USING CMAPTOOLS SOFTWARE TO ASSIST IN PERFORMING JOB TASK ANALYSIS

Jeanie C. Dumestre
US Navy Advancement Center, Pensacola, FL

Abstract. This paper will describe one method used by the Navy to identify jobs, duties and tasks as part of the Job Task Analysis (JTA) process. It will also show the advantages of using knowledge acquisition and concept mapping techniques along with the elegant simplicity of CmapTools software to facilitate structured workshops. The implications of using concept mapping methodology for JTA are considered. Using anecdotal results from the Professional Mariner (PM) JTA workshop, the outcome shows that it is more efficient and more effective to achieve group consensus with the concept mapping and with CmapTools than with ordinary note taking and summarizing. Having a clear focus during the analysis optimized group performance. The concept-map oriented approach to grouping tasks in terms of major concepts (rather than linear lists of tasks) may add to current job understanding and a more meaningful approach to training. Having the projected maps to center their attention, the groups were able to get a firm grip on the task at hand. Those who participated were well informed and actively engaged in the concept mapping process. The facilitators and the mapping modelers were able to lead the groups to the desired end more quickly than with earlier JTA methods.

1   Introduction

New strategies for United States Navy (USN) training require fundamental changes in how the Navy educates and trains its workforce. The Navy's "Revolution in Training" launches new training ideas with a conceptual shift to apprentice-journeyman-master relationships. This approach is depicted in the USN Five-Vector Model (5VM) graphic. In the 5VM, each vector represents a specific path in a sailor's career. This online model is supported by a database, linking sailors to all aspects of a Navy career in specific job areas. The 5VM will link to Navy and civilian certification programs and training opportunities. Figure 1 is an example of a 5VM screen displayed for an Aerographer at the Journeyman level.
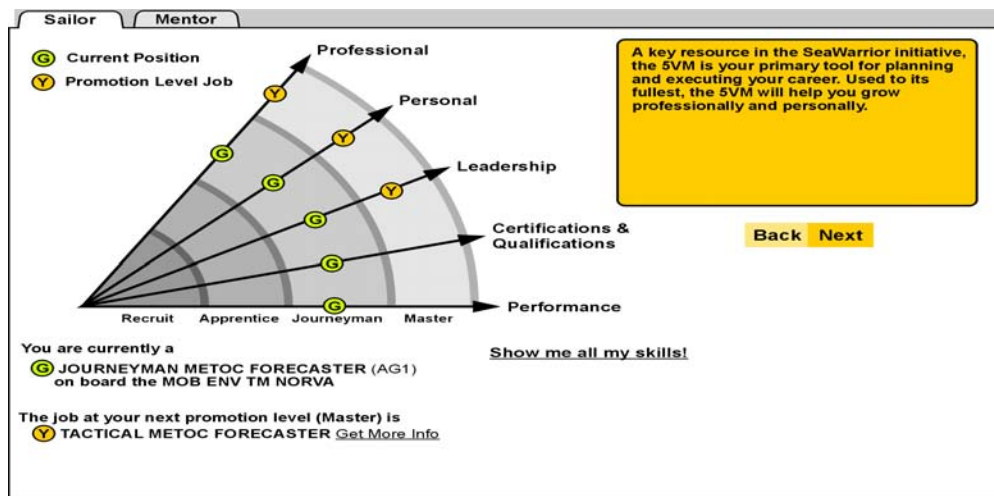

Figure 1: Example of a 5VM for the Aerographers Rating (AG)

1.1   Populating the 5VM

Task Force EXCEL (EXcellence through Commitment to Education and Learning) was established as the catalyst to begin the training revolution. The goal of Task Force EXCEL (TFE) was to create a roadmap for every single sailor on the 5VM, tying military qualifications to civilian certifications. TFE began the process to capture the job specific information needed to make the 5VM available online for every Navy occupation or "Rating." In populating the database behind the 5VM, TFE had the oversight for conducting job and training analyses though a series of workshops. The job data gathered was used to determine the quality of personnel, level of readiness, available resources, mission and manpower requirements.

1.2   Job Analysis Requirements.

The US government (US Department Of Labor 1978) deems job analyses necessary to support job selection procedures. The US Department of Labor (DOL) and the 1991 Americans with Disabilities Act (ADA) set the

standards and guidelines on employee selection procedures. The DOL requires validation of personnel selection procedures by completing a job analysis. There are various ways to perform job analyses that will meet the DOL standards. A web search reveals that numerous companies provide job analysis services to help organizations meet the DOL and ADA standards. This paper will describe one method used to identify job, duties, and tasks as part of the Navy's Job Task Analysis (JTA) process. It will also show how concept mapping and CmapTools software can be used to improve this JTA process.

