Taskonomy vs. Taxonomy: Human-Centered Knowledge Management Design

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ABSTRACT

The main goal of knowledge-based systems is to provide workers with actionable information in support of real-world activities. This includes connecting people with answers, experts with less experienced workers, and delivering knowledge to help solve problems, make decisions, or complete critical work tasks. Many knowledge-based systems and tools, including knowledge portals and performance support systems, have been developed but are simply underutilized because users are unable to locate the information they need. This is largely because these systems are organized more like an encyclopedia structure—alphabetically or thematically—and less like a human activity structure.

What is needed is an organizational and design method to effectively capture, store, and deliver actionable information. Taxonomic structures are appropriate when there is no context. In a hardware store, for example, hammers are in the hammer section, and nails are in the nail section. This organization is based upon a taxonomy. It works well for stores, libraries, dictionaries, and most Web sites. But once a goal has been established and an activity has begun, then a task-based taxonomy, or a "taskonomy", is more effective. This is why, in the real world, carpenters keep their nails with their hammers.

This paper discusses the concepts and framework of a taskonomy and how it is being applied at the Army's Defense Ammunition Center to enable mission performance and information superiority. The paper describes how a taskonomy categorizes tasks into a common format and language. It discusses how this approach serves as the foundation for learning, exercise, and workforce performance objectives to ensure that targeted, timely and relevant training and knowledge resources are in place. Finally, the paper addresses how a taskonomy serves as an important framework for evaluation and assessment of performance.

ABOUT THE AUTHORS

Ms. Janet Cichelli is a recognized leader in the field of human performance and the design and implementation of knowledge-based systems. As the Chief Technologist of the Learning and Performance Support practice for SI International, Ms. Cichelli provides expert consulting to government and commercial clients to develop strategies for managing knowledge and implementing knowledge management solutions that leverage technology investments and support their mission. Ms. Cichelli has provided targeted expert consulting in the design of knowledge portals, communities of practice (COPs) and methods for tacit knowledge capture. She has supported human performance and knowledge management programs for the US Navy, Joint Staff, US Army, USB PaineWebber, the National Security Administration, Department of Homeland Security, and the US Patent and Trademark Office.

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THE KNOWLEDGE EDGE

With an active and reserve military workforce approaching 2.7 million, people are clearly DoD's most important asset, and their skills and knowledge are vital in defending our national interests. Strategically managing knowledge assets—both formal (i.e., *explicit*) and informal (i.e., *experiential* or *tacit*)—is crucial to DoD's transformation effort and critical to maintaining the edge of U.S. forces. The constantly changing dynamics of war and our broad and diverse theater of operation make knowledge management an indispensable defense asset. Defense leaders today are increasingly challenged to achieve the essence of knowledge management—*to deliver actionable, critical, and relevant context-rich information and lessons learned to warfighters, leaders, and other defense personnel and to enable them to connect and collaborate with experts and colleagues in real time.*

When it works, we get precisely the right information into the hands of those who need it and we help to increase their situational performance in support of mission objectives. But when we fail to deliver crucial knowledge at the point of performance—whether in the operation and (relative) calm of a civilian enterprise, or the rapid planning, decision-making, and coordination of a tactical military operation—the consequences can be dire. Consider this scenario:

> *Sgt Brown, a Task Force Lightning Ammunition Specialist, also performs the role of certified shipper for his unit. At 0530 hours on a Monday morning following a three-day R&R, MSgt Smith, Sgt Brown's supervisor, received an order from his Commanding Officer (CO) to ship five (5) liters of Acetone from Camp Bravo to Camp Tango in Afghanistan by air using a CH-47 transport helicopter. MSgt Smith provides the current manifest for the other materials scheduled for this transport, which includes two pallets of meals-ready-to-eat (MREs) and three boxes of small arms ammunition. In addition to the cargo, a command team of four high-ranking officers is scheduled to be onboard.*
>
> *Unfortunately, the more experienced Sgt Jones has just begun her own R&R, so Sgt Brown cannot rely on her for support. He does vaguely remember a recent HAZMAT safety briefing where an incident was reported involving the same material that caused an in-flight explosion due to improper packaging for military air transportation. However, no one can recall the exact details.*
>
> *Now in his eighth month of deployment, Sgt Brown's experience with transporting hazardous material has been limited to certifying shipments of small arms and other types of ammunition. He has no prior experience with Acetone, including the packing and segregation requirements. This Acetone shipment is needed to clean vital engine components for three Bradley Fighting Vehicles completing an emergency maintenance cycle. This is in preparation for an upcoming rapid-strike mission to disrupt and possibly capture high-value Taliban targets. The ground team is scheduled to begin their mission within 24 hours of the arrival of the command team.*
>
> *Sgt Brown searches for additional support using his unit's access to various military transport Web sites. Although he finds a number of potentially helpful sites, he spends considerable time randomly searching and navigating through various paths looking for clues that might guide him to the answers he needs. After three hours, he has become very frustrated and, erring on the side of caution, decides not to approve the container for this air shipment. This results in a significant delay in delivery of critical materials to ground troops and a compromise of the ultimate success of that mission.*
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> .

