical program knowledge, especially from single sources of information" (Arkell, D., October 2007, p. 16). Through capturing interviews and other events such as project close-outs, organizations such as Boeing are able to document any tacit knowledge that may be brought forward by SMEs. This tacit knowledge is then available for use by any potential knowledge user. It is important to note that defense organizations do not seem to use their "own" methodology for KM, but rather adapt various techniques or adapt KM methodologies from other organizations. This is not to say that KM methodologies should be specific to an organization, but should exist to support the strategic goals of an organization.

Chapter 2–Review of Literature and Research

In 1986, Karl Erik Sveiby wrote a book titled “Kunskapsforetaget”. This book, “The Knowledge Company” was one of the early works of business literature to discuss human capital and managing intangible assets. Sveiby, in his discussion of human capital, states that intangible assets are those which “the tacit knowledge functions as a background knowledge which assists in accomplishing a task which is in focus. That which is tacit varies from one situation to another” (Sveiby, December 31, 1997). Tacit knowledge is dynamic in nature and difficult to capture. A methodology for capturing tacit knowledge should provide better KM, as well as a better understanding of how tools such as wikis, Knowledge Management Systems (KMS), and human interaction (meetings, teleconferences, etc.) work to support KM. Its purpose should not only be to meet the strategic goals of an organization, but also to provide refined processes amongst work teams.

KM is an extension of knowledge itself in the sense that unless knowledge is captured and managed, it is of no benefit to others “In the KM process, company management establishes a program whereby experts who possess valuable knowledge collaborate with a Knowledge Engineer (KE)” (Hoffman et. al, May/June 2008, p. 84). It is the tacit knowledge of Subject Matter Experts (SMEs), knowledge that is not evident, that is also captured during the KM process. The authors suggest the inclusion of a KE as a proper means of capturing tacit knowledge.

The research that follows provides seminal and supporting research in not only the defense industry but in other industries as well. It is evident that KM, and specifically knowledge capture, is not bound to a particular industry, but is adaptable for any industry. Though organizations have strategic goals based on a particular industry, the means by which

knowledge is captured, or the methodology, is something that can be used within any industry. That being said, the knowledge of a nurse is different than that of a systems engineer, but how their knowledge may be captured can be the same. It is the intent of the research that follows to provide information that not only directly relates to the defense industry in its current state, but also that can be adapted, or adopted by the defense industry because of the need to capture tacit knowledge.

In a 2009 article G. Mansingh et al. state that in their study of the Caribbean Healthcare sector, "There is no formal system of capturing knowledge from different actors and integrating it with existing knowledge even though knowledge sharing forums exist" (p. 2). The authors are stating that though the knowledge exists, be it tacit or explicit, a formal method does not exist for its capture. The organizations involved take an ad hoc approach through their forums. This approach, as stated by the authors, creates a disconnect where actors possess knowledge, but are unable to codify it, losing its benefit to others within the organization. This, of course, is an issue that can face any industry, including the defense industry. If these forums do not exist, regardless of the industry, implicit knowledge cannot be captured.

Liao, Sun, & Wang (2003) affirm, "Knowledge which has been accumulated only in the minds of the intelligence agents is so called tacit knowledge" (p. 194) and "both tacit and explicit knowledge support the planning function." (p. 194). Yet, the tacit knowledge that belongs to the intelligence agent must be captured. It is assumed that by reporting his or her knowledge, the intelligence agent is able to transfer this knowledge for use at the operational level. Yet again, a formal process does not exist to capture this tacit knowledge. A debrief may be comprehensive enough, but a formal process seems to be missing. This formal process is important in that members of an organization will be aware of where to turn to pass or capture knowledge. A

formal process forces a methodology through standardization across an enterprise. Often, within the defense industry, projects are broken into working groups. These working groups conduct Testing and Evaluation (T&E), Configuration Management (CM), Risk Management (RM), Management, and Systems Engineering (SE), just to name a few functional areas. A formal methodology will facilitate a means of directing knowledge back towards the overall project to enable it to meet the goals in place.

The aerospace division at Federal Mobil Corporation faced a similar problem. According to Gale (2003), “the engineers at the new plant couldn’t figure out how the production process worked” because “the original team found work-arounds and ways to tweak the process that were never recorded” (p. 90). There was not a method or process in place to capture the knowledge of previous engineers. This, as can be seen, was a problem for Federal Mobil Corporation, as knowledge had to be re-learned in the new plant, rather than captured and passed to new engineers.

According to Su et. al. (2007), “A common complaint among Knowledge Management Professionals is that knowledge is difficult to find” and that “knowledge from retirees is asserted as complex and difficult to ‘capture’, necessitating KM (technical) solutions. Aerospace engineers are hard to replace and thusly the knowledge itself similarly so” (p. 199). As with the Federal Mobil example in the previous paragraph, these authors feel that knowledge, especially tacit knowledge in the form of SMEs, is not being captured or catalogued correctly, causing a constant need to re-learn. It is not the personnel themselves that is difficult to replace, but the knowledge they own that becomes a problem if lost. This knowledge capital loss can not only cost an organization SMEs, but also finances lost to new training and new knowledge capture.

As can be seen from the previous paragraphs the problem exists: How does an organization capture something that is inherent to one particular individual while still maintaining its functionality as being beneficial to the organization?

Practicing effective Knowledge Management (KM) is a means of maintaining knowledge that has been captured during projects and as personnel changes. Yet, before knowledge can be maintained, it must be captured. If an ad hoc approach is taken towards capturing tacit knowledge, the KM results may not be comprehensive or accepted by all stakeholders. As an SME, the expert is not only the owner of explicit knowledge, but also of tacit knowledge. If an organization can capture diagrams and pictures representing explicit knowledge, the same should be said for tacit knowledge.

The value in knowledge, particularly tacit knowledge, is its transfer to other knowledge users for re-use. The following figure depicts what Collins (2011) believes are five elements of knowledge transfer:

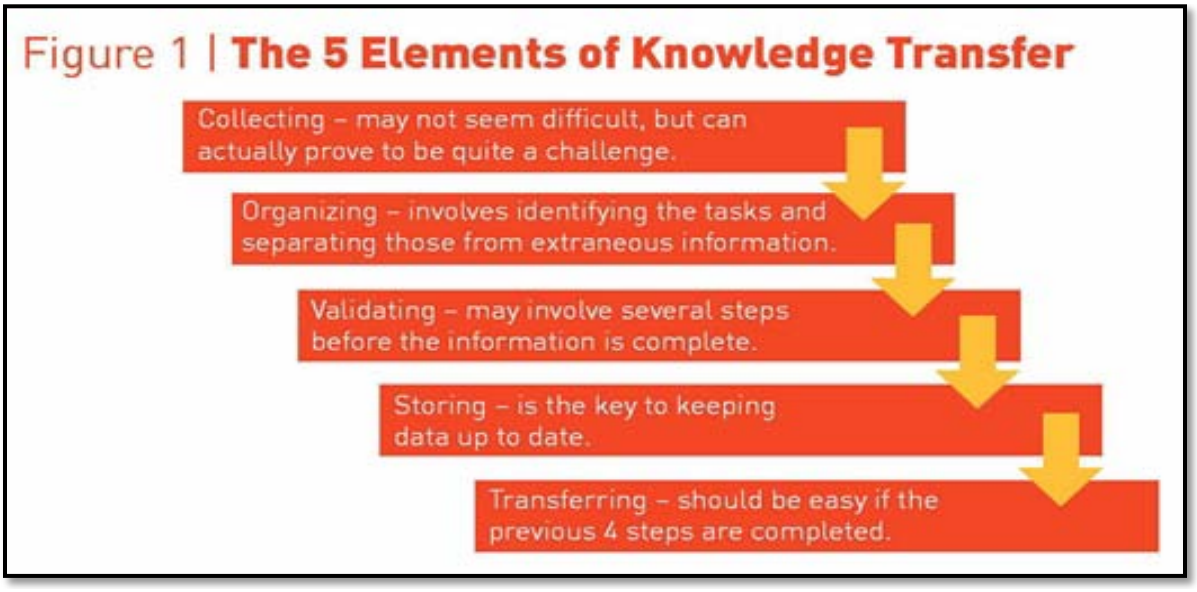

Figure 2–Five Elements of knowledge transfer
(Collins, 2011, p. 61)

The capturing of tacit knowledge, as shown in step one of Figure 2, is important in all organizations, but especially within organizations with dynamic employment changes. The defense industry is no different. Often, employees move from organization to organization, or are left without a contract to work. The JSF program within the Dutch Aerospace field is an example. In their article, Van de Vijver and Vos (2006) state that "innovativeness and the application of knowledge derived from the development of the Joint Strike Fighter (JSF) are, so far, largely unexplored" (p. 155). This, according to the authors, was because workers were not on contract during 2004. If employment was lost after 2004, the knowledge of the SME, the tacit knowledge in particular, was removed from the organization. So, it becomes as if the program had to start from scratch again. Employees that were once associated with the JSF program moved on to other employment, and took their knowledge with them.

Recently, there has been a push by the United States Department of Defense (DoD) to bring work in-house rather than contract it out to industry. This action, dubbed insourcing, has been a strain on knowledge maintenance for those in the defense industry. "Insourcing can build and exploit a reach-back capability to not only capture and institutionalize Best Practices but to draw in and leverage other U.S. Government-wide experts" (Stiens, K. and Turley, S. 2010, p.179). So, as the government brings already trained employees in-house, their inherent knowledge, unless previously captured, is lost to the industry organization. In these instances, there is the loss of employment and knowledge that occurs if a billet is insourced. An employee filling a contractor billet is not necessarily the same employee who will be insourced. If the governmental position is given to another individual, the original SME and his or her knowledge will be lost if further employment cannot be gained. This, of course, can be a significant loss to

an organization. With that said, this research will focus itself on the defense industry, one that is dynamic.

There are, of course, methodologies for the capture of tacit knowledge, and knowledge in general. As mentioned, these can be used in any industry, because the overall goal of capturing knowledge does not change. Jackson (2010) suggests a very general four step process for the capture of tacit knowledge. His suggestion is as follows:

1. Develop an overall strategy for knowledge capture.
2. Prepare the knowledge capture interview.
3. Conduct the interview.
4. Process and load the knowledge capture. (p. 921).

Clearly, the author's suggestions are predicated on a SME being available, as well as an existing ability for the SME to be able to codify and/or fully explain his or her tacit knowledge. Beyond this, it is also assumed that IT will be used as a means of warehousing any knowledge that is captured. By doing so through video and/or audio recordings, historical references are then created and can be searched and examined by a knowledge user.

Becerra-Fernandez et. al. (2004) suggests one means of capturing tacit knowledge is through externalizing it. The authors state "externalization involves converting tacit knowledge into explicit forms such as words, concepts, visuals, or figurative language" (p. 34). Externalizing knowledge, or converting it to a more understandable form (explicit), eases the capture process. In organizations such as Science Applications International Corporation (SAIC), Booz Allen, and even the DoD, this can be done through working groups and Program Management Reviews (PMRs) where inherent knowledge is briefed and captured by the audience involved. This is standard practice on projects.

As a means of capturing knowledge "Nokia elicits proven solutions from standards, universities, research institutes, other companies, and commercial consultants via different kinds of research and partnership arrangements" (Kumar and Thondikulam, 2005/2006, p. 174). Clearly, Nokia's solution to capturing and using tacit knowledge is through researching Best Practices. Through the use of Nokia's Best Practices solutions the authors are saying there must be a means of capturing tacit knowledge prior to being able to disseminating it throughout an organization, or prior to attempting to convert it to usable, explicit knowledge.

Smuts et. al. (2009) have researched and provided process enhancements to a 12-step process for KM first proposed by Calabrese and Orlando. The authors note that the "need to extract wealth from brainpower and knowledge (individual and organizational) becomes increasingly pressing" (Smuts, H., et. al, 2009, p. 70). The authors intimate that knowledge in the form of innovation is as important as, if not more important than, actual wealth as without tacit knowledge, strategic goals cannot be realized. This relates directly to SAIC, where their biggest asset is their employees, as they provide a service, and not a product.

