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"Adapting C2 to the 21st Century"

"A framework for inter-organizational collaboration and sensemaking integrating communication and knowledge management tools."

Topics: Sensemaking, collaborating, new approaches to C2

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ABSTRACT

Different branches of the military are often finding themselves in joint ventures or coalitions with multiple, diverse organizations, including other branches of the military, foreign governments, businesses, and non-governmental organizations (NGO). The ability to successfully communicate across organizational boundaries is important to the success of these collaborations and their sensemaking. While researchers have examined ways to help people communicate with one another and to store and share knowledge, relatively little research has looked at the integration of the two and how it might help support collaborations between people from multiple organizations. The proposed framework integrates communication technologies and knowledge management tools such as the wiki to enable organizations to communicate knowledge across organizational boundaries.

INTRODUCTION

The military is often faced with problems that involve coalitions of several multinational organizations, including other militaries (e.g., The British Army), governments (e.g., national, regional, and local governments), businesses (e.g., Halliburton), and non-governmental organizations (e.g., The International Red Cross and Red Crescent Movement). Each organization in such a coalition may have different cultures, languages, and visions of the world. At a more basic level, each organization has its own processes, procedures, terms, and acronyms. With these differences, how can multiple organizations collaborate, or work together, towards their goals?

One approach to understanding and solving such "wicked" problems is contained in collaborative sensemaking research. Sensemaking focuses on how organizations "make sense" of new information in these complex situations. Some key properties of sensemaking are that it is retrospective, social, and yet highly personal (Weick, 1995). In other words, sensemaking depends on the person, is influenced by both individual and collective past experiences and knowledge, and it depends on interaction and dialog between people.

Because sensemaking depends on past experience and knowledge, one component of a solution involves some form of knowledge management. Knowledge management is "a range of practices and techniques used by organizations to identify, represent and distribute knowledge, know-how, expertise, intellectual capital and other forms of knowledge for leverage, reuse and transfer of knowledge and learning across the organization" (Wikipedia, 2006). In recent years, many researchers, beginning with Peter Drucker, have noted that the global economy is becoming a "knowledge economy" or "information society", which has in turn driven much research into knowledge management (Drucker, 1959).

Another key component of the solution must involve some technology support for communication between people across organizations (a "community of practice"). Communication tools differ in many ways, such as whether people using the tools need to be using the tool at the same time (e.g., telephone) or in the same place (e.g., face-to-face talking). Such tools need to be designed with social processes in mind. For example, one common problem when organizations collaborate is that information stays in one "silo."

For example, important information may be transmitted from a Lieutenant to a Sergeant and up to Army chain-of-command, but it often does not leave the Army silo to other organizations that may need the information.

For each of the components mentioned above (sensemaking, knowledge management, and collaboration), this paper will present research and derive a set of requirements for the framework. Next the framework will be presented, as well as one possible implementation of the framework. Finally, a scenario will be used to show how the framework might be used in the real world.

REQUIREMENTS

Sensemaking

Complex problems faced by the military are often called "wicked." In a wicked problem, there are generally four characteristics: the problem is not fully understood; the problem is never really solved due to constraints such as time and money; the problem changes over time; and the stakeholders have very different views of the world, the problem, and the solution (Conklin, 2003b).

Governments and militaries are increasingly involved in situations involving wicked problems. For example, one United Nations (UN) group set out to plan relief and recovery for Afghanistan following the recent military conflict (Roberts, 2001, p. 364). They were hoping to solve their wicked problem by sharing information, knowledge, and perspectives. The group was composed of several bodies from the United Nations, as well as the World Bank and Oxfam, a group seeking to end poverty world-wide. Despite their good intentions, their collaboration was difficult from the start. The leader spent most of his time working on political issues related to the collaboration. Because the groups were located all over the world, many did not speak to each other until they met for workshops in Pakistan. The problem kept changing, as the situation in Afghanistan worsened and they could not meet there as intended. One key thing that the group lacked was framework for distributed collaboration.

Sensemaking is one approach to understanding and solving wicked problems. Literally, sensemaking means the "making of sense." In the book, "Sensemaking in Organizations," Karl Weick says sensemaking "is about such things as placement of items into frameworks, comprehending, redressing surprise, constructing meaning, interacting in pursuit of mutual understanding, and patterning" (Weick, 1995, p. 6). Weick goes on to say that process of sensemaking is personal (each person has different knowledge and emotions), retrospective (experience plays an important role), social (talking to other people influences thoughts), and ongoing (Weick, 1995).