In war, circumstances and tactics can change quickly, and the ability to convey current and pertinent knowledge becomes increasingly important. Our warfighters and defense personnel must learn and adapt as quickly as the situation in Iraq changes.

At a June 2007 training and simulation symposium, Brig. Gen. Tom Maffey, Director of Army Training, underscored the role of knowledge management in adapting to change, and he identified knowledge management as the #1 enabler to achieve what he called, *"continuous responsive adaptation"* (Maffey 2007).

BG Maffey defined this as the ability to capture "the hard lessons we've learned [in the theater of operation] and to institutionalize the Army's capability to anticipate and responsively adapt…as the mission, threat, or operational environment changes" (Maffey 2007).

Clearly, there has never been a more compelling need to put actionable information, experiential knowledge, and lessons learned in the hands of the right people at the right place and time. Acknowledging this, the Defense Department has continued to increase its efforts in standing up knowledge delivery systems to meet transformational, warfighting, and strategic decision-making requirements. Unfortunately, not all of these efforts have realized their intended benefits.

WHY KM EFFORTS FALL SHORT

Many knowledge-based systems and tools, including knowledge portals and performance-aiding systems, have been developed but are simply underutilized because users are unable to locate the information they need in the time available. Considerable efforts have been undertaken that focus resources on content standards, traditional taxonomies, and metadata. These efforts are necessary, but in themselves are not entirely sufficient.

Taxonomies and metadata provide the framework and structure to manage our content in meaningful ways. But without an equal emphasis on the "human" side of knowledge management—applying the findings from cognitive science and human-centered design methods—these systems fall short in addressing how people think about and approach work. The result is a proliferation of highly efficient but largely unusable systems that are standardized, tagged, and organized more like an encyclopedia structure—alphabetically and/or thematically—and less like a human activity structure.

To better understand how to effectively manage knowledge assets intended for use by humans, and to help ensure success in organizational knowledge management efforts, we must first agree on what *knowledge* is. Simply stated,

Knowledge is information that is contextual, meaningful, and actionable.

Accordingly, doing knowledge management "right" requires a fairly intimate understanding of the knowledge and information needs and uses of our target audience. It requires a keen understanding of their real-world mission-essential activities and the knowledge artifacts—documents, information, data, and tools—that are needed to support work performance. It requires recognition that the objective is not to capture knowledge for the sole purpose of managing it. Instead, it is to provide the capability for warfighters to reach knowledge experts and meaningful artifacts to accelerate and enhance situational performance and decision-making. In other words, knowledge management is about enabling *mission performance through human performance*.

THE DEFENSE AMMUNITION CENTER'S KNOWLEDGE MANAGEMENT INITIATIVE

The US Army's Defense Ammunition Center (DAC) has taken progressive and intentional steps to implement a human-centered approach to knowledge management as an integral part of its transformation process. DAC's mission is to provide ammunition training, explosives safety instruction and logistics support to Department of Defense (DoD) military and civilian personnel worldwide. Since September 11, 2001, the DoD has initiated a series of initiatives to dramatically enhance the safe and secure distribution of military arms, ammunition, and explosives (AA&E) throughout its worldwide logistics chain. Recognizing the value of knowledge delivery systems in addressing this imperative, DAC has formulated a comprehensive strategy to manage its organizational knowledge assets, capture lessons learned, and harvest the know-how that is critical to its AA&E mission.