2   Job Analysis in the US Navy

TFE has used JTA for Navy Ratings, to identify jobs, duties and tasks, and the knowledge and skills necessary to perform a job successfully (Foster, Jones, and Becraft, 2000). In some cases, this process has been used to identify common tasks among Navy Ratings, in order to merge some Ratings and eliminate others. Many JTA workshops have been conducted to identify, by Rating, the jobs, duties and tasks of the Navy's sailors and the skills necessary to perform those tasks successfully. A primary focus of the USN JTA has been to look at a given Navy Rating and match it to a comparable civilian "community of practice" or "occupation" and its associated certification standards.

2.1   Performing Job Task Analysis in the Navy

JTAs initiated by the Naval Air Systems Command (NAVAIR) use a formal process involving scoping meetings, workshop brainstorming sessions, review, and analysis. This improved JTA workshop process identifies functional areas, jobs per function, duties per job, a list of job tasks, and levels of skill required for the jobs. This structure is similar in format to that of other process formats like Joint Application Development (JAD). Key people involved are similar to those identified in the JAD process (Yatco, 1999):

- **Executive Agent:** The executive who charters the project, the system owner. They must be high enough in the organization to be able to make decisions
- **Project Manager**: The military leader representing the Executive Agent. The Project Manager observes the process and answers questions about the project regarding scope, time, coordination issues and resources. This person will assist the facilitator in recognizing issues that can be resolved at the meeting and will take for action issues that must be resolved later.
- **Facilitator**: Provides the structure and keeps the group on task. The facilitator is responsible for identifying issues that can be settled at the meeting and issues that require further resolution.
- **Recorder:** Documents what takes place at the sessions and supports the facilitators and managers producing the final reports.
- **Participants:** Navy sailors directly or indirectly being affected by this project, who are experts in their field and can make recommendations about their work. They provide the input to the workshops.
- **Observers**: The military and civilian members of the upper echelon who work at varying levels to support that Rating. They are present to observe the proceedings and answer questions.

2.1.1   The JTA Workshop

The Navy brings together a group of specialists in a particular Rating (occupation) or group of Ratings. These Subject Matter Experts, or SMEs, represent all levels of proficiency, from apprentice to the master level. Key personnel in the Rating's chain of command are introduced to authenticate the workshop results. SMEs are assured that the results of their efforts will be summarized and reported to the executive agent at the top level of this group, usually an Admiral. The SMEs brainstorm, creating and scrubbing data, adding missing elements, and reviewing for relevant tasks and group consensus on those tasks. This process usually takes about six hours for each job. Each group generates up to 100 tasks and associates them with duties, then jobs, hierarchically. The discussion, identification, and labeling of duties and tasks is led by a facilitator. During the discussions, a recorder takes down all that is said

2.1.2   The JTA Workshop Mind Map

In developing the task statements, SMEs write data on yellow notes and paste them on the wall. Next, the SMEs group the notes put them into hierarchical order. Duty labels are assigned to each group, as the hierarchy begins to develop. The notes are grouped further by the duties associated with each job. Once the notes have been organized and SMEs have agreed to the placement and hierarchy, the recorder transfers the paper-based data from sticky notes to mind mapping software. The group breaks overnight to allow the recorder time to compile the information from the sticky notes. What is interesting about the JTA process using sticky notes is that the