In a study compiled by SAIC, it was determined that the newly developed Onboarding Portal starts the engagement process by helping employees and managers perform the common tasks required to bring on new employees and keep existing talents. (SAIC, 2009). This engagement can take the form of informal discussions, email correspondence, storytelling, or even lessons learned discussions. Regardless of how it is done, engagement is a means of passing tacit knowledge. This is especially evident as organizations transition from one project to the next. Often times, identical or similar processes are needed to complete tasks. If SMEs are unavailable, the knowledge should still be captured, stored, and disseminated if necessary. It

is the ability to capture the knowledge and share with other employees that is the key to studies such as this.

The French defense industry has run in to its own problems regarding the capture of knowledge and KM. According to author Valerie Merindol (2005), "the French system of weapons production is characterized by the drastic restructuring measures that were introduced where relationships between state-user (as customer), the academic research community, and industry have been broken up and restructured several times. This approach has not been favorable for mastering knowledge" (p. 163). What the author is saying is that constant restructuring leads to an inability to capture knowledge in any form. This can be particularly true for tacit knowledge, where as a hierarchy or business relationship changes, knowledge owners are lost, or are reassigned. In the case of this article, there is a direct impact on Research, Development, Testing and Evaluation (RDT&E). A loss of personnel or a change in relationship causes a slowing of the RDT&E process, and hinders the development and procurement of weapons systems.

Workplace learning, or learning on the job is inherent to knowledge. An employee grows as he or she becomes more entrenched in an organization. He or she gains experience in the field of work, and in turn becomes more knowledgeable. Sternberg and Matthew (2009) concede that tacit knowledge may not be captured through a formal system, but can be captured without being aware of doing so stating it is "acquired without awareness and typically not articulated" (p. 530). Yet, the employee is learning as a result of a mentor guiding his or her growth. This is a prime example of knowledge sharing, and knowledge capture by the employee. By practicing the knowledge he or she learns, he or she is codifying it into explicit knowledge.

The engine manufacturer Rolls-Royce, who plays a part in the defense industry, also practices knowledge capture in its projects. The organization "periodically strips jet engines for maintenance and checks for potential issues, each time creating a so-called strip report which describes the analysis of the technical issues eventually found on the stripped engine" (Iria, J., 2009, p. 97). Here, the author intimates that these strip reports are part of a knowledge repository that can be reused in the future, all the while requiring a means of knowledge retrieval. This becomes part of a Lessons Learned that can be reinvestigated on future projects, and a SME is needed to codify the knowledge found in the strip reports and convey it to anyone who may require the information held within.

Dr. Irma Becerra-Fernandez (1998) reiterates a theme for tacit knowledge capture throughout her writings at the organizational learning level by stating "in order for Cambridge to efficiently function and interact among its 41 offices and more than 3,000 employees worldwide, the creation of virtual teams and its interaction must be at all times facilitated and supported with the necessary technology" (p. 47). Organizations such as SAIC function out of hundreds of offices worldwide. Becerra-Fernandez is not far off, as Cambridge faces the same struggles as any defense organization. These virtual teams allow for not only knowledge sharing, but the ability to capture the tacit knowledge of a particular SME that may reside in a different location than a possible knowledge user. This allows for codification and reuse of knowledge.

Likewise, Hoffmann et. al. (2008) suggest implementation of a Chief Learning Officer (CLO) type position stating "We could then use the knowledge bases, including corporate "lessons learned," in training and corporate problem solving. (p. 84). The CLO could then manage these repositories and ensure that valuable intellectual capital in the form of tacit knowledge is not lost. SAIC, along with most corporations, typically have a Chief Information

Officer (CIO), but he or she does not often focus on organizational learning, but rather Information Management (IM) and IT infrastructure. This again supports the need for organizational learning. As an organization evolves, additional positions are created to fill the executive void, and create additional buy-in to support the Knowledge Management Plan (KMP).

The healthcare industry faces a similar problem to that of the defense industry and can be used as a benchmark for KM capture practices. It is necessary for those in the healthcare field to convey their knowledge, typically in rapid fashion. The inability to capture and convey may prohibit treatment or inhibit research that can lead to improved treatment. To circumvent the possible loss of knowledge in healthcare, Mansingh et. al. (2009) suggests the use of knowledge retainers as a means of capturing knowledge because "personalized retainers interact with each other to create organizational intellectual capital, which may also build social capital between retainers" (p. 2854). In other words, a means of tacit knowledge capture is by warehousing existing knowledge when it is shared through various means such as storytelling, or even through demonstrations. If a healthcare provider conducts a procedure to which he or she is a SME, it can be recorded and warehoused, or observed by a learner. This in turn leads to the capture of the tacit knowledge thereby codifying it into explicit knowledge.

2.1 Possible Solutions for Tacit Knowledge Capture.

Tan et. al. (2007) propose the capture of knowledge involves three subprocesses: "identifying and locating knowledge, representing and storing knowledge, and validating knowledge" (p. 19). The authors believe these three steps assist in properly capturing knowledge and ensuring its validity and relevance. The authors make the assumption that regardless of the type of knowledge, these subprocesses will fulfill knowledge capturing requirements.

It has been shown that tacit knowledge is a struggle for the defense industry for several reasons. Yet, because its capture is a struggle, this does not necessarily mean it is an impossible task.

Another method of capturing tacit knowledge is through job rotation. This can be extremely important in the defense industry. According to Castledine (2008) "job rotation is a reciprocal exchange of staff between two or more areas for a predetermined period of time." (p. 1). Here, Castledine is discussing the healthcare industry, but this is a perfect tool for the defense industry as well. Defense organizations such as Boeing provide employee training rotations. Often times, the employee spends six months in varying functional areas, learning each skill. Clearly, each functional area maintains a SME that mentors the employee who is rotating. This not only allows for a sharing of tacit knowledge by experienced SMEs but also provides a means of employees to learn while doing, fostering an organizational learning environment. This can support the ability to create an ever evolving organization so long as planning and executive support is involved in the implementation of job rotation.

Authors have also suggested the use of podcasting as a means of capturing tacit knowledge. Clegg and Montgomery (2008) advocate, "podcasts let us capture tacit knowledge 'hot off the press', through interviews with project teams. They can provide the background and contextual information that PowerPoint decks and Word documents often lack, and give participants an opportunity to tell their story" (p. 11). Knowledge owners are able to convey their tacit knowledge to knowledge seekers through their own voice. The concept of tacit knowledge being lost in translation becomes irrelevant if the knowledge owner is passing their tacit knowledge in their own words. This tacit knowledge can be captured through the podcast recording, where it can be deployed, if necessary. If the owner of the knowledge is available, he

or she can teach others, or another SME may be required to decode the tacit knowledge. Regardless, the captured tacit knowledge is now available for the organization to use in the future. When teams are spread out nationwide, a tool such as this becomes important. A SME is able to convey knowledge to team members, regardless of location. So, an engineer in San Diego at a testing facility can provide his or her input to a scheduler in Virginia who may not be as adept in the engineering domain. This is but one possible solution to the challenge of capturing tacit knowledge.

In support of these authors, Ormond (2008) provides an out of industry example, stating "some common usages in higher education are: taped lectures, guest speakers, group presentations, tutorials on lab assignments, exam reviews, reinforcement of key concepts, and drill or repetition" (p. 233). This is not any different than informal "brown bag lunch" lectures that are provided by organizations such as defense contractor SAIC as a means to share knowledge. Also, every other example provided by Ormond can be used in the training of newer employees, as well as for career training and learning. The requisite knowledge here must be provided by SMEs and accurately recorded for use by knowledge users. In this way, the tacit knowledge of the SME is being codified, and when watched is being expressed as explicit knowledge. However, when initially recorded, the knowledge is captured as tacit.

Lessons Learned is another way to capture tacit knowledge and allow it to be shared across domains of an organization. This holds true for both government and industry. "In the United States, repositories of lessons learned, knowledge-sharing forums, and communities of practice are being used in the Air Force, Army, Navy, Department of Energy, and National Aeronautics and Space Administration (NASA) for experienced employees to share stories and knowledge with junior members and for agencies to exchange security-related intelligence with

one another" (Pee, L. G. and Kankanhalli, A. 2008, p.439). In the past, organizations have often struggled to find a way of passing along knowledge from the senior personnel to junior personnel. The opportunity to establish KM within an organization permits organization wide knowledge capture, storing, sharing and re-use.

It is evident that technology is an important tool in capturing tacit knowledge. As technology evolves, there become more effective means for the capture of tacit knowledge within organizations. Web based systems such as wikis are becoming more and more a part of daily work processes. Yet, to support the technology a backbone or framework is needed as a means of structuring the strategic goal of tacit knowledge capture. Boyce et al (2008) suggest the following:

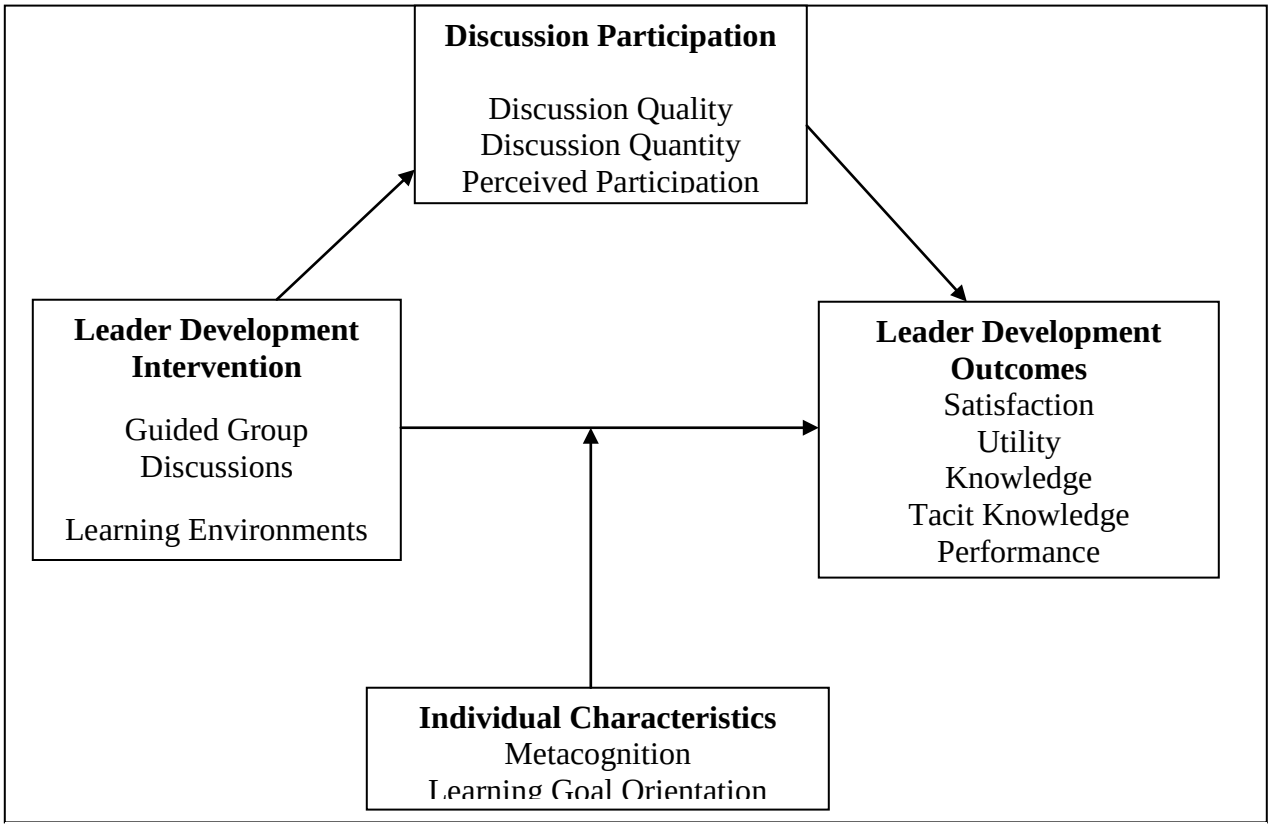

Figure 3–Conceptual framework for understanding the effectiveness of technology in developing leader tacit knowledge
(p. 272)

Technology and best practices should not be the only means of tacit knowledge capture that are investigated. Proper organizational structure and management also supports the ability to capture tacit knowledge. To be a learning organization, leadership must be involved. Dr. David Skyrme (1997) suggests several organizational needs that will foster KM and knowledge capture. These are:

- A knowledge leader or champion-someone who actively drives the knowledge agenda forward, creates enthusiasm and commitment
- Top management support–a CEO who recognizes the value of knowledge and who actively supports the knowledge team in its work
- A clear value proposition–identification of the link between knowledge and the bottom line business benefit; new measures of performance and appropriate rewards
- A compelling vision and architecture–frameworks that drive the agenda forward
- Effective information and knowledge management processes

(Section 5.1)

It is important to have this organizational support as, most times, top management and a champion are the decision makers. These decision makers possess the organizational knowledge that will support the growth of a KM program. If a CEO is in favor of supporting the growth of a learning organization, chances are this will come to fruition. What Skyrme is saying is that for an organization to "learn" the capture of knowledge is not enough. A plan must be in place that will support the goal of becoming a learning organization.