Suppose that an emergency manager is attempting to construct a procedure for allocating food and water following a hurricane. No person can develop such a procedure alone, because the problem spans across several groups, so it is inherently social. A local Red Cross official has handled food and water problems in the past and knows that their planning has to be flexible. Her experience (and that of others) makes the problem retrospective. Church leaders and local governmental officials want to make sure that their communities are not disadvantaged in the plans (it is personal). Their "flexible"

solution will constantly be in flux to deal with the situation as it happens, so the problem is ongoing.

Sensemaking is an important concept in the new, information age approach to warfare called Network Centric Warfare (NCW). Alberts and Hayes describe NCW as a way to achieve shared awareness, which may lead to more autonomous, "self-synchronizing" groups, increasing both the agility and effectiveness of the military (Alberts & Hayes, 2006). To achieve agility, these groups must be able to quickly react using the most up-to-date information. To have this timely information, Alberts and Hayes say that information sharing and collaboration must be easier. They recommend creating socio-technical networks that are facilitated by technology. They go on to say that "the most interesting and challenging endeavors are those that involve a collection of military and civilian sovereign entities with overlapping interests that can best be met by sharing information and collaboration that cuts across the boundaries of the individual entities" (Alberts & Hayes, 2006, p. 64).

Thus the sensemaking requirements (see Figure 1) are at the very core of the framework. In order to move forward in a positive, purposeful, and effective way, stakeholders need to achieve mutual understanding with one another. Some potential sources of misunderstanding are listed in the diagram (e.g., information, acronyms), though there are likely many more.

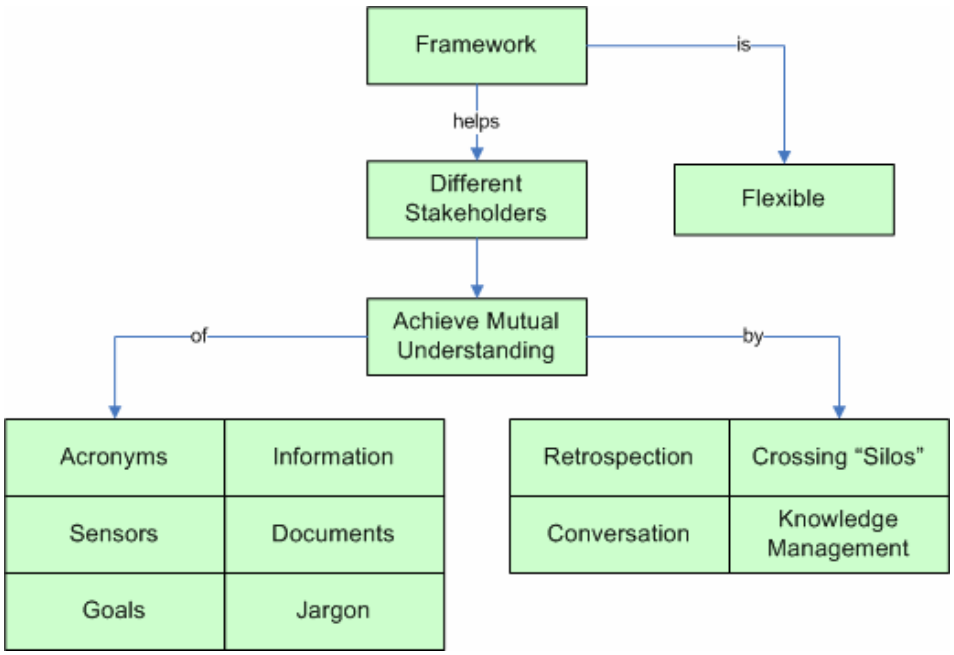

Figure 1 - Sensemaking Requirements

The processes that people must engage in to achieve this mutual understanding involves retrospection (looking backwards), conversations, crossing silos (e.g., having discussion outside of ones normal group), and knowledge management (e.g., finding a way to systematically supply the information), which will be discussed in more detail later. Finally and not insignificantly, the framework must be flexible to allow for the

changing needs of the people using the framework. It should be able to handle changes in artifacts (e.g., acronyms), processes, software, people, and organizations.

Communities of Practice

The term communities of practice likely came from Etienne Wenger, though as he says, the concept is not new (Wenger, McDermott, & Snyder, 2002). Communities of practice are evident in all walks of life, either through local artist or farmer communities, engineers discussing software development on the web, students learning a new subject, or parents discussing child rearing at sporting events. According to Wenger, communities of practice can vary in their size, how long they exist, whether people live in the same place, whether people are similar to one another, and whether they stay within or span business or organizational boundaries.