Like many government agencies, DAC is faced with an aging workforce that is a valuable source of knowledge and that is quickly approaching retirement. When these employees leave, they will take with them valuable organizational and experiential knowledge about the AA&E domain and procedures. Even more compelling today is the source of knowledge and lessons learned that are held by DAC personnel

returning from deployments in active areas of responsibility. DAC understands fully that these lessons are learned only when they can be quickly channeled to other personnel at the point of performance in order to impact behavior, and not simply when the example is dropped into a database.

To further focus its KM activities and resources, DAC is addressing operational performance issues identified at the Army's Field Commanders' Ammunition Logistics Seminar. This seminar, initiated by GEN Benjamin S. Griffin, Commanding General, Army Materiel Command, was held in December 2006 to assess issues related to ammunition logistics distribution for combat operations.

During the conference, a multidisciplinary group discussed ammunition logistics operations and identified the safe transportation of the classes of HAZMAT that encompass AA&E as a primary issue. They discussed factors contributing to each issue and determined recommendations for ways in which the U.S. Army Materiel Command can improve current and future combat operations (Field Commanders' Report 2007).

Further contextual task analysis of the issues pointed to the need to organize and centralize access to the body of knowledge for HAZMAT transportation, to pass on critical lessons learned, and to capture the tacit and experiential knowledge of accomplished performers. As a result, DAC selected this mission area to be addressed through knowledge management methods and technologies.

PRINCIPLES OF HUMAN-CENTERED KM

In formulating its human-centered approach to knowledge management, DAC has adopted these three overarching principles:

1. Deliver Content in Context
2. Define Content by Need, Not Availability
3. Make Knowledge Actionable

For DAC, these principles acknowledge the indelible connection between cognition and information science in effecting knowledge solutions that drive performance. Information science alone is insufficient for KM because *information* and *knowledge* are not the same. Information technology (IT), by definition, is good at managing information, and it can provide the seamless "channels" for the flow of knowledge across multiple learning and performance contexts.

But knowledge management is at the intersection of IT and cognitive science, which is necessary for understanding how people acquire knowledge and the mental models they have in approaching work. This helps ensure that we capture and organize content with sufficient flexibility to render it meaningful and applicable in a variety of contexts.

Deliver Content in Context

As the saying goes, content may be considered "king," but without an appropriate *context*, content is nothing more than a hidden asset, unavailable to the people who need it most.

Context helps put the right information into the hands of the right people at the right time—so they can make the right decisions and perform effectively. The word "context" is from the Latin *contexere*, which breaks down as **con** (together) and **texere** (to weave)—*to weave together* (Encarta). Content and context work together to share the responsibility of delivering meaning, by weaving the whole fabric (meaning) from simple threads (content items).

DAC has identified these six *contexts of use* to define how the AA&E audience intends to interact to acquire and share knowledge:

1. *Foundational learning*—acquiring new knowledge and skills from knowledge objects that are fully integrated within formal courseware.
2. *Continuous learning*—"push" or "pull" access to individual knowledge objects that provide modular learning and satisfy requirements for refresher, remediation, or new knowledge/skill acquisition.
3. *Peer-to-peer collaboration*—acquisition of knowledge and skill through active helping and supporting among equals (Topping 2005).
4. *Contextual inquiry*—ability to query or submit a question for a specific need and receive relevant, authoritative, and meaningful knowledge content.
5. *Job process support*—knowledge content that is "baked in" to the work process, and all relevant guidance, expertise and information are displayed in the user interface as the work suggests it.
6. *Content browsing*—ability to traverse content for general inquiry and incidental learning.

These six categories can be further distilled into the three types of interactions that Nichani (2006) says humans do in virtually any knowledge-based system: 1) we *seek*, 2) we *learn*, and 3) we *do*.

When a soldier is browsing a parts inventory list or searching for an explosives domain expert, he is *seeking*. When reading a bulletin for the revised SOP for packaging Class 1 hazardous materials, or reviewing the lessons learned just posted from an Ordnance Officer returning from deployment, he is *learning*. And when he is performing ammunition supply stock control or preparing a shipment of Acetone to load onboard a CH-47 helicopter, he is *doing*.