It becomes clearer that a learning organization must tap several areas of development to fully take advantage of KM. Not only is organizational support needed, but formalized planning

is also a necessary means of ensuring an organization not only has a means of capturing knowledge, but also has a plan in place for what to do with knowledge once captured.

In ensuing publications, Skyrme (1998) suggests IT is also a contributor to KM and knowledge capture. The use of organizational intranets is suggested as a means of tacit knowledge capture. "Booz Allen Hamilton's (BAH's) Knowledge Online is an intranet that provides a wealth of information (e.g. best practice, industry trends, database of experts) to their consultants worldwide" (p. 36). SMEs are able to manage this information and ensure their tacit input keeps everything up to date. At the same time, the SMEs input is captured and is codified while becoming part of the knowledge housed within Knowledge Online. BAH, as a services oriented defense contractor, uses such systems to capture and provide knowledge to its thousands of employees. Knowledge is considered an asset to the organization, and something that must be captured and maintained.

2.1.1 Planning

To support the concept of KM as well as the capture of knowledge itself, an organization must plan. Part of this is the development of a Knowledge Management Plan (KMP). In the defense industry, often times projects last several years, or continue until no longer funded. Knowledge goals are extremely important because they support the overall output goals of the project. Those in the DoD must answer to the Joint Chiefs of Staff and brief the Pentagon not only on funding, but programmatic planning. This includes the strategic goals that are fed by knowledge goals. McGarrity (2000) offers the following reasons why a formalized KMP is needed:

- Provide broader and deeper knowledge at the fingertips of staff.
- Provide a ready reference for users, especially when out in the field.

- Provide consistency in understanding policies and procedures
- Provide a repository of how-to knowledge to expand the knowledge of all staff about the work of other areas as well as a reference on knowledge in their own areas.
- Eventually make sections of the knowledgebase available to customers via a knowledgebase. (p. 109)

2.1.2 Knowledge Management Systems

Organizational Intranets are another means of capturing tacit knowledge. As has been previously conveyed, employees' inherent knowledge is tacit knowledge. An organization can capture employees' tacit knowledge through the use of capabilities databases.

Knowledge Management Systems (KMS) can be used to capture tacit knowledge, specifically through the use of Knowledge Capture Systems (KCS). According to Becerra-Fernandez (2006) "Knowledge Capture Systems preserve and formalize the knowledge of experts so that it can be shared with others" (p. 334). The key is to not only capture the inherent tacit knowledge, but also codify it into an easily communicable form of knowledge. The knowledge owner must be able to successfully identify his or her skill level to provide an accurate judgment as to whether he or she is indeed a SME. Regardless, a KCS allows for the knowledge of any level of expertise to be captured and reused at a later date. As an example, Becerra-Fernandez (2006) suggests that when looking for an expert "anyone seeking an expert in a particular field has to use a combination of different tools in order to find the appropriate information. Therefore, a Web-searchable repository of university funded research project information could serve to effectively identify experts in an objective manner" (p. 345).

Many work teams within the DoD are using SharePoint wikis to continually capture tacit knowledge. Team leads are expected to update the sites regularly to share discussion topics as

well as future goals. A wiki is a living document that can be constantly updated with personally owned (tacit) knowledge. Sousa et. al. (2010) state "many corporate intranets now include wikis to encourage sharing. Wikis are convenient tools for collaborative writing and, consequently, for collaborative production of knowledge" (p. 34). Therefore, through the use of wikis, SMEs of an organization can disseminate their knowledge throughout the enterprise, ensuring it is codified. This also fosters a KM concept of a learning organization. By practicing KM and capturing tacit knowledge, an organization must strive to constantly mature. New knowledge should be seen as a vital asset that in the future will provide an advantage against competition. In almost a "train the trainer" concept, socialization is a means of fostering a learning organization. "Socialization is the process that people transfer tacit knowledge to tacit knowledge" (Sousa, F., et. al., 2010, p. 34). The ability of SMEs to convey their tacit knowledge, as well as the ability of knowledge users to comprehend the SME, allows for knowledge users to also become SMEs in a certain functional area.

Wikis are becoming a common means of capturing and codifying tacit knowledge to be shared within an organization. In agreement with Su et. al (2007) the use of wikis provides the ability to fact check at any given time. The authors are stating that putting pen to paper allows for knowledge to be captured, codified, and conveyed to any individual or organization. But beyond this, especially in the defense industry where a 30,000 strong organization is not uncommon, enterprise wide tools become important. Enterprise Resource Planning (ERP) tools are certainly assistive in nature. Supplementary tools, such as SAP, can better streamline an organization's business processes, and support a more efficient passing of knowledge.

Concurrently, Yang and Huh (2008) suggest that "to enable identifying experts in organizations, the expert profile database showing who possess expertise in which fields should

be built" (p. 1446). This is a reoccurring theme, where not only are SMEs required to be identified, but a system must be in place, similar to a set of yellow pages, that allow for faster identification of a SME should their services in the form of tacit knowledge, be needed. As has been noted, organizations such as SAIC use an employee capabilities database to do such things. This enables the ability to identify SMEs for potential contract bidding opportunities.

When business development is consistently ongoing, such as with SAIC, it is necessary to document any knowledge for reuse. This is not only employee knowledge, but organizational as well, in the form of Best Practices and processes. As an example, when the Marine Corps Systems Command (MCSC) contracts department releases a Request For Proposal (RFP), any defense contracting organization must be able to quickly pull together a proposal to meet the deadline. This often requires the reuse of verbiage, or an identification of Capability Maturity Model (CMM) processes. According to Becerra-Fernandez and Stevenson (2001) organizations should have a technological repository of best practices and lessons learned to benchmark performance against standards (p. 509). Regardless of what the product is, the authors of this article are adamant about capturing best practices as a means of retaining knowledge. By capturing the knowledge through best practices, an industry is able to repeat the process through the use of knowledge, and ideally improve upon it, saving money and improving quality. All the while, the knowledge is never lost, but rather becomes part of the organizational capital. It is a permanent asset rather than a potential loss.

Yet, a defense contractor must also ensure naming conventions are used and data organization/management is in place to quickly identify knowledge residing in its databases. Falconer (2011) warns of the pitfalls of using IT for the storage of Best Practices. "In many organizations, their corpus of knowledge is just like this: it consists of a lot of useless material

and some quality stuff that is probably quite difficult to unearth (p. 176). Therefore, though IT is certainly an important tool for the capture of tacit knowledge, it must be designed and used wisely. Failure to properly plan and develop a KMS will result in a tool that hinders an organization and that may cause difficulties in not only capturing tacit knowledge, but also re-using it.

The use of SharePoint is becoming more and more common within the DoD. The Marine Corps Enterprise Information Technology Service (MCEITS) is hosting SharePoint portals and many Product Groups (PGs) within MCSC are using SharePoint for collaboration and knowledge sharing. Hayes et. al. (2005) support this and suggest a "Web-oriented knowledge capture tool must be more than simply a user interface to an ontology editor; it must in addition provide intuitive mechanisms for *locating* appropriate formalized concepts in previously published Web ontologies" (p. 99). The authors believe knowledge sharing tools are of no use to a possible knowledge user if he or she cannot locate the knowledge in question. If a user is not an expert, he or she may be unaware of exactly what to look for. The knowledge user must be educated on how to use KM tools. An intuitive search capability allows for a user to mine knowledge and locate knowledge. Knowledge must be tagged properly; otherwise it may be undiscoverable even when added to SharePoint in the form of white papers, wikis, and briefs. Therefore, by having a knowledge expert provide and map knowledge, while having a knowledge user search for knowledge, the lifecycle depicted on the following page comes in to place:

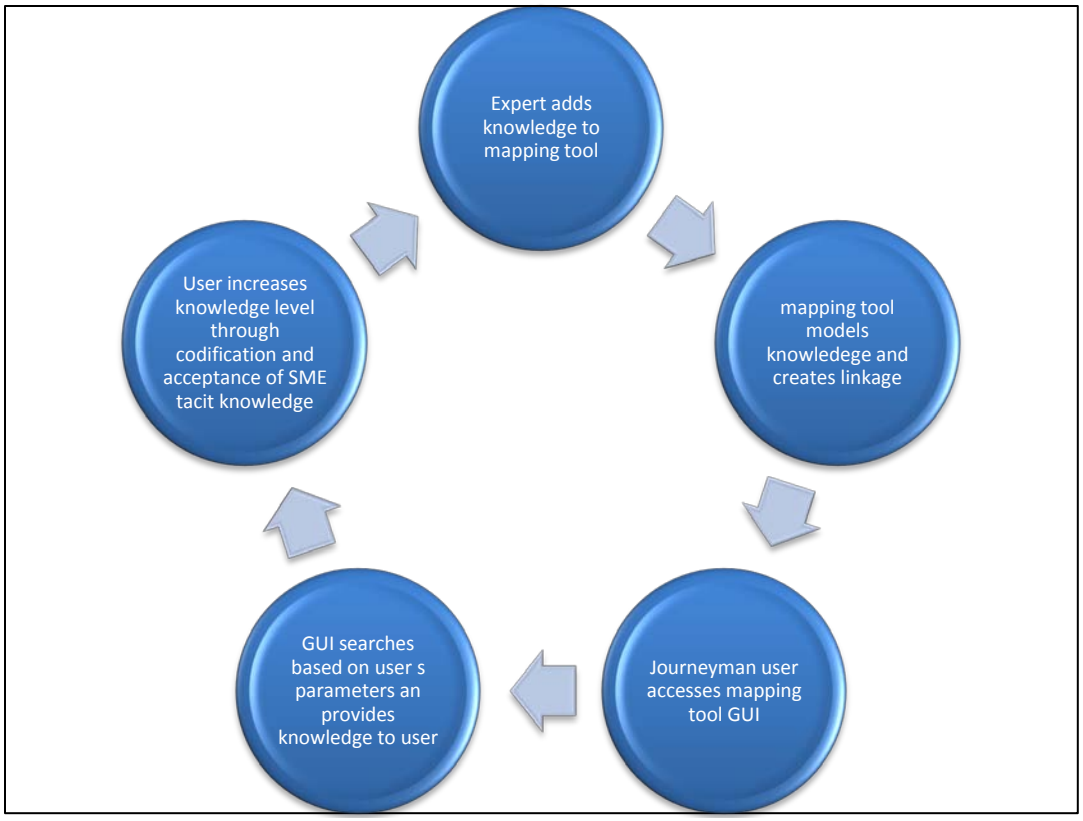

Figure 4–Knowledge Mapping Lifecycle
(Derived from Hayes, et. al, 2005)

2.1.3 Organizational Learning.

Learning by experiencing is especially important in areas such as engineering. In "learning on the job" Anis et. al. (August 2004) suggest in dealing with a situation, an individual will first identify and make sense of relevant information necessary for understanding the issue. Next, he/she needs to integrate all the relevant information into a comprehensive cognitive structure. The final step in this process is to relate and compare this newly formed information to relevant prior knowledge (p. 558). The authors are suggesting capturing tacit knowledge by learning it. Once it is learned and integrated, it can then be used on the job as knowledge. This becomes an important aspect for new employees. If an employee such as a junior Enterprise Architect (EA) is not learning and progressing, not only is knowledge being kept internal to the

SME, but he or she is not value added to the team. Therefore, the lack of knowledge capture demonstrates that not only is the new employee not an asset, but if unable to convey his or her tacit knowledge, the SME becomes less of an asset as well.