According to Wenger, communities of practice have many immediate and long-term benefits for organizations. In the short term, organizations gain by improving the quality of decisions, finding answers more quickly, and getting more perspectives on problems. In the long term, they gain by facilitating new capabilities and alliances, increasing the ability to think strategically about employee knowledge and capabilities, reduction of group "silos," and better retention of talent (Wenger et al., 2002). From the strategic point of view, communities of practice enable "distributed cognition," which essentially means that the group is able to pool knowledge and collectively achieve more than they would be able to on their own. In other words, the sum of a community of practice is greater than the whole of its parts (Davenport & Hall, 2002).

The frameworks that have been developed to explain collaboration often underestimate the complexity, dynamics, and lack of constraints inherent in real-world problems (Carroll, Rosson, Convertino, & Ganoe, 2006). Carroll et al present a framework that accounts for dynamic collaboration and also provides a convenient way in which to view issues related to supporting collaboration. Three main facets of this framework include common ground, community of practice, and human development. The first two will be used to organize the discussion about collaboration, communities of practice, and online communities. Since human development refers to learning and knowledge, it will be discussed in the knowledge management requirements.

The success of communities is often dependent on the degree of "common ground" between the organizations (Newell & Swan, 2000; Preece & Maloney-Krichmar, 2003). Common ground refers to shared knowledge, beliefs, and assumptions. The process of establishing common ground, or "grounding," is thought to influence the success of collective actions (Clark & Brenna, 1991). Grounding is influenced by many factors (see Table 1, adapted from Preece & Maloney-Krichmar). For example, it may be easier for two people from the same town talking face-to-face to ground, than it would be for the same two people using the telephone. However, if the parties speak different languages, and are located across the world, then grounding may be easier using asynchronous collaboration methods. These two scenarios differ by whether the people involved are synchronous (occur at the same time) and whether they are co-located (occur at the same place).

Table 1 - Factors that Affect Collaborative Communications

Factor	Description
Grounding	People can hear and/or see one another (visibility, audibility)
Common Ground	People have shared interests, knowledge, and experiences.
Co-presence	People in same physical space (local vs. distributed)
Synchronicity	People experience conversation at the same time (synchronous vs. asynchronous)
Reviewability	People can review messages
Revisability	People can revise messages
Anonymity	People can send messages without being identified

The dimensions of co-presence and synchronicity form the basis for the time-place matrix that is shown in Table 2 (adapted from Ellis, Gibbs, & Rein, 1991). The table shows which of the four combinations are required, as well as some examples of each type. For example, because the "asynchronous local" modality is an unusual occurrence, the framework does not need to support it.

Table 2 –Time & Place Requirements

	Same Time	Different Time
Same Place	"Synchronous Local" Ex: Face-to-face Required	"Asynchronous Local" Ex: Group Calendar Not required
Different Place	"Synchronous Distributed" Ex: Telephone Required	"Asynchronous Distributed" Ex: E-mail, bulletin board Required

In addition to the dimensions above, Alberts and Hayes characterize the degree of "smartness" required by the initiator of each technology (Alberts & Hayes, 2003). For instance, the telephone (a one-to-one communication) is considered a "smart, smart push," which means the person sending a message must know that the message is important (the first smart); they must know who might also consider it important (the second smart); and then they push the message by calling that person. The broadcast (a one-to-many communication) is considered "smart push," in that the person is no longer required to determine who is might want the message because everyone will receive it. However, this places an additional burden on all of the receivers, as they must receive and screen more messages. E-mail is flexible and that it can be sent to one person, like the telephone, select groups of people, or everyone (like the broadcast). The central point for Alberts and Hayes is that any networked environment should include several technologies so that all needs are met.

Whereas Alberts and Hayes focus on difficulties the sender may experience, other frameworks focus on the receivers of the information. For example, collaboration tools can also vary by whether they require the receiver to push information (such as list-servers) or pull information (bulletin boards). The distinction is potentially important if, for example, the user is waiting on important information. In a pull technology, they must continually check the information source. In a push technology, it is automatically

delivered to them. Because they fill different needs for collaborators, each of these methods (push, pull, broadcast) is required for the asynchronous, distributed modality.

In addition to co-presence and synchronicity, people must be able to review messages, conversations, and information when they need to. Typically, many asynchronous communications are inherently reviewable, but synchronous communications are not. Finding a way to make synchronous communications reviewable is another important component of the framework. In some cases, people must also be able to revise the messages to correct inaccuracies or mistakes. The ability to revise does not necessarily need to be done on the original message. For example, with e-mail, people can "revise" messages by sending another message with corrections. Where possible, the framework should support revision of the message containing the inaccuracy so that the misinformation does not propagate.