Regardless of the specific nature of the user's goal or the work being performed, knowledge content should be provided in the context of existing processes and activities, not as something apart from them. When content is outside the context of what people do in their jobs and disconnected from the systems and processes they use to do them, they must set aside their regular work to process this information. By weaving this knowledge content into the systems and processes people use regularly, it becomes an enabler of learning and work effectiveness instead of a distraction from it.

Define Content by Need, Not Availability

"What information consumes is rather obvious:
it consumes the attention of its recipients.

Hence a wealth of information creates a poverty of attention."

This quote from a cognitive psychologist (Simon 1971) is still relevant today. All too often, in KM design, there is a sense that "more is better." This creates a tendency to use knowledge-based systems to house content that has been acquired but that no one is quite sure where to put. As a result, most knowledge repositories are cluttered with documents, information, and data that serve no critical need and that simply get in the way of finding the information that is critical. Knowledge content that is acquired and maintained should be driven by need, i.e., that which is necessary for the optimal performance of people's jobs, rather than information content that happens to be available.

Make Knowledge Actionable

This principle is quite simple: We need to easily and quickly get to the stuff that enables us to get our work done. Having knowledge implies that it can be put into action to solve a problem, whereas having information doesn't carry the same connotation. Usability expert Don Norman believes that to support real-world goals and behavior, we need to consider *activity* in the design of knowledge-based systems. Norman (2006) describes this activity structure as a further refinement of human-centered interface design. But organizing knowledge resources around a real-world activity structure instead of logical categories requires that we also look differently at the classification methods and systems that we use to organize and represent knowledge.

TAXONOMY VS. TASKONOMY

There are a number of useful knowledge classification and representation systems and methods, such as ontologies, taxonomies, thesauri, and graphical knowledge representations available to organizations to help them leverage, logically organize, and articulate their knowledge. The value of a categorization scheme is not simply in terms of organizing information, but in the role it plays in *facilitating access* to information. Built and implemented effectively, such schemes are crucial to helping users find actionable information.

The most common classification method for knowledge-based systems is a *taxonomy*. A taxonomy is a *controlled* classification schema, with an associated controlled vocabulary. It is controlled in the sense that changes to the taxonomy are managed carefully. Changes are not random, and ordinary users cannot change them. This is very different from a *folksonomy*, which is completely dynamic and user defined.

Norman (2006) believes that a thematic taxonomy structure is most appropriate when there is no specific work or learning context. In a hardware store, he illustrates, hammers are in the hammer section, and nails are in the nail section. This organization is based upon a traditional taxonomy. It works well for stores, libraries, dictionaries, and many Web sites. But, once a specific goal has been established and a work activity has begun, then a task-based taxonomy, or a "taskonomy" provides the necessary context for more effective knowledge discovery and use.

In a knowledge system, such as a portal or Web application, users will look through the screen labels and navigational links and use them as visual cues to the information and answers they seek. Labels that map to "card catalogue-style" content groupings, such as Tools, Shared Documents, News, Lessons Learned, References, etc., are less meaningful and require more time to get to the right content because they do not map to what users want to *do*.

Using a taskonomy, content is *organized for use*, i.e., the content is indexed and metadata tagged by how it is most likely to be used by others, rather than by subject matter category. As Norman explains, this is similar to how, in the real world, carpenters keep their nails with their hammers (Norman 2006).

In the past, the design of a computer system's user interface was driven by the structure of the underlying technology, typically a database structure. In recent years, however, the human-centered design movement has brought an emphasis on performer tasks and helped drive designs that optimally support performers and their tasks (Wang and Garlan 2000). A taskonomy, with its inherent activity-centered focus, provides the necessary underlying structure and content organization to enable human-centered knowledge system design.

CONSTRUCTING A TAXONOMY OF TASKS

For DAC, the Army Universal Task List (AUTL) provides an effective activity-based construct for a taskonomy. AUTLs are the operational expression of the Army's core competencies and identify the specific activities and tasks an organization has to be proficient at in order to accomplish an appropriate portion of its operational mission.

Though AUTLs were created to focus and prioritize training tasks—acknowledging that organizations cannot train and sustain proficiency on every possible task—they can be leveraged for activity-based taxonomic efforts. DAC is employing a HAZMAT Transportation AUTL as the foundation of its taskonomy to link mission to tasks, and to represent the mission areas, specific activities, and associated knowledge artifacts needed to support HAZMAT transportation activities.