SME grouping of the Jobs, Duties, and Tasks is similar to a concept map, with top down hierarchy. SMEs first visualize the data as a type of concept map. It is the recorder and facilitator who reinterpret the data as another type of image. The software used requires a very structured format that lays out information as a mind map. An example of a partial mind map is shown in figure 2.
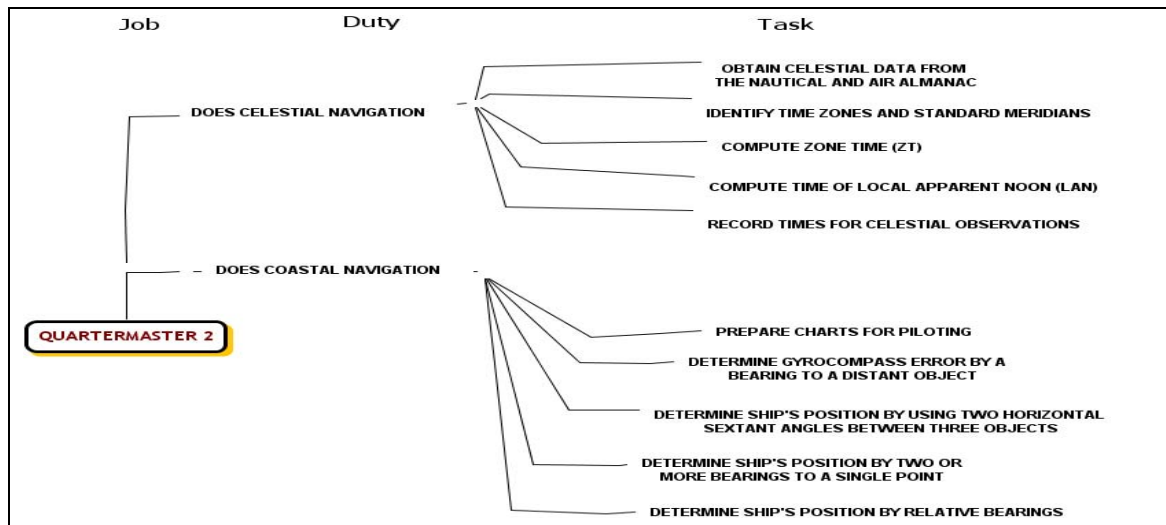

Figure 2: Partial mind map created using CmapTools

Mind map format (Buzan, 1991) focuses on a central point, with the most important ideas recorded closest to the center or hub. Ideas radiate out from the center, with relative importance diminishing as the distance from the hub increases. Its hierarchy radiates from the central point outward, rather than from the top down. The links between key concepts will be recognizable based upon proximity and connection (Buzan, 1991). Mind maps are circular in nature, extending in all directions from the center. CmapTools software was used to simulate part of a QM 2 mind map. (The actual mind mapping software was not available to draw the map, but CmapTools flexibility allowed creation of the mind map graphic.)

Once data has been transferred to mind mapping software, the SMEs reconvene to confirm tasks, to eliminate duplicate tasks, and to find similar tasks performed across multiple jobs. This is done using the mind map results projected on the wall. Further dialogue takes place, this time over the mind map instead of over the previous day's "sticky-note" concept map. This is the first time that SMEs see the collective results of their labeling and organization. Cross-links are not identified in this process. The facilitator assists the process flow, builds consensus among the participants, and assists the project manager in writing a summary report from the textual notes taken by the recorder; the Project Manager delivers the final report

2.2 CmapTools and the Navy

In 1997, the Naval Education and Training Center (NETC) began collaborating with the Institute for Human and Machine Cognition (IHMC) on a network-enabled prototype for knowledge modeling, browsing and sharing (Cañas et al., 2004, CmapTools, 2003), based on Dr. Joseph Novak's work with Concept Mapping and Learning Theory (Ausubel, Novak, et al, 1978, Novak & Gowin, 1984). In 1999, NETC chose representatives from the Naval Education and Training Professional Development and Technology Center (NETPDTC) to work with IHMC to find potential Navy applications for this prototype. By teaming with established Cognition Institute mapping experts from a meteorology concept mapping study and with Dr. Novak himself, the Navy/IHMC project team explored ways to leverage Navy training opportunities and performance support. As the IHMC software prototype evolved, and as more Navy users became familiar with the product, it became apparent that the top down hierarchy of a concept map, with linking words forming propositions, offered a clear way to organize training information.

2.3 JTA Workshop Using CmapTools

In the summer of 2002, NETPDTC was asked to facilitate a TFE commissioned JTA workshop for the Navy's Professional Mariner (PM) Ratings. The facilitators were expected to use the JTA "sticky notes" format of

gathering and mapping SME data, but no mapping software was provided for the workshops. At this time, NETPDTC was collaborating with IHMC to see how CmapTools could be used to improve Navy training. Since the "triplet" design of a concept map proposition, containing object-verb-object, parallels the Job-Duty-Task reports being amassed under JTA, the PM workshop was an ideal way to show how CmapTools software could make the JTA process more efficient. The purpose of this workshop was to identify current jobs, duties, and tasks associated with three Navy Ratings: Signalmen (SM), Quartermasters (QM) and Boatswain's Mate (BM). Since these Navy series have similar civilian jobs, key members of the civilian community were invited to identify civilian equivalent certification requirements.