The need for anonymity likely depends on the specific situation in which the framework is used. For example, King (King, 1994) found a positive correlation between the number of months a group of recovering addicts used an electronic bulletin board and the average duration of their recovery. King theorized that bulletin broads provide two key necessities for recovering addicts: anonymity and having time to reflect before replying. In the military, anonymity could be useful in eliciting more honest opinions. In other cases, registering to use the framework could take some amount of time (depending upon the implementation of it and the security policies), so allowing people to post anonymously bypasses the time delay. This might be important if, for example, an ad hoc asynchronous communication tool was setup in order to help people displaced by a war find family and friends. Requiring them to register and verify their identities may cripple the system. Consequently, the framework must support ways in which anonymous users can contribute, even if it is in a limited way.

Returning to the need to allow multiple communication modalities, it should be obvious that the framework must also allow multiple devices on which to use those modalities. The devices must also fit within the contexts in which they would be needed. For example, a laptop is not an ideal device to use in the middle of a hurricane or a desert wind storm. There are several contexts in which the framework would likely be used (see Figure 2).

Figure 2 - Device & Context Requirements

These contexts can be grouped into roughly two types of scenarios. The first type is typified by command and control, battlefields, and emergency management, where many people from multiple organizations are actively working in a field environment (e.g., near a battlefield or a riot) and regularly have information that may be relevant to many people. In addition, there are commanders or managers who are not in the field but who need to get information from people in the field, and from other managers. In this scenario, a troop in the field does not have time to boot up a computer in order to send an e-mail to their supervisor. Nor do they want to carry around a laptop while performing missions. Instead they call the supervisor using a synchronous method such as a satellite telephone. The supervisor has access to a computer, but not all the time. Because they may be constantly traveling, they may need to use a range of devices, including cellular phones, computers, Blackberry's, PDA's, and specialized military devices. Each of these devices can run different technologies to varying degrees of ease. For example, when using a computer the supervisor can easily send e-mail, post to a bulletin board, or view a webpage. However, when using cellular phone, the same tasks become more difficult or even impossible.

The second type of collaboration involves people from multiple organizations who wish to collaborate from afar (e.g., the office and travel contexts), but they lack a common understanding with one another and the necessary communication tools, so their progress towards their goals is slow and difficult. The people involved in this collaboration will likely have regular access to a computer and the internet, and the time to compose messages and to read responses. However, if they are busy or traveling, they may spend critical periods of time away from an internet connection. Giving them better methods to stay in touch during critical times will be beneficial.

While these two scenarios may seem drastically different, they can actually occur in the same collaboration scenario. For example, in a large-scale disaster, local emergency officials must coordinate with regional officials, who may need to coordinate with national officials. In terms of the contexts above, the framework must allow the National Guard troop to send information to his or her supervisor, while also allowing the supervisor to have discussions with a regional manager, and so on.

Knowledge Management

At the most basic level, knowledge is built on data: raw numbers, observations, or pure stimuli, before any interpretation has been done or meaning has been assigned. Data may be sensor readings, position coordinates, or the answer to a question. If the data is meaningful, it is typically given the name "information." Knowledge, then, is information that has been put into a framework in a person's mind. In other words, knowledge is information that makes sense to the person, or as Nonaka says, "justified, true belief" (Nonaka, Takeuchi, & Umemoto, 1996).

What an organization knows and does not know can have an enormous impact on its ability to be successful. For example, suppose a large software company has been looking to develop a new product and they have identified java as the only suitable language. If they are to pursue the project and deliver it on-budget and within their time constraints, they must know if they have the relevant knowledge in the organization in

order to be successful. How do they find out? Similarly, imagine a military that needs to quickly train officers on NATO procedures. What percentage of employees knows the procedures? Are there internal tools available that help make sense of a procedure with new terminology, acronyms, and concepts? Short of training every soldier, how do you give them the information they need?

These scenarios bring up key issues in knowledge management in a military collaboration environment. What do people know? What are their levels of experience, skills, and knowledge? How can you transfer knowledge from the people who have the knowledge to the people who need the knowledge? Suppose a foreign official is attempting to understand the process the U.S. Army uses to allocate basic resources, and they are given a document filled with new words, acronyms, and concepts. Suppose that many people in the U.S. Army have learned the new document and had discussions about various difficult-to-understand sections. Good knowledge management allows the transfer and creation of knowledge. Such a system would allow the foreign official access to those discussions, to frequently asked questions (FAQ's), and to experts on the procedure so that they can learn more quickly.