At the highest level of the taskonomy, tasks are organized according to mission area (e.g., Transport HAZMAT). Following the mission level, the next level of organization, as shown in **Figure 1**, depicts the major activities that define how the mission will be achieved. Below the objective level are the individual HAZMAT Transportation tasks and subtasks that will be implemented to achieve the objectives and the mission.

This connection provides DAC with a means to define a knowledge-based system that supports task performance and mission success. It provides a taskonomy framework to focus knowledge collection and harvesting activities on those artifacts that are meaningful, relevant, and actionable. It also affords DAC the ability to unify learning, leader development, and knowledge management initiatives around a common set of workforce performance objectives. And finally, it provides the important framework for evaluation and assessment of performance.

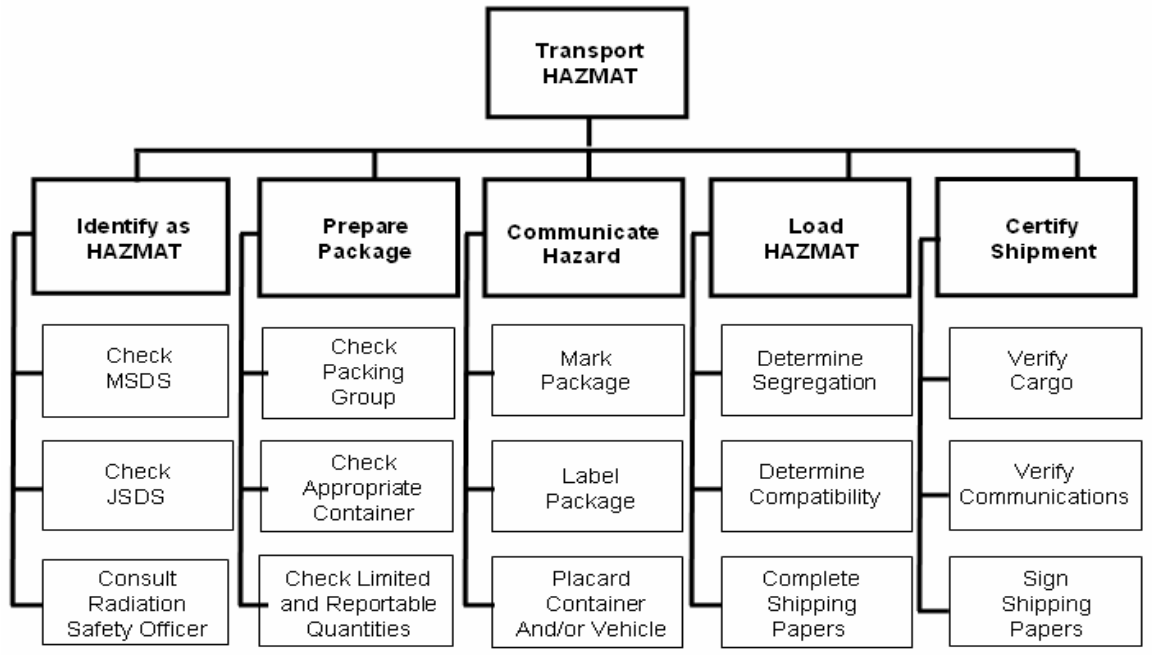

Figure 1. Taxonomy for HAZMAT Transportation.

KNOWLEDGE MAPPING

When we take the time to learn about our performers and to assess what they need to do their jobs, we come to better conclusions about their mental models of work and their critical work tasks. Why is this so important? Because the more we know about the context of users' work—their goals, work environment and constraints, and work processes—the more precise we can be about the types of artifacts that they will look for in support of work activities (Earley 2007).

A taskonomy works like the *branches* of a tree that provide people a way to get to the *leaves*, i.e., the meaningful knowledge content. In a knowledge delivery system, these content objects—or *knowledge artifacts*—are the living repositories of our collective and individual know-how. They are the representations of knowledge, information, data, and tools that are stored as objects and integrated with tasks. They anticipate and answer questions that a performer will have in completing an action or making a decision, and they can include policy and procedures, advice and best practice methods, accomplished performer interviews, diagrams and other visuals, expertise locators and profiles, case studies and lessons learned, and other meaningful and appropriate resources.