Even defense industry organizations maintain an education department. As an example, SAIC maintains its SAIC University as a means of continuing training and fostering continuous learning. The purpose behind this is to gradually improve its employees' tacit knowledge, causing them to be greater assets for the enterprise's strategic goals. Education itself deals with the passing of knowledge as an aid for learning. In the field of education it is widely accepted that a Grade Point Average (GPA) is a measure of tacit knowledge. Its cumulative effect shows knowledge that a student has obtained. "Tacit knowledge is developed through action and experiences" (Insch, McIntyre, and Dawley, 2008, pg. 563). Insch et. al. are saying that education received is a means of developing tacit knowledge. Each student takes away different knowledge from their experiences, therefore converting explicit (known) knowledge to tacit (abstract) knowledge. If formalized, this creates a means of not only passing tacit knowledge, but tracking who receives knowledge, and identifying them as SMEs in specific areas. This, of course, is true in the defense industry within SAIC or Boeing, or any other of the numerous organizations that support the DoD.

According to Gold et. al. (2001) "employees should have the ability to self-organize their own knowledge and practice networks to facilitate solutions to new or existing problems and to generate or share knowledge" (p. 189). This ability to socialize not only can increase employee satisfaction, but provides a means of fostering a learning environment. Going beyond storytelling, employees work as teams to pass and capture tacit knowledge while codifying it in

to knowledge that is easily understood by the knowledge user. In the DoD, as well as other industries, this occurs in working group meetings, PMRs, and training sessions.

Organizational learning is prevalent in the education field, but is nonetheless something that should be considered by all organizations in all industries to ensure all employees grow and become more valuable knowledge capital. It has been suggested that by measuring performance, organizations are able to capture knowledge that may be inherent to a SME. "Regardless of whether they are public or private sector organizations, each should give the same amount of emphasis to planning and managing of human resources in order to increase competitiveness, and to develop the potential competency of the entity" (Wang, Tseng, Yen and Huang, 2011, p. 44). In other words, any industry must take into consideration knowledge capture when conducting business and undertaking a project. It becomes evident that by stressing the need for organizational learning, the tacit knowledge of personnel will increase. They are able to capture the knowledge of a SME and in time it becomes part of their expertise.

It has also been suggested that experiential learning is a means of capturing tacit knowledge. This supports the concept of organizational learning as well. Learning in the workplace equates to learning by experience, and supports the capture of tacit knowledge. Sternberg and Matthew (2009) believe "learning requires social interaction, including feedback and collaboration on shared activities in an authentic context" (p. 531). This interaction is a means of not only developing, but capturing (personally) tacit knowledge that is inherent to another individual. Through informal social discussions, new ideas can be fostered and hence codified. This is the centerpiece of mentor-mentee relationships that may exist in work teams. As a senior level employee leads a team as a SME, he or she is expected to pass knowledge to

foster the growth of junior level employees. As in a previous paragraph, this can take the form of informal discussions by the water cooler, or even monthly "brown bag" lunch sessions.

Three knowledge acquisition components have been introduced by Sternberg (1998): "selective encoding, selective combination, and selective comparison" (p. 69). The underlying theme here is that knowledge capture is not one sided. Organizational learning, explained by Sternberg as a student/teacher relationship, requires the SME (or teacher) to teach before the knowledge user (student) can capture the tacit knowledge. Military cadets have been used as a sample size in the acquisition of tacit knowledge. "Preliminary research conducted with military academy cadets provided initial evidence that students participating in guided group discussions structured around the three knowledge acquisition components demonstrated greater tacit knowledge acquisition compared to students in control conditions who did not participate in such discussions". (Boyce et al., 2008, p. 273). These three knowledge components, discussed in the previous paragraph, show that organizational learning in the form of group learning fosters the capturing of tacit knowledge, or, as the authors suggest, tacit knowledge acquisition.

At the organizational level, in order to capture knowledge it must first be found. If knowledge is an unknown, or a potential user is unaware that it exists, it cannot be captured. Fabbi (2009) suggests an "organizational Call to Action as a means of engaging the entire organization in shared learning and input" (p. 165). As an example, SAIC surveys its employees for input to support strategic goals. This does not immediately relate to direct work, but may assist in future directions, or even something as simple as changing the organization's slogan. If, as discussed, the entire organization is not involved in all phases of knowledge use, the appropriate tacit knowledge will not be captured. This input that Fabbi discusses is the tacit knowledge inherent to SMEs.

To foster the concept of organizational learning, it has been suggested that mentoring is effective, particularly in the field of education. This goes beyond the SAIC University example, and includes ensuring that managers and SMEs are engaged with their team members. "Experienced teachers and novices do not differ significantly in their skills at identifying poor solutions to problems. This finding suggests that tacit knowledge is not so much a matter of learning how best to approach a problem so much as it is about learning how to avoid making a really bad decision" (Elliot, J., 2011, p. 98). Here, the author suggests that mentoring in the field of education assists junior or novice teachers with acquiring the proper tacit knowledge that allows for successful or "good" decision making. The novice professionals are not acquiring SME knowledge through teaching, but rather through professional navigation.

Fægri, et al. (2010) state, "knowledge is embedded in the software systems and direct experience is needed to understand them. Personal experience, such as enabled by job rotation, can improve the ability to create shared understanding" (p. 1121). Through job rotation, knowledge users have the ability to capture the tacit knowledge of particular SMEs and in turn create their own knowledge. As has been stated with Boeing, those selected for the training programs gain the opportunity to learn from SMEs in various functional areas, and possibly on various projects. The diversity fosters thought and knowledge creation, yet before it is created, its tacit nature must be captured.

Chapter 3–Methodology

The intent of this study is to provide a method for the capture of tacit knowledge within the defense industry that involves both Best Practices and the use of KMSs that are designed to facilitate KM. This study was one of Case Study which is a methodology that employs detailed exploration of a particular topic and how it relates to particular subjects. This study consisted of qualitative research derived from the in-depth information retrieved via interviews with individuals throughout several defense industry organizations. The researcher studied select work teams in the functional areas of safety, engineering services, project management, and EA working in support of the United States Army, Military Aeronautics, and United States Marine Corps based on the various functional areas found in a typical DoD project. This researcher then captured the successes and/or issues involved in using currently implemented knowledge capturing methods, and used the responses provided by the interviewees to provide a method for capturing tacit knowledge that will ideally serve as an aid to defense industry organizations.

In the following sections, the method used to complete this primary research will be discussed in detail. A visual depiction of the steps that will be discussed is provided in Figure 5.

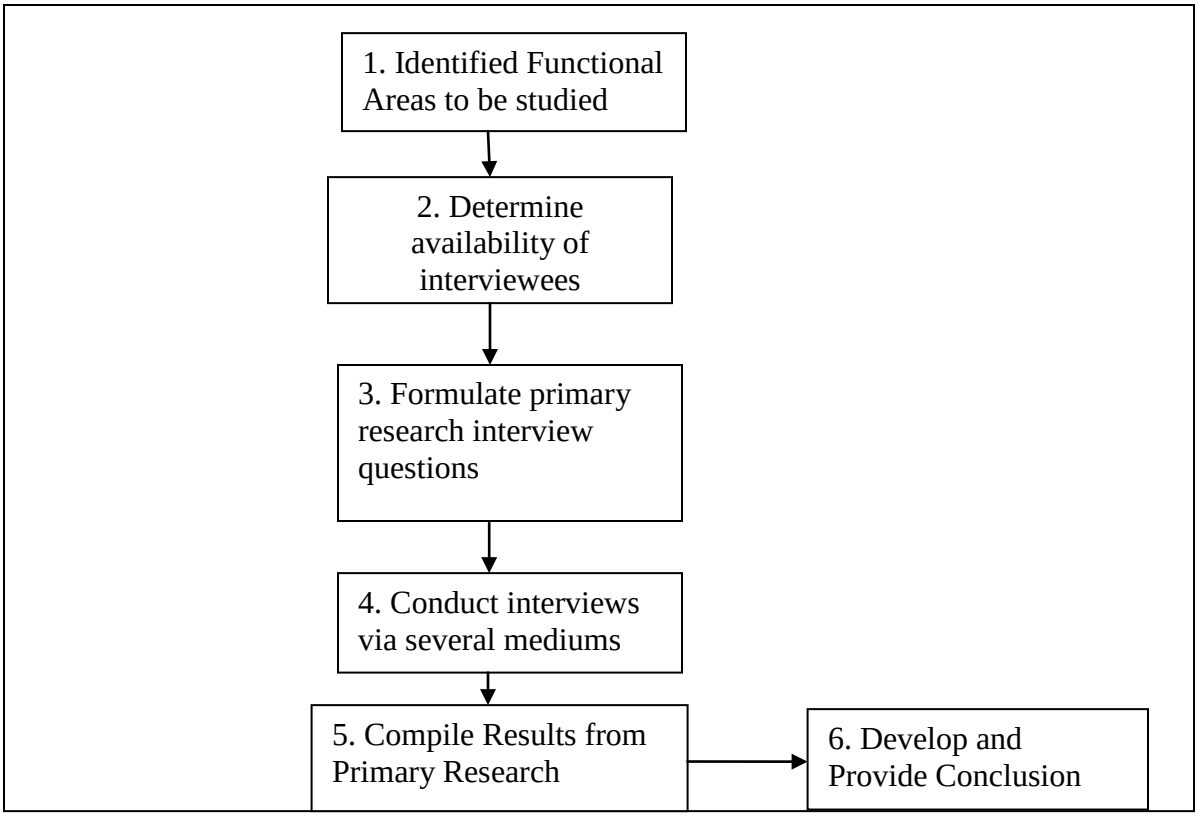

Figure 5–Methodology for Master's Thesis

3.1 Determination of Industry and Interviewees

In this study, the researcher used the defense industry as a means of compiling data. By nature, it is an industry that is volatile and dynamic. Most work is done on a contractual basis that can run anywhere from one year to much longer. It is, of course, at the discretion of the United States government to determine the type of contract awarded.

Many times, personnel become attached to a contract, as they own specialized knowledge that is vital to programmatic success. Because of this, it is not uncommon for a SME to move from organization to organization, or “re-badge” to remain with the same contract. As he or she leaves one organization, this specialized tacit knowledge is lost, but is then gained by a new organization.

Conversely, a SME may choose to leave an organization on his or her own accord to work on a new, unrelated project. This becomes especially detrimental to an organization that is still requiring this subject matter expertise. If the tacit knowledge is not captured before the SME leaves, it can negatively affect the organization's future performance on a project.

These reasons were important deciding factors in the choice of the defense industry for this study. Most times, the organizations can run upwards of 50,000 employees at the enterprise level, yet often act as small businesses at the local office level. The gain or loss of knowledge at any level can have negative ramifications, but this becomes especially evident when it occurs at the work team level while in the middle of a Period of Performance (PoP).

3.1.1 Job Titles

In order to provide a varied sample size, this researcher requested the voluntary involvement of personnel from both the junior and senior level of several organizations, in the areas of project management, safety engineering, architecture and engineering. In order to garner the assistance of personnel, management within several organizations was asked to contact their subordinates and request their voluntary assistance. Each employee, regardless of eventual participation, was explained the interview process, as well as the strictly voluntary nature through the issuance of an Informed Consent. Employees were asked to provide their job title, and nothing more. The following job titles voluntarily participated in this research: (note: more than one person may exist with the same job title)

1. Safety Engineering Branch Manager
2. System Safety Engineer
3. Project Management Analyst
4. Architecture Segment Manager

5. Junior Enterprise Architect
6. System Engineer (Jr. and Sr. level)
7. Program Manager
8. Associate Vice President
9. Program Control Assistant
10. Section Lead
11. Program Management Coordinator
12. Software Engineering Manager
13. System Integration Analyst
14. Project Manager
15. Executive Director
16. Enterprise Architecture Segment Manager
17. Quality Customer Consultant
18. Site Support Technician III

3.1.2 Location of Research

In order to compile a truly varied sample size of research, this study was completed both through email and verbally within the confines of several major defense contractors who provide Engineering Services to the DoD. The purpose behind using multiple points of research is to determine differing methodologies and practices. The organizations that were researched are located on both the East and West coast of the United States, with locations internationally, as well. That being said, most organizations' headquarters reside in the Washington D. C. region, with members of the work teams typically residing in varying locales based on where a particular project is located.

3.2 Formulation of Primary Research Interview Questions

Individuals were targeted not based on particular knowledge, but because an understanding of tacit knowledge capture, or lack thereof, was involved in this research.