One popular way to look at the process of creating and transferring knowledge is to use Nonaka's "spiral of knowledge" framework (Nonaka et al., 1996). Like many other researchers, Nonaka splits knowledge into two types: explicit and tacit knowledge. Explicit knowledge is typically defined as factual knowledge, while tacit knowledge is defined as procedural knowledge or know-how. Tacit knowledge is intrinsically difficult to describe in words because it is very personal and relies upon our individual views of the world. Nonaka describes the process of creating new knowledge as a transfer from one type of knowledge to another, in one of four processes: socialization, externalization, internalization, and combination (see Table 3). From the knowledge management perspective, it is important to support as many, if not all, of these knowledge creation processes.

Table 3 - Models of Knowledge Creation (adapted from Nonaka)

		To:	
		Tacit	Explicit
From:	Tacit	Socialization	Externalization
	Explicit	Internalization	Combination

Socialization involves the creation of tacit knowledge from external tacit knowledge (e.g., from another individual), and is typified by the apprentice relationship. In the online collaboration context, socialization usually requires synchronous communication (e.g., telephone call, video conferencing, white board), though recorded video can work as well. For example, suppose you are learning a new email program. A colleague uses a remote connection to view your computer and you talk over the phone. She guides you to how to setup your email, providing both explicit and tacit knowledge.

Internalization involves creating tacit knowledge from explicit knowledge. For example, consider the previous example. Suppose that instead of having a colleague, you are given a guide that contains the server addresses and settings. You then follow the

guide, along the way learning how to interact with the menus and interfaces. You have converted the explicit knowledge contained in the document into tacit knowledge.

Combination involves sharing facts, or learning facts and grouping them, cognitively, with a set of related facts and knowledge. For example, after setting up the email, you learn from a friend that sometimes when you are at a coffee shop you sometimes cannot send email using the program. In these cases you need to send email using the web mail program. You have added this knowledge to other explicit knowledge. Combination may be supported online by providing places where people can learn more about what they already know. In this way, people may develop more complete mental models about how things work.

Externalization involves putting into words your tacit knowledge, often through metaphors and analogies. Extending the e-mail example, suppose that you have become an expert at using the e-mail program. A friend is confused by the text editor and its modes (HTML, Rich Text, Plain Text) and asks you to help. You tell your friend that the Rich Text mode is similar to WordPad, and the Plain Text mode is like Notepad. You have converted your tacit understanding into explicit knowledge. Since your friend is familiar with WordPad and Notepad, he or she may also be able to internalize the new knowledge. Metaphors are especially good for communicating tacit knowledge because they make use of shared experiences that two people have (using WordPad).

An alternative way to think of things is to consider the processes involved in actually managing knowledge. Some of the key processes, according to Rollett, are: assessing, maintaining, integrating, organizing, creating, and transferring (Rollett, 2003). Assessing refers to the assignment of value or quality to knowledge. For example, is the knowledge relevant, accurate, comprehensive, timely, and secure?

Organizing refers to how the knowledge is organized. Some knowledge may be easier to find if placed in a hierarchy, linked to from other documents, or tagged with keywords. Organization can present significant barriers to using knowledge management systems. For example, on a company intranet, information may be located on many different servers, written by different teams, having different headings, permissions settings, search engines, and interfaces. Thus organization is critical. Maintaining refers to "reviewing, correcting and updating, refining, preserving, and removing" knowledge, from both people's minds and from technological knowledge containers (repositories)". Maintenance is far from trivial. As will be discussed later in this section, maintenance is one of the bottlenecks in the design of current knowledge management systems (Wagner, 2006).

Integration is perhaps the key to the framework. Integrating refers to both how well the knowledge is captured by systems and how much it is used once it has been captured. Too often, tools are developed separately and the points of integration between the tools are either non-existent, or poorly designed afterthoughts. For example, suppose that a person wants to know the definition of "sensemaking." Searching for the term requires them to find the link to the search engine, to type "sensemaking" correctly, and then to hope that the term is actually in the database. The framework must integrate these two tools such that the knowledge tool is closely coupled to the communication tools in a persistent but non-intrusive way.

Wagner claims that there are several bottlenecks to traditional knowledge management that software fails to address: narrow bandwidth, acquisition latency,

knowledge inaccuracy, and maintenance trap. Knowledge management tools often have a narrow bandwidth to capture knowledge from its source (e.g., experts, documents, and transactions). Acquisition latency refers to the delay from when knowledge has been captured and when it can be shared. For a rather obvious example, consider the publication process: it can take days, weeks, or years for the results to become available. Knowledge inaccuracy refers to mistakes that may be made, and which are often very difficult to correct (again, publications are fairly permanent once they are distributed). Such publications can also become out-of-date rather quickly. Finally, maintenance trap refers to the problem that as more knowledge is captured, more has to be kept up-to-date (Wagner, 2006).