The taskonomy structure—shown conceptually in **Figure 2**—provides the framework to map these knowledge artifacts (KA) to their appropriate tasks, creating a contextual body of knowledge.

As a dynamic and relational structure, the taskonomy provides a collection mechanism for ongoing knowledge capture and *knowledge harvesting*. Knowledge harvesting is a cognitive and management science technology that allows the tacit knowledge (i.e., knowledge that is in an expert's head versus contained in external documentation) of experts and top performers in an organization to be captured and documented (i.e., made explicit).

The taskonomy also provides the ability to manage the complexity of a knowledge repository and buffer the performer audience from transformational activities that may evolve new doctrine, standards, and their resulting knowledge artifacts. As new content is identified and then approved through governance processes, it can be immediately associated and made available to personnel in the context of an activity.

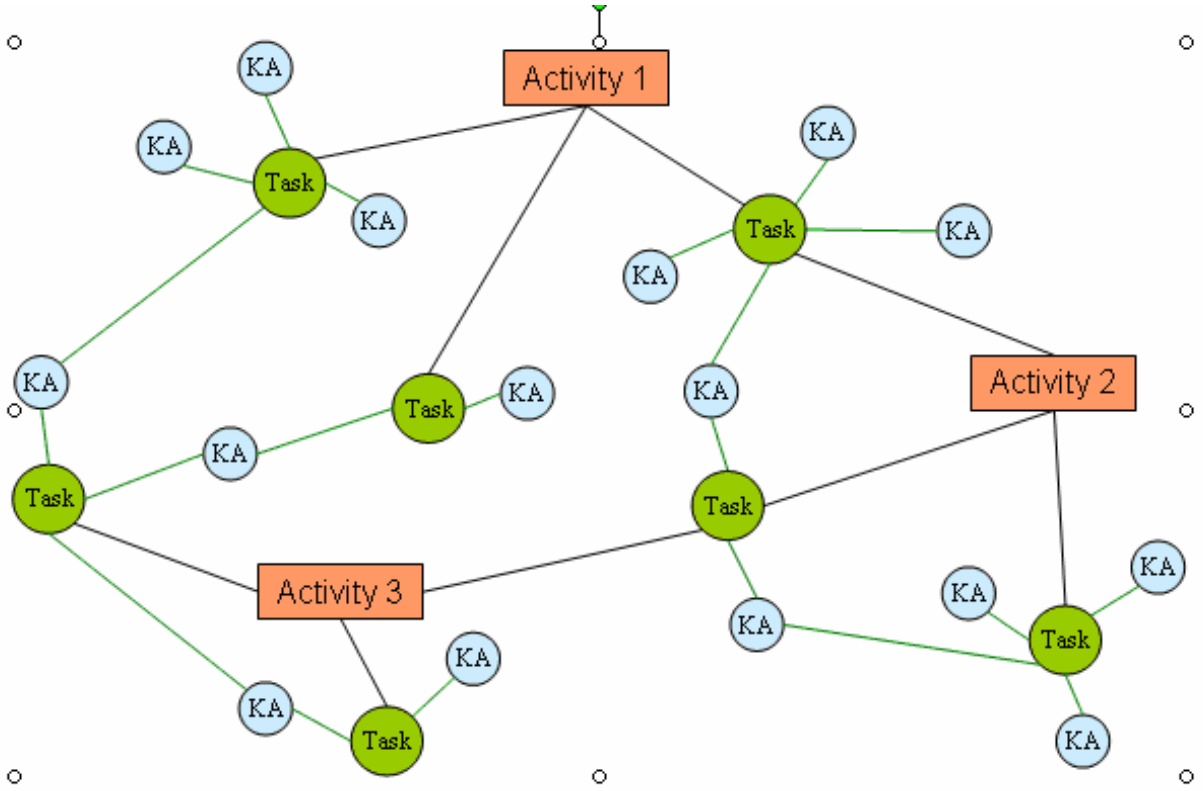

Figure 2. Conceptual Activity/Knowledge Map.

ASSIGNING A THESAURUS AND METADATA

The taskonomy is completed by generating a thesaurus and the metadata that further describe its structure and the relationships among and between its components. Various degrees of automation can play an important role in generating the thesaurus and metadata, ranging from fully manual to semi-automated to fully automated. In KM practice today, fully manual systems are rarely used in taxonomy construction.