2.3.1 Concept Mapping Jobs, Duties, and Tasks

IHMC staffers Dr. John Coffey and Ms Andrea Jost were provided as concept mapping and knowledge acquisition experts to assist the two facilitators at the June '02 PM Workshop. They introduced IHMC's CmapTools, using Cmaps to automate the brainstorming and mapping steps in the JTA process and to replace sticky notes with automated concept map projections. Coffey's research (Coffey, 2004) describes in detail how group generated concept maps made the decision process more efficient. The groups worked diligently creating and refining the projected maps that led to other maps. Initial work was finished rapidly, and group members collaborated on additional mapping tasks that took advantage of the capabilities of CmapTools and the expertise available. Task duplication was easily identified. In addition, SMEs were quickly able to map the process of skill level advancement and certification in the Navy and to link those levels with the certification in equivalent civilian occupations. Using the software to collectively tap into the knowledge of civilian community certification experts who would not normally be gathered to brainstorm together made the outcome of the workshop more valuable. The adaptiveness of CmapTools to diverse graphical images greatly contributed to the success of the workshop.

Seeing the results of their dialogue develop before their eyes as the Cmap modelers placed their suggestions into the map helped the SMEs develop and group the tasks more efficiently than in the workshops using the sticky-note method. By taking advantage of what the SMEs already knew and by capturing that information quickly for all to see, the concept map modelers and the facilitators were able to stimulate group thinking. Collectively, SMEs were able to build on each other's knowledge. SMEs saw the value in using concept mapping in a collaborative effort to identify some of the future occupational challenges they would face in their Ratings. Figure 3 is a concept map result of one of the future challenges brainstorming sessions.
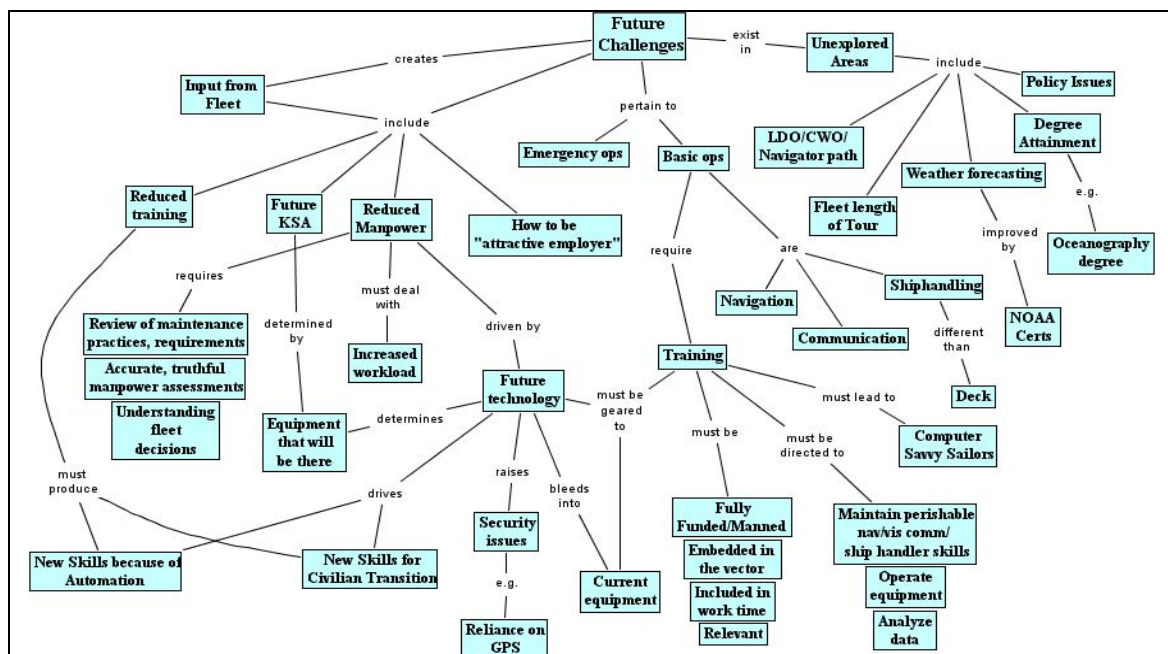