The requirements for the knowledge management portion of the framework are summarized in Figure 3. The knowledge management processes in the top layer (green), the modifiers and properties in the middle layer (gray), and the bottlenecks in the bottom layer (red). The document object at the top represents the product of the knowledge management system (the "content"). This document can only be built through the knowledge management processes.

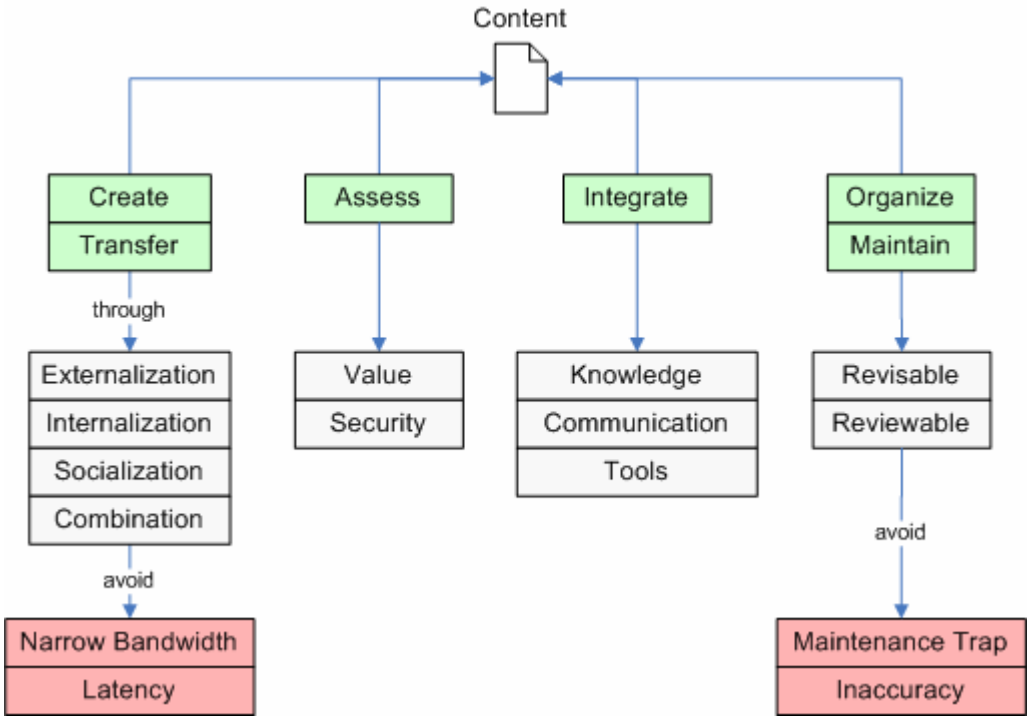

Figure 3 - Knowledge & Content Requirements

THE FRAMEWORK

A diagram representing key aspects of the framework for inter-organizational collaboration is shown in Figure 4. Though only three collaborators are shown, the

framework is extensible to thousands of people. The devices shown for each collaborator represent possible choices which they can use to access the framework. The "Asynchronous Tools" are the methods collaborators can use, beyond phones, to communicate with one another. In addition, using a computer, the collaborators can interface with the portal directly ("Pull").