An interview was conducted with members of the volunteering work teams from the fields of project management, safety, and engineering including those at a management level who are currently involved in some aspect of KM with this researcher's intent of supporting an eventual methodology for capturing tacit knowledge. These interviews provided information towards determining knowledge capturing practices currently in place, based on a series of questions. The questions asked of each volunteer are as follows:

1. How long have you been employed by your current organization?
2. Does your organization face high turnover?
3. Are Lessons Learned collected at the completion of a project? If so, briefly describe the process.
4. In your experience, does the loss of a Subject Matter Expert (SME) greatly affect your work team? Briefly describe.
5. As a knowledge owner, how do you codify and pass your tacit knowledge within the work team?
6. What formal methods/processes does your organization have in place to capture tacit knowledge?
7. Does your organization use IT (systems, procedure. etc.) to collect knowledge? If so, briefly describe how knowledge is captured using IT (systems, procedure, etc).

8. Has knowledge been passed to you that has assisted you in your duties? How was this knowledge passed to you?

3.3 Procedure

Tractability is an important part of this thesis' methodology and KM as a whole is a broad field of research. This research focused on the methods of capturing tacit knowledge as a means of allowing tractability in this research. The study will be tractable in the fact that it will be limited to several work teams in the defense industry.

Most defense contractor organization's employee numbers are in the tens of thousands. To make the research focused and manageable, a sample of this number must be used. This researcher contacted 50 individuals to participate in the interview process. Twenty-two individuals volunteered to anonymously participate. No interviewee was eliminated from research, but rather considered a valuable member of the sample size.

To conduct the interviews and collect primary data, each interviewee was asked to provide a timeframe of availability. This researcher then scheduled the interview within this time frame. In instances when face to face interviews were conducted, this researcher used a conference room or office space to ensure privacy. Once the interview began, the researcher asked each individual the identical set of questions. In instances where email interviews were conducted, volunteers were sent an Informed Consent form, including a description of intent, as well as the series of interview questions. These volunteers were then asked to return any responses either through mail or email. All transcripts can be located in Appendix (1) of this thesis.

3.3.1 Instruments and Materials

In order to capture interview responses that were conducted verbally a digital recorder was used. Transcripts were then produced, and any digital recordings were destroyed in order to maintain anonymity for any volunteers.

3.4 Data Analysis

Following the completion of all interviews, the researcher thoroughly reviewed all responses and identified any correlations between work teams and use of KM as well as capture techniques. The responses that were obtained were then analyzed to determine how teams are currently conducting KM and capturing knowledge, as well as presenting a more refined methodology for doing so. A detailed analysis of interview responses as well as this researcher's methodology for capturing tacit knowledge can be found in Chapter 4.

3.4.1 Ontology and Epistemology

There is a specific ontology and epistemology used in the underlying research of this thesis. This Case Study consisted of qualitative research derived from the in-depth information retrieved via interviews with individuals throughout an organization.

An interpretivist epistemology suggests that there is more than one correct answer, though one result may be more favorable than another. The researcher believes this epistemology directly relates to the research being performed. Though tacit knowledge may reside within an organization, there is not a "correct" means of capturing it, though one method may provide more favorable results for an organization as a means of preventing knowledge loss.

Chapter 4–Results

4.1 Compilation of Results

In Chapter 3, interview questions were presented as a means of discussing how primary research was conducted. In this section the researcher wishes to provide an in depth discussion of the findings. The remainder of Chapter 4 will then compile these results into a methodology for capturing tacit knowledge in the defense industry.

4.1.1 How long have you been employed by your organization?

This question was asked of all participants as a means of tracking how long knowledge remains with an organization. That is, it may be of the benefit of an organization to retain knowledge owners. Longer or shorter duration of tenure does not reflect poorly on an organization, but simply means that it is possible for knowledge to be lost more frequently.

4.1.2 Does your organization face high turnover?

As has been previously discussed, the defense industry is a dynamic industry in that employees often re-badge in order to continue working with the same customer. As contracts are won and lost, employees must often move on. As a result, high turnover may directly correlate to a loss of SME knowledge. The following graph represents a breakout of responses to questions 1 and 2.

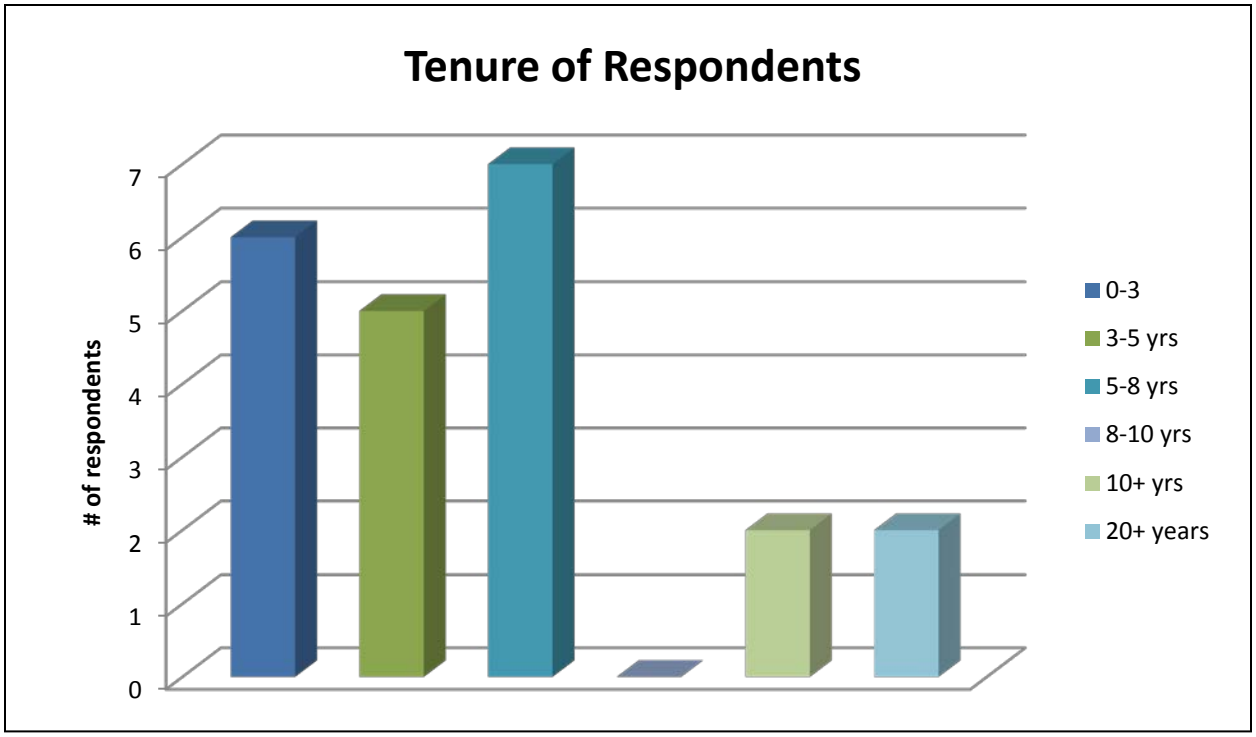

Figure 6–Tenure of Respondents

As can be seen above, the majority of respondents in this sample size have remained with the same organization for between 0-8 years. This may seem like a large amount of time, but in a 40 or 50 year career, eight (8) years is not an extensive amount of time. One employee interviewed was at the junior level, but the majority of those in this tenure range had an immense amount of experience and were considered "senior" either by job title or by work experience. In other words, a SME does not necessarily remain with the same organization for his or her entire career. As he or she moves on to a new project, the tacit knowledge that belongs to the individual is taken to the next organization.

4.1.3 Are Lessons Learned collected at the completion of a project?

Lessons Learned are a means of collecting SME gained throughout the duration of a project. According to the results of the interviews conducted, 41% of respondents claimed Lessons Learned are not completed at project closeout. Therefore, in 41% of projects, all

knowledge that was captured by personnel during the project is not captured or codified and must be re-learned should a similar need arise in the future. This tended to be a common theme across this research study. The consensus was that employees move on to other projects, or other organizations when a Period of Performance (PoP) ended. The project either continues on with no personnel or is simply terminated with an informal closeout. One resounding response spoke to the lack of formal processes:

> Yes (depending on the project), but there is no formal process. On individual solution architectures, findings are documented in the AV-1. At the conclusion of our CBA IPTs, we sat down with our customer, discussed the lessons learned, and developed a briefing. We placed this file on our shared drive, but unless you know that it's there, you wouldn't even know to look for it. We do not have a formal process. (Anonymous, 2011).

In these instances where Lessons Learned were captured, those on this work team were able to then plan for future projects without having to relearn knowledge that was gained throughout the initial project. The effect of the reuse of Lessons Learned is out of the scope of this research and is therefore not included in the study. However, as shown by the individual quoted above, though Lessons Learned is captured, their location is not communicated, nor is it in a location that can be accessed from those offsite. The use of a Shared Drive limits accessibility to those physically located in that office.

Yet, an employee of a defense organization noted that Lessons Learned were a part of daily work. In this interviewee's experience, daily quality reports were collected and then briefed to the IT group. So, on a daily basis, the group was providing and receiving knowledge as part of the overall project knowledge goals.

4.1.4 Does the loss of a Subject Matter Expert (SME) greatly affect your work team?

This question's intent provided reactive responses. Most respondents believed that either another SME would step up to replace one that is lost, or that after an initial reaction of "panic", team members soon realized that though a SME brought excellent knowledge to a team, his or her loss was not a show-stopper.

Some interviewees noted that if only one SME is available, and he or she is lost, then there may be a greater impact. Yet, if several SMEs exist in a particular area, a loss of one does not impact the team as a whole. Yet, his or her loss may still impact the work team, as his or her tacit knowledge may not be shared by other SMEs, even in the same functional area.

Responses to this question varied by individual, as those at a more junior level may not realize the effect of the loss of a SME as immediately as a team lead may. That being said, a junior level employee may realize the effect of the loss of a SME in the long term. Often times, SMEs are responsible for conveying their knowledge to other team members in the form of training. As a junior level employee grows in to his or her position, they are capturing the tacit knowledge of the SME and in turn learning and reusing it. A feedback loop, so to speak, exists in that knowledge is created by the SME, captured by the junior level employee, who in turn becomes a SME in time. When a junior level employee responds that he or she did not feel the affect of a loss, it simply means that the learning, or knowledge capturing phase of the relationship was not initiated between either employee.

4.1.5 How do you codify and pass knowledge within a work team?

The codification of tacit knowledge varies throughout not only organizations, but individuals as well. That being said, a common response to this question was that of hands-on

interaction amongst a work team. As an example, a member of an Operational Architecture team provided the following response:

> I pass on knowledge via internal weekly hands-on team workshops and staff meetings. Also, collaborate with stakeholders in weekly architecture development meetings the solutions are captured in the architecture developed. On a daily basis and as questions arise, emails are the preferred venue to share information, collaborate on solutions and document decisions. (anonymous, 2011).

Through this response it can be seen that this knowledge owner relies on interaction to codify and pass tacit knowledge. The SMEs must be able to make available to the rest of a particular work team the knowledge or expertise. A response as given above did not only come from the those involved in architecture, as 35% of those involved provided an identical, or similar response regarding workshops and meetings. At the same time, 15% of respondents noted that no means exists of codifying and capturing tacit knowledge to work team members, whereas 45% noted some other form of codifying and passing knowledge other than meetings. This left 5% of respondents where this question was an unknown. The responses to this question clearly identify meetings and workshops, as well as use of organizational resources such as IT, as a key quality for the capture and reuse of tacit knowledge. The following chart demonstrates the responses to means of passing tacit knowledge within various defense industry work teams of varying experience levels.

Respondent	Meetings	None	Unknown	Other	Other type
1	1				
2	1				
3			1		
4	0			1	3 P's–Prime, Prompt, and Perform
5				1	training
6		1			
7				1	personal experience
8	1			0	
9		1			
10	1				
11				1	Use of IT
12	1				
13	1			1	Use of IT
14				1	Document creation
15	1			1	weekly reports
16				1	weekly reports
17		1		1	training
18	1			1	shared drive
19	1			1	Quality Reports
20				1	email, verbally, and Q&A sessions
21				1	Handwritten form data, that is then transferred to computers
22				1	By action, phone, and email

Table 1–Ways of Passing Tacit Knowledge

4.1.6 What formal methods/processes does your organization have in place to capture tacit knowledge?

Large corporations are known for adopting and implementing formal processes for various needs and concerns. As an example, and as discussed in the opening to this thesis, SAIC uses the British Petroleum methodology for KM. For one large organization to adopt the KM process of another is proof that it is in some way successful. Yet, it is evident at the team level that KM and the capturing of knowledge is informal, even if formal processes exist at the enterprise level.