Figure 3: Future Challenges

At the end of the first day, the data had already been input and viewed by the participants as maps. The maps were printed for participants as a record of their decisions and as documents to review. In previous workshops, participants could not see the results of their collective efforts until the next day, after the recorder had input the data from the sticky-notes. Using CmapTools software to develop concept maps based on the concept mapping principles developed by Novak, the participants were able to come to consensus much faster

than in JTA workshops using sticky notes. They were able to accomplish more in a shorter period of time, especially on the first day, and they were able to take away printed copies of the day's work to review and to prepare for the next day's session. The TFE Program Manager also reviewed results at the end of each day and commented on the speed in which the results were ready compared to previous workshops. Facilitators also remarked that this workshop was progressing faster than previous ones using sticky notes. They noted that the jobs, duties, and tasks, presented as concept maps at the end of the first day, would not have been compiled and presented as mind maps until the second day in the sticky note workshops. SMEs stated that using the CmapTools projections rather than sticky notes helped them work more efficiently. They liked being able to see the results immediately, rather than waiting for the data to be input and to see the results the next day. What was especially helpful in this exercise was the ability to make cross connections and show relationships not always so obvious in the day-to-day operations. Seeing each other's ideas captured collectively, SMEs were able to expand data as each contribution was recorded.

2.3.2   Mapping the Vector Information

In addition to making Novakian concept maps, CmapTools was easily adaptable to the flow of the discussion and did not limit the user to a specific structure. The skilled concept mapping modelers were able to capture certification data offered by civilian community experts and combine it with USN certification data to make a linear vector. Figure 4 is an example of a resulting certification vector graphic.
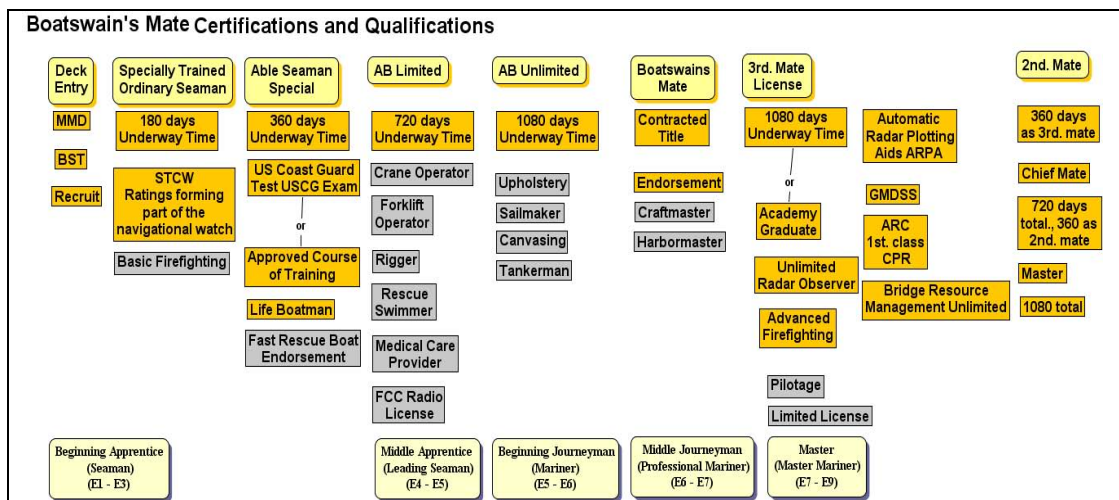

Figure 4: BM Certification Vector Information

By inserting certifications at appropriate points, the modelers depicted the type of information that would be available along one arm of the 5VM for BM and QM Ratings. Sailor and civilian experts could see the progression as it developed and were able to make instant comments and corrections that increased the accuracy of the graphic. With the benefit of adding resources to concept objects, modelers were able to attach links from civilian and military experts that could be used for further explanation. Civilian and military certifications were colored differently, so that variations and gaps were clearly apparent. SMEs stated that they appreciated being able to collaborate with the civilian community experts and see for the first time how their certifications matched or did not match civilian job certification. They remarked that the civilian expert data could not have been captured and merged with theirs so easily without CmapTools. The civilian experts were impressed at how quickly the information they offered could be organized and merged with the military data. Because of the CmapTools projections, they were even able to collaborate among themselves and better capitalize on the civilian knowledge available than in previous JTA workshops. The loosely termed "map" could be used by the Navy to identify where to align USN certifications more closely with the civilian community.