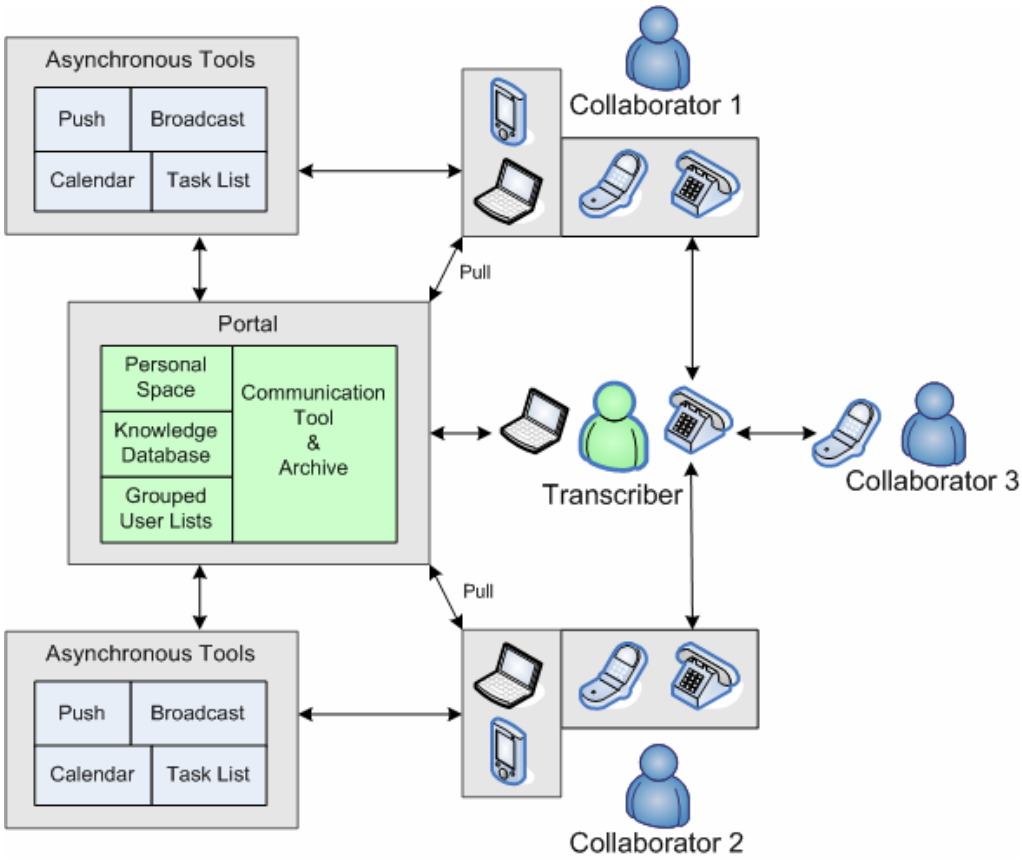

Figure 4 - Framework for Inter-Organizational Collaboration

Portal

The "portal" is the virtual center for collaboration activity. The portal provides a customized view into the knowledge and communication tools, and helps people find information that they need. It is the gateway to access much of the functionality of the framework. Just beneath the portal layer are an asynchronous communication tool and archive, knowledge database, grouped user lists, and personal space.

One important characteristic of the portal is that it is very flexible. With a single link, an entire application can be launched from the portal. In other cases, using standards such as XML (extensible markup language) and RSS (real simple syndication), the portal can view information from multiple sources at once, including news, e-mail, new entries in the communication tool, weather updates, etc. Consequently, entire applications (or views to those applications) can be added to the framework with minimal intrusion on the user. However, providing points of integration for those new applications with existing applications will always be a helpful yet potentially time-consuming task.

Communication Tool & Archive

At the very heart of the portal and the framework is the communication tool and archive. This component must provide a place for collaborators to hold new discussions and to view discussions that have occurred in the past. Such an archive must assure that messages or communications are both revisable and reviewable. One key aspect of such an archive is that it provides some amount of inherent organization, as well as ways for collaborators to find needed information as easily as possible. For example, collaborators should be able to perform searches, browse by organization or user or hierarchy, or possibly search by tag words. Other tools may be explored, such as a tracking tool which suggests potentially relevant topics to the user based on the people posting to it or the information contained in it.

Knowledge Database

For collaboration to work between organizations, the people involved must become familiar with processes and procedures, language, documents, terminology, and acronyms used by other organizations. The knowledge database can help reduce problems related to the lack of familiarity between organizations. However, for a knowledge database to work, it must support the processes mentioned in the requirements (e.g., create, transfer), and it must be tightly integrated with the communication tools that the organizations use to talk to one another.

Perhaps the best way to couple a knowledge database with a communication tool is to explicitly link from the communication tool to the database any time a word or concept arises that is contained in the database. In this way, users are not required to know that the term is contained in the database; if they are using a computer, then they could simply click a link and read about the concept. This interaction could be improved in any number of other ways. For example, if the database always includes a short definition of the term or concept, then that definition could be displayed when a collaborators hovers over a word in the communication tool. This would be especially helpful for terms with easy definitions (e.g., acronyms), or terms where the participant only needs a reminder.

Supporting the knowledge management processes requires attention to both the functionality in the application and the policies related to the use of the application. For example, the application should make it easy for people to transfer their existing knowledge into the database. If policies restrict who can enter the knowledge too severely, then the time it takes to implement such a knowledge database would be adversely affected (due to the “narrow bandwidth”). One method for ensuring quality that has been used widely is that of peer review. Instead of limiting the number of people who can create knowledge, it might be better to alert the content providers when a page has been modified and to provide good version control systems so that the content can be reverted to a prior state if the new information was incorrect. This safeguard will give people the freedom to experiment and to add new knowledge without the fear of doing irreparable harm.