DAC has evaluated several automation tools and is currently employing the Concept Search tool, which reduces the human intervention requirement and provides semi-automation of the thesaurus and metadata set. The thesaurus is a constructed vocabulary set that specifies multiple terms that describe the same concept or task. Concept Search is being used to normalize vocabulary and more efficiently perform vocabulary management tasks. DAC has adopted the ANSI/NISO Standard Z39.19-2003 "Guidelines for the Construction, Format and Management of Monolingual Thesauri" as its specification for establishing the set of equivalent terms and to facilitate discovery and interoperability across functional domains (National Information Standards Organization, 2007).

Metadata tagging provides the descriptive properties for the context, quality, condition or characteristics of the tasks and knowledge artifacts. Dublin Core (http://dublincore.org) is one of the most widely used models for the interoperability and description of all the types of information resources. The "core" Dublin metadata set includes, in its simplest format, fifteen metadata elements for use in resource description: *title, author* or *creator, subject* or *keywords, description, publisher, other contributors, date, resource type, format, resource identifier, source, language, relation, coverage,* and *rights management*. These elements are being augmented with context-identifying tags, which associate the task nodes of the taskonomy structure, as well as their contextual knowledge artifacts.

The completed taskonomy structure provides a flexible, maintainable, and dynamic knowledge infrastructure for supporting individual tasks—both explicit and decision-making tasks—as well as broader mission-related activities.

A VERY DIFFERENT SCENARIO

A knowledge system that is designed and developed using this human-centered approach can provide enhanced capabilities with significantly better outcomes. Consider a very different scenario:

Sgt Brown prepares to ship five liters of Acetone by air using a CH-47 transport helicopter. Sgt Brown's experience with transporting hazardous material has been limited to certifying shipments of small arms and other types of ammunition. He has no prior experience with Acetone, including the packing and segregation requirements. But he knows that he can quickly tap into the expertise and "know-how" of more experienced staff to get the answers he needs.

He immediately turns to his unit's knowledge-sharing system, available on a laptop computer. He begins by entering some basic information about Acetone into the system and is immediately presented with a concise display that identifies Acetone (UN1090) as a Class 3 hazardous material. From this display Sgt Brown views a threaded discussion where other certified shipper personnel have discussed recent Acetone packaging and transportation issues. He also notes the listing of HAZMAT transportation experts, and is reassured that he can send an email message or initiate a live chat session with an expert, if needed.

He accesses the "Prepare to Transport" task area and is guided through a display of Acetone characteristics, including the proper shipping name and other information he will need to include on the forms, links to various modes of transportation, and specific guidance based on pre-defined quantities of Acetone needing to be transported. Choosing the applicable quantity, Sgt Brown quickly finds the appropriate restrictions and packing information—including procedures and animated images—specific to packaging Acetone for Military Air transport. He follows a compatibility and segregation link that takes him to an easy-to-read look-up table for assessing requirements. Finding no compatibility issues with the MREs or ammunition, Sgt Brown prepares to certify the shipment.

Last, he reviews a high-priority bulletin that describes a recent in-flight explosion incident. After drilling down to the full briefing, he reads about the cause and recommended safeguards, and he is confident that he has performed his duty correctly and exercised proper safeguards for the shipment. Within thirty minutes from receiving the order, he is able to certify the shipment. The critical materials arrive on time to the ground troops and the mission is a success.

IN SUMMARY

A human-centered approach to knowledge system design helps to ensure that our workforce has relevant and actionable information in support of real-world activities. It helps foster the connection between people and the answers they seek, between experts and less experienced workers, and it helps channel the right knowledge at the right time to help solve problems, make decisions, and complete critical work tasks.

If we agree that mission performance is achieved largely through the performance of people, then we need to look at the critical activities and tasks that must be performed and the knowledge resources that need to be available. The task-based taxonomy—taskonomy—provides an effective knowledge organization and delivery method to do this.

The Army's Defense Ammunition Center has adopted this human-centered approach for the behavioral organization of its AA&E knowledge assets. This has required stepping out of old models and ideas about how people access information and how technology supports this access. But the results are helping to foster a knowledge sharing and continuous learning culture that can deliver *real answers* in *real time* within the *right work context*. And ultimately, for DAC as well as other defense organizations, this is the measure against which any such initiative should be measured.

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