The certification vector data was compiled and organized so quickly using group brainstorming over the CmapTools software projections, that the group also had time to map out the professional development vectors for the PM Ratings. In the final version, the group was able to attach text files as resources describing what is required at each level along the vector. The work progressed so quickly at this point that the SMEs were also able to add resources that described each duty assigned to each job. Figure 5 shows the final result of a QM professional vector brainstorming session map.
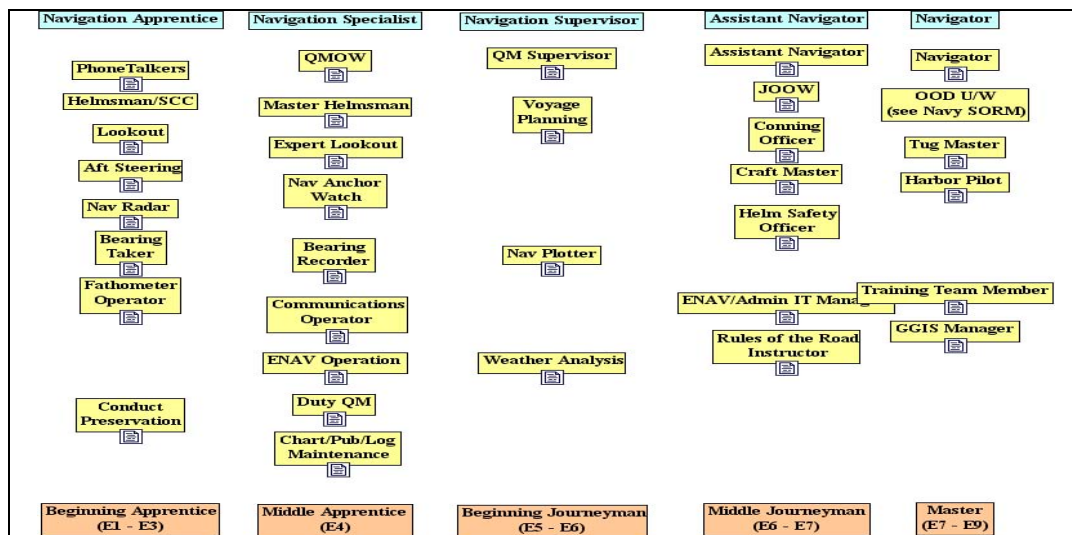
Figure 5: QM Professional Development Vector information

The concept maps and graphical representations of the workshop results were easily converted to jpeg format and were used as illustrations in the final report Word document and in the PowerPoint summary presented at the end of the workshop. CmapTools software was even used to show a graphical job progression (figure 6), where duties diversify as a sailor progresses, then merge again into common duties at the top level of the sailor's career. The program manager was so impressed with the versatility and efficiency CmapTools software that, in his out-brief to the executive manager, he specifically stated that using CmapTools software greatly improved the PM JTA workshop process. He also recommended that this software be considered for use in all future JTA workshops.
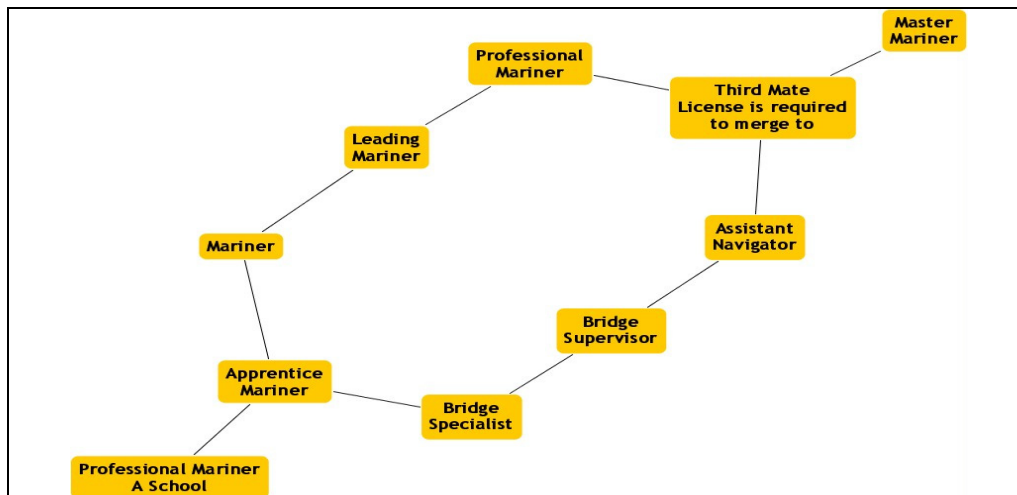