An interesting response to this question revolved around standardization. To interviewees work for the same organization, but in completely different areas and projects. One interviewee documented a fairly in depth knowledge capture process, whereas the other employee, working in a more managerial role, noted in the interview that no formal process existed on his/her project. This leads the researcher to believe that though companywide policies may exist within organizations, they may not necessarily be implemented at the project level.

4.1.7 Does your organization use IT (systems, procedure. etc.) to collect knowledge? If so, briefly describe how knowledge is captured using IT (systems, procedure, etc).

In this instance, at the working team level, the common theme was the use of SharePoint type portals, or shared drives. At the enterprise level, organizations implement knowledge management systems to capture and store knowledge, but clearly at a work team level the resources are not as readily available. Most interviewees considered various types of knowledge storing devices or systems as the main artery for knowledge capture/storage.

That being said, employees who were interviewed that work for a major defense contractor mention the use of a corporate wide intranet for knowledge capture and dissemination.

According to one interviewee, their organization's intranet "is the organization-wide authoritative online source of information" (Anonymous, 2011). It is used as a knowledge center for all employees, and provides linkage to any resource that may be required, from employee benefits to business development. Responses from other organizations were similar, with a use of some sort of database or data repository as a means of capturing SME knowledge.

Those interviewed generally agreed that IT does play some part in knowledge capture, but one resounding response was that IT is now difficult to work with due to Information Assurance (IA) concerns. IA is used to counteract security concerns with IT. If a particular system is not IA compliant within an organization, it cannot be used, regardless of the benefits it may afford or efficiencies it may provide. Also, certifying a system may be too costly or time consuming, and therefore other IA compliant systems must be identified should they be needed.

4.1.8 Has knowledge been passed to you that have assisted you in your duties?

This question was asked to develop whether not knowledge capture is only undertaken at the team level, but also whether or not further use of the capture knowledge is evident. Of the 22 respondents, 100% noted that knowledge has been passed to them as a means of assisting current or future duties. Yet, further investigation into the response indicates that personnel often times have difficulty differentiating between knowledge and information/data. In the responses provided in by interviewees, it can be seen that many interviewees discuss the use of data dumps, and passing of information through thumb drives. This does not necessarily mean knowledge is being passed, or captured by the interviewee. That being said, some interviewees noted that training was a method in which knowledge was passed to them. If a SME is conducting the training, which is usually the case, then this is certainly a means of passing knowledge, and of capturing knowledge by the interviewee.

One area of results that was not clear, or not addressed, was that of clearance levels. This is extremely important in the area of KM, as unless multiple individuals have the same clearance or “need to know”, knowledge is most definitely lost with the individual. In these instances, knowledge cannot be captured or passed without high levels of security, and any passage of knowledge may be considered against Federal law. This is obviously difficult to overcome and address, as any tacit knowledge in highly secure projects is vital, but its capture may cause more trouble than intended.

In previous chapters tacit KM and seminal thoughts on ways of capturing it have been discussed. It has become clear that means of capturing tacit knowledge is a completely subjective procedure that varies in its methodology. Commonalities have arisen that point to areas where many organizations in the defense industry use similar tactics for the capture of tacit knowledge. Though there may be areas that differ, and there may be technologies that differ, the intent remains the same–capture, and eventually codify, tacit knowledge to enable its reuse when necessary.

Chapter 5–A Methodology for Capturing Tacit Knowledge

In Chapter 3–Methodology, it was discussed how this research was undertaken. The interview questions that were asked of the voluntary subjects were also provided. The remainder of this chapter will be used to provide the results of the primary research as well as a methodology that can be used in the defense industry based on the responses of the interview subjects. The intent is not to criticize other methodologies that may exist, but rather provide additional support and research to assist in the capture of tacit knowledge by organizations in the defense industry.

Through extensive research, both at the primary and secondary level, this researcher has developed what he believes is a methodology to support this thesis. This methodology is a set of Best Practices that will provide a standardized set of practices that will facilitate the capture of tacit knowledge. It should be stated that this is not the only methodology for doing so, but can be tailored to suit the needs of any work team. The following sections will address the sections of the methodology.

5.1 Planning

Through the extensive research completed, it has become evident that the first step any defense organization should take is proper knowledge capture planning. From the primary research conducted, most work teams informally capture knowledge, and may often ignore it all together. This is detrimental to future success. By planning, an organization can then formalize processes that will assist work teams in the future.

This researcher has stated that a KM Plan should be implemented at the onset of a project. This will ensure that tacit knowledge will be identified as either an input or output of a project, and will be more easily identified. This becomes the most important aspect of the

planning phase of this methodology. The researcher further recommends that a KM Plan be broken up as follows:

- Key knowledge inputs and outputs–knowledge needed, knowledge being learned about, knowledge being shared external to a project.
- KM Protocol–Technologies that will be used, including development of them. This would include identification of SharePoint portals, collaborative environments, Lessons Learned databases, and the like.
- Identification of key roles and responsibilities.
- Plan for implementation (training, if needed, key personnel, etc)

The four areas identified above are essential to support KM as a whole, and specifically the capture of tacit knowledge. Planning should be the first step in a project. A KM Plan enables identification of knowledge goals. By having SMEs involved in this stage, as part of knowledge workshops, not only is their knowledge captured and shared with others involved, but it is also documented as part of the KM Plan. Beyond this, processes and technologies are identified, as well as key players, including the SMEs. This then solidifies the case that planning and the creation of a KM plan is absolutely necessary as part of the tacit knowledge process.

5.2 Codify Knowledge

The codification of tacit knowledge is the transformation from tacit to explicit. Once knowledge is explicit, it becomes more apparent to any potential knowledge user. The biggest underlying acknowledgement in the interview process was the possible misunderstanding of what tacit knowledge is by nature. Therefore, it may be difficult for a knowledge owner to convey the tacit knowledge in a way that can be captured, and to capture knowledge as explicit rather than tacit would ease this process.

Through the research conducted, particularly the secondary research, the codification of tacit knowledge is a major player in the capture of tacit knowledge. The reason behind this is that once the inherent knowledge of a SME is captured, it becomes codified. Therefore, if tacit knowledge can be codified as early in the capture process as possible it will become not only more readily available for future use, but also will allow for greater variability in the use of knowledge capture tools.

Busch, Richards, and Dampney (2003) state "if the knowledge is difficult to acquire it is also potentially difficult to transfer" and "the important point to note is that tacit knowledge cannot by its very nature be passed in written format, as at this stage the knowledge is no longer tacit, but explicit" (p. 38). Here, the authors are stating that codification of knowledge from implicit (tacit) to explicit through writing is a means in which knowledge can be more easily understood. By easing the means of which knowledge is acquired (captured) the authors are suggesting that codification will also increase an organization's ability to then reuse this knowledge should become necessary or important on future projects. This is not industry specific, but is clearly valuable in any industry that may face the loss of a SME at one point in time. The defense industry is clearly affected by this, as contract work is dynamic, and turnover within an organization can be high at times.

The following figure provides a visual (explicit) example of explicit and tacit knowledge capture methods:

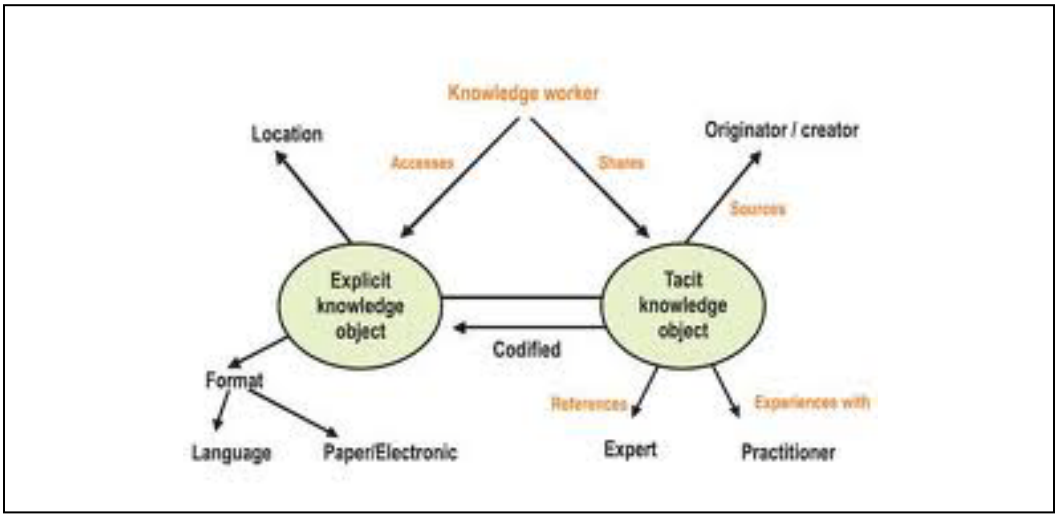

Figure 7–Codification of tacit knowledge and the resulting capture methods (www.trainmor-knowmore.au)

The previous figure results in some knowledge capture methods in the form of papers or an electronic media becomes not only easier to locate, but also easier to reuse. Tacit knowledge, when captured, must reside within the SME or user. So, unless a journeyman knowledge user expects to have a SME with him or her 100% of the time, tacit knowledge should be codified as explicit knowledge. Its codification also provides much more flexibility regarding where the knowledge ends up, in various forms of media, both electronic and non-electronic.

5.3 Formalize Processes

Most respondents in the primary research noted that no formal processes were in place for tacit knowledge capture. Those processes that were in place were considered informal, and not always conducted on a regular basis. This does not involve Business Process Reengineering (BPR), but may just require greater communication throughout the work team, as well as the addition of standardization in certain areas of the work team, such as change management.

Before processes can be formalized, project inputs and outputs must first be standardized. Based on the results of the primary research conducted, most work team processes and

knowledge capturing is done ad hoc. Training varies, and team members may not be aware of the passing of knowledge, should it occur. To ease the knowledge capture process, it is the recommendation of the author that inputs and outputs are formalized in the form of a document or content management plan. Doing so ensures that anything that is captured moving forward is in a standardized, more searchable form. This, of course does not mean that the content must be stated in a certain way, but rather that updates should be provided at certain times, or that file names and change processes are standardized across a project. If a SME has knowledge to convey, he or she is able to identify the correct repository, because the knowledge center is standardized.

The previous paragraph is the first step in formalizing processes. The industry of study being the defense industry means that often times, teams are spread throughout various states or even countries. This researcher has noticed firsthand that when teams are spread out in various areas, knowledge centers are beneficial, but engineers or other SMEs have trouble identifying where to add knowledge if a formal process does not only identify procedure, but also location. A team should formalize and document the process involved in how to share knowledge, so that IT solutions in the form of KMSs can properly capture tacit knowledge. As was shown in the primary research, employees are often unaware of how to share the knowledge they may possess. This then means that attempting to capture it becomes a moot point.

5.4 Educate

It cannot at all be expected for an organization at the work team level to capture tacit knowledge if there is not first an understanding of what tacit knowledge, knowledge capture, and KM are, and how they are all vital to an organization. Often times, organizations provide

training on using time cards, ethics, and even Personally Identifiable Information (PII). Training in KM can certainly support organizational interests as well.

The simplicity of many interview responses showed a journeyman level or below understanding of KM and tacit knowledge in general. On several occasions, interviewees noted they had to research the meaning of tacit knowledge and tacit knowledge capture prior to being part of the interview process. Many noted that after learning what tacit knowledge was, they had a greater understanding of how it could assist in project planning. That being said, if a formal education, if even through a brief PowerPoint presentation, is conducted to the team at kickoff, all team members will not only have a greater appreciate for how KM will assist the project, but also how to deliver their tacit knowledge to a capture method that is formalized by the organization.

It has been brought up by several authors that organizational learning assists in the ability to capture tacit knowledge. If an employee is more understanding of what tacit knowledge is and how it benefits the organization, he or she is more capable of not only passing the knowledge inherent to them, but the organization is more prepared to capture it. As with any other area of interest, education is the first step in successful integration. Work teams with a more educated understanding of tacit knowledge can then relate to its capture. This was true at the work team level, where once interviewees understood what tacit knowledge was, they were able to provide a more educated response to the questions posed to them.

5.5 Leverage IT tools and solutions

The areas discussed in sections 5.1-5.4 are extremely important in the capture of tacit knowledge. As with any skill, to truly be successful at knowledge capture, both SMEs and the organization must have an understanding of what is to be accomplished, and why. But once that

understanding is achieved, it is apparent from the results of the interviews that IT and KMSs are not being leveraged nearly enough at the work group level. The researcher believes that as part of a formal methodology, some sort of KMS, be it a SharePoint portal, or something more sophisticated, should be used as not only a Knowledge Center, but also a means of capturing and disseminating tacit knowledge. Education about tacit knowledge, and a realization of possessing tacit knowledge are important to the capture process, but IT must be used in conjunction with education to physically capture tacit knowledge.

To do so, a formal IT approach to tacit knowledge capture must be designed. This can be done as part of a KM Plan. Section 2 of a KM Plan is typically described as KM Protocol. In this section, KM Champions will discuss any technologies that are being used, as well as how they will be developed. Ideally, a project should initiate a KM Plan at the project kick-off. However, to engrain IT into an already existing project a work group can simply create a Standard Operating Procedure (SOP) that addresses how KM will be conducted, including how knowledge, both tacit and explicit, will be captured and stored.

The best approach to accomplish this is through the use of wikis that can be dynamically updated by SMEs on a scheduled or ad hoc basis. The following sections will discuss several sources of IT or KMSs that this researcher believes should be formally included to aid in the capture of tacit knowledge.

5.5.1 Use of Wikis

As has been discussed, wikis are collaborative IT based arena that allows for a SME, or other member of a work team to dynamically provide knowledge that can in turn be read by others. In conducting secondary research, it was shown that wikis were an excellent means of capturing tacit knowledge. The ability of a SME to put his or her knowledge in to words ensures

that nothing is lost in translation. SMEs can also link to other knowledge areas, creating a mesh-net of captured tacit knowledge. These wikis should be updated in some sort of formal process, be it weekly or even monthly. Allowing updates to be ad hoc is a surefire way to promulgate outdated information. Work teams this researcher has experienced tend to use wikis as a means of collaborating and allowing other members of the team, or other work groups to become aware of the knowledge being created at that work group level. Yet, the use of wikis must also be designed in a way that the knowledge being captured is not only beneficial, but is also updated. This then reverts back to the planning stage of section 5.1.

It became evident in the secondary research collected that wikis are increasingly more common, as they allow for ad hoc tacit knowledge dissemination. By putting subject matter expertise down in words, the knowledge owner is then codifying tacit knowledge in to explicit knowledge, and is able to capture it within the wiki and share it with the work team. Personnel must remember to update the wiki regularly, as knowledge may become out of date if not updated on a regular basis. Out of date knowledge becomes of no use to a work team, or a project.

5.5.2 Use of Knowledge Centers

At the time of completion of primary research this researcher is currently employed by Science Applications International Corporation (SAIC). The organization's vision is "to be the leading systems, solutions, and technical services company, solving [their] customers' most important business and mission-critical problems through innovative applications of technology and domain knowledge" (SAIC, 2011). Even though its endeavors are often at the forefront of technology research, the organization can still benefit from the use of technology tools. The first of these tools that will benefit the organization is an Employee Capabilities Database (ECD).

This is a Knowledge Management (KM) tool that captures the various capabilities of all employees within a noted defense contractor. By having such a tool, the organization is better equipped to diversify itself in the various realms of industry for greater success in contract awards. "This application is intended to help managers, business developers, and other business users find employees based on capabilities. It may also be used by employees to locate other employees with same and similar skills and interests for the purpose of building virtual communities and collaboration" (SAIC, 2011). In other words, an ECD allows not only better positioning for bidding on contracts, but also enables socialization amongst employees–the sharing of knowledge. By sharing implicit knowledge it becomes codified and therefore explicit. There becomes a ever increasing repository of knowledge that can be used organization wide, and it is also catalogued when and if a knowledge owner leaves the organization.

Collaboration through knowledge centers such as SharePoint is ever increasing, especially in the defense industry. Many respondents of the interviews conducted noted that they used some sort of SharePoint portal for day to day activities. It not only allows for document repositories, but can also contain wikis, as discussed in section 5.5.1. To foster knowledge capture, knowledge centers must have a standardized look and feel, so regardless of the section a SME navigates to, he or she is able to locate an area to collect tacit knowledge. It has become evident from primary research at the work team level that teams tend to use KMS such as SharePoint as more of a document repository more than anything else. This is perfectly fine, but systems such as SharePoint and other collaborative knowledge centers can provide much more functionality when designed correctly.

To properly capture tacit knowledge through the use of KMSs, the systems must be designed correctly. This directly correlates to the previous paragraph's discussion of look and

feel. A stovepiped design does not support the capture of a SMEs tacit knowledge, nor does it support potential reuse of tacit knowledge once it is codified. The sites must not only have the ability to capture knowledge through wikis and even podcast recordings, but navigation to them must be evident, as directed in the KM Plan.

This researcher is currently involved in the development of a KM Plan, a process that was not covered in the primary research of this section, as his experience was omitted. Yet, in investigating a systemic process to foster the capture of tacit knowledge, it has become apparent that work teams often "fire and forget" when it comes to collaborative Knowledge Centers. Because of this, Knowledge Centers are beneficial, if planned properly, and governed accordingly. The planning stage discussed in section 5.1 directly impacts this. To take the fullest advantage of IT solutions to capturing tacit knowledge, personnel must be capable of not only locating the Knowledge Center, but also the processes involved in conveying and capturing knowledge. The IT solution should be standardized so as to provide ease of use. Also, personnel must be aware of an update schedule to purge outdated knowledge. Tacit knowledge is not beneficial if it is obsolete.

5.6 Conduct and Record Lessons Learned

Throughout a project every individual has a different takeaway, and every individual "learns" something new. In order to capture what is learned throughout a project, or the tacit knowledge achieved, a Lessons Learned session should be conducted during project closeout. Primary research has identified that most projects go through a closeout stage, but a formal Lessons Learned is rarely conducted. Employees walk away on to the next project. When this occurs, not only is the SME knowledge lost, but achievements from the project may not be

documented. If the organization faces a similar challenge in the future, team members must relearn knowledge that was already learned during a previous project.

By conducting a Lessons Learned, a formal process is added where SMEs and project team members are able to share their tacit knowledge. As an example, as part of this research, this researcher has learned that planning is extremely important in capturing knowledge. It feeds the other areas that truly capture tacit knowledge. If this is not documented, and this researcher researches another thesis, it may take him a month of research to come to the same conclusion. However, if it is documented following the completion of this thesis, he will not have to re-learn his tacit knowledge, as it is already documented and available.

The primary research conducted showed that 59% of interviewees have been involved in projects that conduct Lessons Learned at some point. This is low, in that work team members and leads are not capturing anything learned throughout the duration of the project. Subsequently, 36% of interviewees noted that their teams are not including Lessons Learned at all, whilst 5% noted that they were unaware as to whether or not Lessons Learned were a part of projects they may work to support. It is because of this that the inclusion of Lessons Learned is vital to this tacit knowledge capture methodology. The areas of interest discussed in previous sections culminate in this, as it is the last opportunity to capture tacit knowledge gained throughout a project. The following statement best summed up the responses with regards to this question:

> Lessons Learned collection and recording is frequently talked of but not often followed through. Many of the Science and Technology projects build on previous projects with similar functionality thus Lessons Learned from these previous projects are always at the

forefront of dialogues and discussions, but again they have rarely been documented. (Anonymous, 2011).

5.7 Repeat on Future Projects

The previous sections of this chapter provided a cohesive balance of Best Practices to capture tacit knowledge. Yet, the most important piece of this methodology is the understanding that these Best Practices are not specific to one project, and should be used on every project. SMEs and Project Managers should implement a KM Plan and each of the above supporting steps at the inception of every project. This in turn not only ensures a knowledgeable staff, but also ensures that knowledge capture is part of the project management process.

5.8 Retain Personnel

This is the last piece of the puzzle regarding a methodology for capturing tacit knowledge. The various steps of the methodology discussed in sections 5.1-5.7 are very beneficial to the ability to capture knowledge, but being able to retain the SME is probably the most crucial aspect. As can be seen in the primary research, many of the interviewees believe that the loss of a SME can greatly impact a project if there is not enough knowledge amongst the rest of the team to backfill the lost knowledge.

5.8.1 Quality of Life

A happy employee is a productive employee. It is common knowledge that it is always easier to remain with an organization rather than be in a dynamic state for one's entire career. Therefore, in order to capture (and retain) the tacit knowledge of a SME, an organization must make its working environment a desirable one. This can range from more vacation days, to better fringe benefit packages, or even better health insurance. Regardless, if employees are happy, they will stay. This is true with junior and senior level personnel alike.

5.8.2 Maintain Contract Continuity

It has been noted in the primary research that the defense contract industry faces sometimes high turnover due to the "nature of the industry". SMEs leave one organization for another simply because they are following the contract. If an incumbent does not win the re-compete of a contract, it is very likely that a SME will be hired away to the winning organization. Because of this, and for strategic growth, organizations in the defense industry must constantly re-compete contracts in pre-determined numbers of years. Often times, SMEs are named out specifically by the customer. Therefore, if an incumbent can state in their proposal that a specific SME will be involved, odds are the contract will be re-awarded. By doing so, the SME may stay with an organization and his or her tacit knowledge will be retained.

As respondents to the primary research interviews have stated, having a senior member as part of a team is considered golden. They not only bring their expertise, but as long as the SME is willing, he or she also becomes a teacher for those who are journeyman or junior level employees. Maintaining contract continuity, if possible, ensure that not only will a SME remain with an organization, but also that he or she will be passing their tacit knowledge. It then becomes the responsibility of the work team members to capture this knowledge and put it to use to support the strategic goals of the organization. This is extremely important in the defense industry, where as stated previously, retention may be dynamic in nature at times.

Chapter 6–Conclusions

As has been shown in previous chapters, the area of tacit knowledge capture is one that is dynamic and non-specific. It is apparent that there cannot be one methodology for the capture of tacit knowledge, and the ability to do so is not a straight forward process. Much of the issue behind the capture of tacit knowledge lies in the fact that many SMEs and work team members are unaware of tacit knowledge when using that terminology. In a professional setting, it is more apparent to personnel when subject matter expertise is used rather than the phrase "tacit knowledge". It became apparent while conducting interviews that in some cases, those on work teams understood tacit knowledge only after it was explained to them.

6.1 Lessons Learned

As mentioned in the previous paragraph, as well as shown in the primary research, tacit knowledge capture is difficult, at best, but not impossible. Through this research, it is evident that the tacit knowledge that is captured may only reside in the SME or expert. In order to be captured in a way that makes it accessible to the enterprise, tacit knowledge must be codified in to explicit knowledge prior to its capture. Figure 7 in Chapter 5 shows this in a visual representation.

It became apparent following the conduction of primary research that it is extremely difficult to pass tacit knowledge when security clearances are involved. This was an unexpected area that may or may not become an issue for organizations when replacing a SME. This researcher found that for everyday work, work teams used meetings and emails to pass knowledge, and in turn capture knowledge. That being said, if a SME possesses inherent knowledge about a particular weapons system, he or she may be unable to pass this knowledge, and in turn this knowledge is unable to be captured unless a team member possesses the same

"right to know" clearance. If a SME were to leave the program, this knowledge would be very likely lost.

It also became apparent in this research that process-based KM is not a focus area for work teams. Those who are "doing the job" on a day in and day out basis are mostly focused on their tasks at hand. They interact with each other, and informally pass knowledge, sometimes unknowingly, but most of those who work at the project level do not think about, or are not involved in, the processes that may be in place at the enterprise level to capture and reuse knowledge to benefit strategic goals at the organizational level.

6.2 Future Research

The intent of the research undertaken in previous chapters, as well as the methodology described in Chapter 4 was not only to further the research of experts in the field of KM, but also to provide a basis to further investigate the capture of tacit knowledge in the future. This researcher believes an area of interest for further research could be one that was discussed in section 6.1. That is, research surrounding the capture of tacit knowledge within projects of high levels of clearance. Often times, defense projects require Secret clearance or above. It may or may not be legal to store knowledge when "right to know" is involved.