Figure 6: Job Progression

2.3.3   Evaluation

The use of Concept Mapping and CmapTools software helped not only to streamline the PM JTA effort but also to assure that participants had a clear understanding of the outcome. The PM concept maps really drove home the fact that concept mapping can reveal relationships not usually recognized in ordinary discussions and can show the big picture as well. Many concept maps were developed that contributed to the group processes and eventually led to final consensus maps. A total of 11 final concept maps and 7 object maps were produced and used in the final reports. Although other JTA workshops had included experts from the parallel civilian occupations, the expert knowledge had not been captured as effectively as it had using collective collaboration and CmapTools. The projection of the map graphic, and the use of experienced concept map modelers, gave the group a clear picture of the progress they were making and of the outcome at the end of each day. Usually participants waited for the written report to see final results. Sometimes the written report did not agree with the participants' perceptions of what was concluded.

Mapping can eliminate the pitfalls of linear, sentence-oriented note taking and can help to recall verbal images and ideas. Buzan has found that 90% of the words used in note taking are unnecessary. He has identified a few of the problems that occur when we attempt to get information from the linear note structure (Buzan, 1991): there are wasted words that do not assist in recall; there is wasted time searching for words needed to recall ideas; there are unrelated interruptions between related ideas and key words. Using mind mapping software can produce good JTA results. Building on existing knowledge and using a graphical representation in the form of a concept map with linking words (Novak, 1998) allows participants to visually enhance communication as well as build on existing knowledge. Although the links may be assumed to be understood in mind maps, the links are clearly stated in concept maps.

The advantages of using CmapTools software as an automated version of the JTA "sticky note" process were apparent from the onset. The facilitators observed that group dynamics began to surface much sooner than in earlier workshops. The SMEs were highly engaged as a cohesive group to produce the tasks, discuss them, group them, and to come to consensus much more quickly than waiting until the sticky notes could be grouped on the wall then copied into a software product. Using CmapTools software and expert modelers, the facilitators were able to distill the most useful information from the vast amount of knowledge and expertise present at the workshop. The anecdotal results of the PM JTA workshop show that it is more efficient and more effective to achieve group consensus using the concept mapping of CmapTools than with ordinary note taking, summarizing, and mind mapping later. This was not a controlled study, so the results are based on observation and comments:

JTA Using CmapTools	JTA Using Sticky Notes
Group focuses on projected map and stays on task; group dynamics form quickly.	Participants work individually on sticky notes, then in small groups; dynamics are slower to form.
Concept mapping can reveal cross relationships not easily identified.	Cross relationships are not identified or revealed.
Changes can be made quickly, gaining group consensus immediately.	Changes are not as easily made; group consensus is not obtained until the next day.
Group product (map) is visible to all as work progresses.	Group product (mind map) is not available until all data from sticky notes can be input.
Group determines construct of the concept map; group reviews map as it is built.	Recorder determines construct of the mind map based on the sticky notes; group must review and concur or suggest changes a day later.
Modelers can make graphical depictions in styles other than true concept maps; software can be used for sequences and stages required for the 5VM as well as flow charts.	Software used only allows construction of a structured mind map.
Results are easily provided for review; maps can be printed at end of each session, and group can suggest changes at next session.	Some results can be compiled and made available for review the next day; some results are not available until after the workshop concludes.
Facilitators distill information with the participants and during the meeting.	Facilitators distill information without the participants and outside of the meeting
Facilitators can quickly acquire expert knowledge from outsiders (i.e. civilian community, industry, etc.) and integrate/merge it with SME knowledge with SME/ expert consensus during mapping.	Facilitators gather outsider knowledge in a linear format and integrate/merge it with SME knowledge in isolation, after the workshop concludes.

Table 1: Using CmapTools versus Sticky Notes

3   Summary

JTA processes can benefit from the use of concept mapping (Trochim, Cook, & Setze, 1994) and CmapTools software. A concept-map oriented approach to grouping tasks in terms of major concepts (rather than simple lists of tasks in a table may potentially add to current job understanding and a more meaningful approach to training. Using CmapTools software to develop concept maps based on the concept mapping principles developed by Novak helps the participants to come to consensus faster than using the sticky note and mind mapping method; they are able to accomplish more in a shorter period of time. Job progression, Certification and Professional Development requirements can be depicted graphically, as well as concept maps of Jobs,

Duties, and Tasks. Group dynamics are evident as the participants start thinking together to build on each other's knowledge; visual images are quickly completed by expert concept mapping modelers to keep group on task. Using the software to collectively tap into the knowledge of experts who would not normally be gathered to brainstorm together could make the outcome of the workshop more valuable. The usefulness of graphically flexible CmapTools software to depict maps and process flows outside of the actual concept map format suggests that this software has many applications. It can be used to facilitate many types of Knowledge acquisition, process flow and mapping meetings. A key factor in taking advantage of the group process flow is the use of expert modelers who are able to keep up with the diverse ideas being presented. Recording skills and software knowledge is important, but mapping and modeling ability is also necessary. The adaptiveness of CmapTools to different graphical representations can greatly contribute to the success of a JTA workshop.

4   Acknowledgements

References

Ausubel, D., Novak, J. D., et al. (1978). *Educational Psychology: A Cognitive View* (p. 163). New York: Holt, Rinehart and Winston.

Bransford, J. D., Brown, A.L., & Cocking, R. R., editors (2000). *How People learn Brain, Mind, Experience and School* (p. 62). Washington, DC: National Academy Press.

Buzan, Tony, (1991). *Using Both Sides of Your Brain* (pp. 85-95). New York: Plume.

Coffey, J.W. (2004). *Facilitating Idea Generation and Decision-Making with Concept Maps. Journal of Information and Knowledge Management*. (to appear).

Cañas, A. J., Hill, G., Carff, R., Suri, N., Lott, J., Eskridge, T., Gómez, G., Arroyo, M., & Carvajal, R. (2004). CmapTools: A Knowledge Modeling and Sharing Environment. In A. J. Cañas, J. D. Novak & F. M. González (Eds.), *Concept Maps: Theory, Methodology, Technology, Proceedings of the 1st International Conference on Concept Mapping*. Pamplona, Spain: Universidad Pública de Navarra.

CmapTools. (2003). *IHMC Concept Map Software: a knowledge construction toolkit.* [online] available: http://cmap.ihmc.us/

Foster, D., Jones, P., and Becraft, R. (2000). *The Importance of Job Task Analyses.* Originally published in the Summer issue of Professional Certification Magazine. [online] available: http://www.computer.org/certification/procert_jta.html?SMIDENTITY=NO

Glossary of Terms Used in Job Task Analysis. [online] available: http://syllabus.syr.edu/IDE/maeltigi/ide713/TOOLBOX/CLASS97/CJ/analysis/glossary.html

Department of Defense (31 Aug 01) *MIL-HDBK-29612-2A Instructional Systems Development/Systems Approach to Training and Education.*

McKillip, J. (1999). *MCSE Job Task Analysis: Report to Participants.* [online] available: http://www.microsoft.com/traincert/downloads/MCSE_Task_Analysis.doc

Mintzes, J. L., Wandersee, J. H., & Novak, J. D., editors (2000). *Assessing Science Understanding, A Human Constructivist View.* San Diego, CA: Academic Press.

Mintzes, J. L., Wandersee, J. H., & Novak, J. D., editors (2000). *Teaching Science for Understanding, A Human Constructivist View.* San Diego, CA: Academic Press.

NAVAIR (2002). Task Force EXCEL Working Group Guidelines. [online] available: http://www.ntsc.navy.mil/Resources/Library/TaskForceExcel/Files/HPToolbox/GroupGuidelinesMay.doc

Navy message: R 171405Z MAR 03, FM CNET PENSACOLA FL//N00//, SUBJ/*JOB TASK ANALYSIS (JTA) PROCESS POLICY FOR NETC CLAIMANCY//*

Novak, J. D. (1998). *Learning, creating, and using knowledge: Concept Maps(R) as facilitative tools in schools and corporations.* Mahweh, NJ: Lawrence Erlbaum Associates.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn.* New York: Cambridge University Press.

Schulmeister, R. (1997). *Hypermedia Learning Systems Theory - Didactics - Design (English version of Grundlagen hypermedialer Lernsysteme Theorie - Didaktik – Design translated by Flügel, T.)* [online] available: http://www.izhd.uni-hamburg.de/

Trochim, W. M. K., Cook, J. A., & Setze, R. J. (1994). Using Concept Mapping to Develop a Conceptual Framework of Staff's Views of a Supported Employment Program for Persons with Severe Mental Illness. *Journal of Consulting and Clinical Psychology*, *62* (4), 766-775.

US Department Of Labor (1978). *Uniform Guidelines on Employee Selection Procedures, Part 60-3.* http://www.dol.gov/dol/allcfr/Title_41/Part_60-3/toc.htm.

Yatco, M. C. (1999). *Joint Application Design/Development.* [online] available: http://www.umsl.edu/~sauter/analysis/JAD.html