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APPENDIX A–Additional Research

Organizational Design

Persuad et al. (2001) believe a fix for the inability to capture and move tacit knowledge is "establishing R&D labs in specific locations and assigning these labs specific roles and reporting relationships" (Persuad, A. et. al, March 2001, p. 14). Following this procedure may allow for a standardized capturing ability regardless of the business relationships involved. This may be especially true when dealing with government. The labs become responsible for all areas of research. Because their use is mandated formal processes would then be put in to place. The DoD maintains government labs nationwide enabling defense contracting organizations to support them by providing laboratories in nearby locales that provide specialized knowledge towards the task at hand. As an example, as the US Army migrates its Communications and Electronics Command to Aberdeen, MD, contractors shall provide SMEs in these areas in their own labs to support government projects.

Questionnaires

In his 2005 article Sternberg discusses WICS, or Wisdom, Intelligence, and Creativity Synthesized. In the article, the author proposes tests that can be used to capture and record wisdom, which the author believes is akin to tacit knowledge. Sternberg (September 2005) suggests the following two tests that can be relevant in the defense industry:

1. Everyday Situational Judgment Inventory
2. Common Sense Questionnaire (p. 31)

These tests provide a benchmarking tool to understand inherent tacit knowledge. Situational judgment shows knowledge towards a particular situation, as does the Common

Sense Questionnaire. Both of these tests provide insight in to the knowledge of a SME, as it has been stated that tacit knowledge can be referred to as common sense.

Storytelling

Corporate culture is important in fostering team environments, and this is evident in the defense industry where though employees may work in varying defense functional areas, organizations attempt to unify them and create an identity of being an employee. The organization provides SME support to new employees through its New Employee Network, and foster employee equality through its Women's Network. Storytelling is a recurring theme in the sharing of knowledge. A SME can disseminate his or her knowledge by telling stories or sharing experiences that relate the knowledge that is sought. Communication itself is a means of sharing knowledge, and in turn allowing a knowledge user to capture inherent tacit knowledge. "In the holy writing of various religions, historical and philosophical texts, we encounter icons like Jesus, Mohammed, Confucius, Plato, Aristotle and even the griots of the ancient West African kingdoms, who relied on storytelling to teach social values, customs, ethics, traditions, and the essence of being human" (Agan, A. 2006, p. 77). As deeply profound as this sounds, the moral of Agan's words are that SMEs use storytelling to pass and teach, thereby allowing the capture of knowledge by their coworkers. Storytelling does not see race or religion, but the growth of religions throughout the world strongly supports storytelling's ability to pass knowledge, and as a result capture knowledge.

Historically storytelling provides a means of learning and passing knowledge. A SME must be able to express tacit knowledge to allow for a user to capture it in either the implicit or explicit form. This also relates to the culture of a particular industry. A South African mining company, Kumba Resources, uses storyboards and storytellers stating "each storyboard included

a number of characters who were depicted in a setting designed to be familiar to the story listeners. Storytellers, either members of the management of the mine or specialist storytellers, were deployed to tell the stories, both in English, as well as in a number of African languages" (Tobin and Snyman, 2008, p. 135,137). The DoD uses storyboards to provide insight to projects that are underway. This not only provides pictures, but assists the visual learner in capturing the capabilities provided by a given system that is under development. If the system happens to be Marine Corps specific, Marines may be shown in live fire situations to which those viewing the storyboards can relate. So, by relating to the employees' cultural roots, the organization is able to implement storytelling to share the tacit knowledge that is first storyboarded by SMEs. The everyday worker is then able to capture knowledge on the job in a way that is easily relatable.

In a more modern example Santoro, Borges, & Pino (2010) suggest the use of Tellstory, as it is a "web application where a teller can start a story and invite new participants to join in, recollect and link important facts about a situation they have accomplished together" (p. 140). As SMEs are involved in the process, the amount of knowledge that is captured grows by the number of participants providing relevant knowledge. A weapon systems engineer can simply join the application and virtually provide his or her tacit knowledge. It then becomes the responsibility of the potential knowledge user to capture and codify through learning, as well as the responsibility of the SME to provide updates to what exists, similar to a blog or a wiki.

Most systems developed in the defense industry are deployed worldwide. It becomes the responsibility of Field Service Representatives (FSRs) who are typically defense contractors, to maintain and upgrade these systems. Xerox uses storytelling as a means of improving repair capabilities that can be easily adopted by the DoD FSRs. "Xerox's technical reps (repairmen) famously learn how to fix copiers not from manuals or classrooms but from swapping stories

around the coffee pot, as a series of studies has shown. Those stories have since been collected in a database called Eureka, whose annual value to the company, according to chief scientist John Seely Brown, is over $100 million" (Stewart, T. A., 1998, p. 166). By employees having ad hoc discussions about their success and horror stories, more experienced repairmen are able to share their SME knowledge, and other employees are able to absorb (capture) the tacit knowledge and codify it based on their understanding of the print/copy system being discussed. So, the Xerox example can easily adapt to FSRs, who may choose to swap stories in the mess hall following a day in the field. The only difference between Xerox and FSRs becomes the environment. Fixing a copier in Omaha may be less stressful than fixing a Command and Control (C2) system in Afghanistan.

Collins (2011) believes that interaction in the office place is an important aspect in the collection (capture) of knowledge. "Storytelling is another technique that can be used to gather knowledge gained from experience throughout a career. It's always good to hear about what happened in the past, but the real value comes from learning what actions the employee took and why" (p. 60). By relaying a firsthand account, a knowledge owner is capable of codifying the tacit knowledge he or she owns, and is able to share it with other knowledge users. These users are then able to use this knowledge to better serve as knowledge capital to an organization. This is no different than a debrief that occurs following a mission, or a lessons learned outbrief following the completion of a project or task. Becerra–Fernandez and Sabherwal (2001) concur with the use of storytelling through organizational learning by stating that "by transferring ideas and images, apprenticeships allow newcomers to see the way others think" (p. 3). This is something that is done quarterly or sometimes biannually within the defense industry, where Project Officers (POs) are expected to provide the Command or others within their organization

with a better understanding of the direction of his or her project through a series of slides conveying his or her knowledge.

Becerra–Fernandez, Gonzalez and Sabherwal (2004) also support Collins' technique of storytelling. "Storytelling can help managers and employees to actively think about the implications of change and the opportunities for the future of their organization" (p. 282). In other words, storytelling is a means of conveying tacit knowledge from the SME to the possible knowledge user. Again, a requisite of storytelling is the need for organizational buy in and planning to support KM endeavors throughout the enterprise.

To foster storytelling, mentoring is necessary. It becomes important to foster a teacher/student type relationship to ensure knowledge is being passed from a SME and captured by a knowledge user. A mentor–mentee approach to employee development in project management may not only help improve team morale, but will increase the efficiency of a project and/or organization. According to Swap et. al. (2001), Personnel "learn much incidentally, while eating in the cafeteria, chatting in the halls, observing their colleagues' and supervisors' behavior—and through the vicarious experience of others. Therefore knowledge transfer can occur even in the absence of deliberate intention to teach or learn" (p. 98). By being involved and listening, even informally, personnel are able to capture the tacit knowledge that may be unknowingly passed from an SME. In the defense industry, just as in any other industry, teams are broken in to a team lead, and the "worker bees" underneath him or her. The purpose of this is not only to have the team lead manage the team, but also ensure the team members work towards personal goals. As an example, the DoD uses the National Security Personnel System (NSPS) to track personal goals and objectives. The PM is responsible for fostering employee development.

IT Solutions

Several respondents in the primary research mentioned the use of SharePoint. To elaborate on the use of SharePoint as a knowledge tool and capture system, multimodal knowledge capture brings about joining more than one distinct method to capture tacit knowledge and express it for potential knowledge users. Through the use of system architecture, knowledge can be captured from a SME. The DoD has been striving to use architectures to not only identify current system functions, but to identify future capabilities. In a system architecture, "text is translated to controlled English and diagrams are sketched using CogSketch" (Lockwood and Forbus, 2009, p. 67). Granted, this is simply an example, and various mapping tools exist on the market, including IBM's System Architect. Regardless of the tool, the ability to create a visual, as well as a verbal representation of one's knowledge allows for such tacit knowledge to be captured. The key here is to properly represent any knowledge in a way that is understood by a potential knowledge user. Enterprise Architects (EAs) meet with Capabilities Officers (Capos) who are able to convey their knowledge that is in turn created in to visuals by architects. These architects are often contractors, while the Capos are many times Military Officers. Tools such as this support the overall goal of a project, and capture the knowledge of a Capo while codifying it for future use.

Stenmark (2000) suggests a different approach to tacit knowledge capture. Rather than attempting to codify knowledge in to explicit knowledge, the author states "we should design IT solutions that will help us locate and communicate with knowledgeable people. Expertise is a quality highly dependent on tacit knowledge, and it can often only be observed and recognized through its resulting actions" (p. 10–11). Therefore, the IT used by an organization would not simply capture knowledge, but rather capture the SME and make him or her available for usage.

He or she is then able to disseminate their subject matter expertise in a way that is more easily understandable to potential knowledge users. In other words, by capturing the individual, you capture his or her tacit knowledge.

The Korean companies, OilCo and SteelInc have proven that the use of KMS assist in fostering a positive impact on tacit knowledge capture. "IT tools that support knowledge management activities provide features that encourage certain communication and collaboration practices that facilitate the development of Transactive Memory Systems (TMS) in teams." (Choi, et. al., 2010, p. 857). In other words, TMS allows for not only coordination, but also the sharing and capture of tacit knowledge, so long as it is properly identified by the SME. Choi et. al. (2010) go on to state that "members of a team that has a well–developed TMS are likely to be able to effectively pull knowledge from other team members, drawing on their knowledge of who knows what" (p. 858). By implementing IT, organizations must plan for and understand the strategic goals, as well as be able to properly use a system to foster knowledge capture and sharing.

Knowledge Dissemination and its Importance

Once knowledge is captured, it also becomes an issue of retrieving it and disseminating the knowledge across the enterprise. According to Iria (2009), "traditional information retrieval (IR) techniques not only tend to underperform on the kinds of domain–specific queries that are typically issued against unstructured repositories, but they are also often inadequate" (p. 97). The author assumes that an underlying problem exists not only in the capture of knowledge, but any subsequent meta tagging that may accompany it. If captured knowledge is not properly identified within a repository, it becomes troublesome to retrieve. Irretrievable knowledge is then useless to an organization. As an example, if a SME provides his or her expertise on a

specific type of software code, but then labels the knowledge incorrectly, it becomes lost in the depths of the repository, and possibly unsearchable.

In another study, it has been proposed that "in the corporate sector the Chief Learning Officer (CLO) also known as the Chief Knowledge Officer (CKO) is responsible for the leadership of intellectual assets within the organization and the deployment of resources for learning" (Becerra–Fernandez and Stevenson, 2001, p. 509). Though the authors conducted their research in the education field, this is no different than in industry, where individuals are being asked to operate in an ever increasing fiscally constrained environment. The authors insinuate a need for knowledge to be captured and deployed to meet goals. Innovative thinkers warehousing tacit knowledge can create new and/or creative ideas that support strategic goals. The authors agree that if the education field can capture best practices and knowledge, industry should be able to as well. At the same time, Becerra–Fernandez and Stevenson (2001) also believe "it is up to the organization to adopt the right methodologies and software tools that best meet the demands for storage and reusability of past project experiences" (p. 511). So, though it is admitted that knowledge must be captured, how to adequately do so remains a challenge. The authors also intimate that methodologies are not industry bound, but rather should be tailored to fit KM goals, including enterprise strategic goals.

Busch, Richards and Dampney (2003) agree that the capture and dissemination of tacit knowledge is important to an organization's success by stating that "the capturing of professional expertise usually means articulating tacit knowledge in the form of generalizable principles so that these principles may then be transferred to others" (p. 38). In other words, mentoring becomes a necessary step in the capturing and passing of knowledge within an organization. But the knowledge owner must first be able to codify tacit knowledge in a way that the journeyman

employee can understand and re–capture the knowledge as explicit. Otherwise, the tacit knowledge is unusable to anyone other than the initial tacit knowledge owner. When working in an engineering or SE domain such as the defense industry, this communication is often part of employee growth. SMEs are expected to support their team by passing knowledge to facilitate team success. This success in turn leads towards achievement of enterprise goals of growth of business.