To help prioritize pages that need to be improved or added, the knowledge database should have some method of analyzing discussion content for re-appearing

words, concepts, etc. In addition, the tool should also be able to show the number of links (both internal and from the communication tool) to a certain page (both existing and not yet created). These statistics can help moderators of the tool prioritize which pages need to be added or routinely updated.

Transcriber

Because collaborators may need to talk synchronously with one another (e.g., via telephone or a conference call), an important component to the framework is the presence of a transcriber. The transcriber essentially serves to convert synchronous information that would otherwise be lost into asynchronous information that can be communicated to many people and saved for later. In small collaborations with no budget to pay for one or more people to provide this service, the transcriber may be a person taking notes or a secretary. In some cases, such a transcriber could also use other applications, such as Compendium (Compendium Institute, 2006; Conklin, 2003a, 2003b), to assist with the process.

In large-scale collaborations such as in emergency management, having a dedicated transcriber may be more feasible and also more critical. Since people in the field are unlikely to be able to use laptops or even PDA's (personal digital assistant) much of the time, the collaborative framework allows them to use their telephone, cellular phone, or satellite phone to call the transcription service. The transcriber will then create a conference call with the desired parties (e.g., their manager), and then write a summary of the conversation and place it in the relevant place using the communication tool so that other people have access to the information. Such a transcriber can also add tag words, or set message priority levels to determine who will get the message.

If necessary, the burden of calling the transcriber can be placed in the hands of the manager, who could use three-way calling to connect the participants. Once the transcriber is in the conversation loop, he or she would summarize the phone call and place it in the appropriate place in the communication archive, where the discussion could be seen (and commented on) by many other people. One potential benefit of such as transcription service is that it could serve as a hotline for all field personnel. Such a hotline would have one easy-to-remember number that takes burden off of the people who are most time-constrained.

Grouped User Lists

Supporting grouped user lists is important for both the distribution of messages in the framework, and for controlling security and permissions for the framework. Ideally, the framework should be able to import such lists from organization's existing structures; however, setting up grouped user lists will likely be a major information technology (IT) support task. Again, integration of the grouped lists with the other components of the framework is critical. The grouped lists should support the communication tool and the knowledge database. The grouped lists should also be flexible enough to accommodate people who need to setup lists on the fly.

Personal Space

The personal space provides a place for people to include either personal (e.g., a picture, favorite links) or professional information about themselves (e.g., their main skills). While this may seem like a trivial and low priority need, helping collaborators find common ground is an important goal in any collaborative activity. For example, pictures could help collaborators recognize one another should they meet in person. Some parts of the personal information could be automatically supplied by the organizations involved. For example, the training, ranks, and awards of an officer could be imported from military-controlled databases.

Asynchronous Tools

As mentioned earlier, collaboration is likely to involve three of the communication types in the time-place matrix. Instead of trying to create new tools like custom PDA's, this framework looks to take existing technology and incorporate or integrate it in the best way possible to fulfill the communication needs of collaborators. In addition to the synchronous communication methods (telephone), people should have a variety of asynchronous methods are their disposal, including push and pull type interactions, and one-to-one and broadcast message distribution.

Push technologies such as e-mail are useful because people have to exert less effort in order to be notified of new information. One disadvantage of push technologies is that they can push too much information, making it difficult for people to find the information they really want to know. Pull technologies are needed so that people can find information on their own time, especially for types of information that they would not normally need to know. For example, an army officer may want to see where the Red Cross is focusing their efforts. One-to-one communications are important, but they do not need to be explicitly supported by the framework because most people already have a one-to-one asynchronous communication method (e-mail). However, people should be able to broadcast important messages to groups of people, and they should be able to receive broadcasts that are important to them. These broadcasts can be setup through the grouped user lists, which is another part of the framework.

Though calendars and task lists are not required, they may be very useful if the collaborators are working on projects and dealing with timelines. Shared calendars are not a necessary component in the framework because the usage of them depends to a great extent on their usability and the collaborators willingness to learn and check the calendar program. The most likely implementation problem with electronic calendars is that there are many applications which offer their own calendar programs and some organizations may wish to use their own application. Unfortunately, most of these applications are proprietary (e.g., Microsoft Outlook) and thus would force collaborators to buy the same software in order to share calendars with one another.

IMPLEMENTION

While the proposed framework is helpful for conceptualizing how to fill the requirements of inter-organizational collaboration, it is necessary to also consider how

the framework could be implemented in the real world. Towards this goal, a diagram similar to the framework is shown in Figure 5. In this figure, specific applications are used to show how each component may be fulfilled.

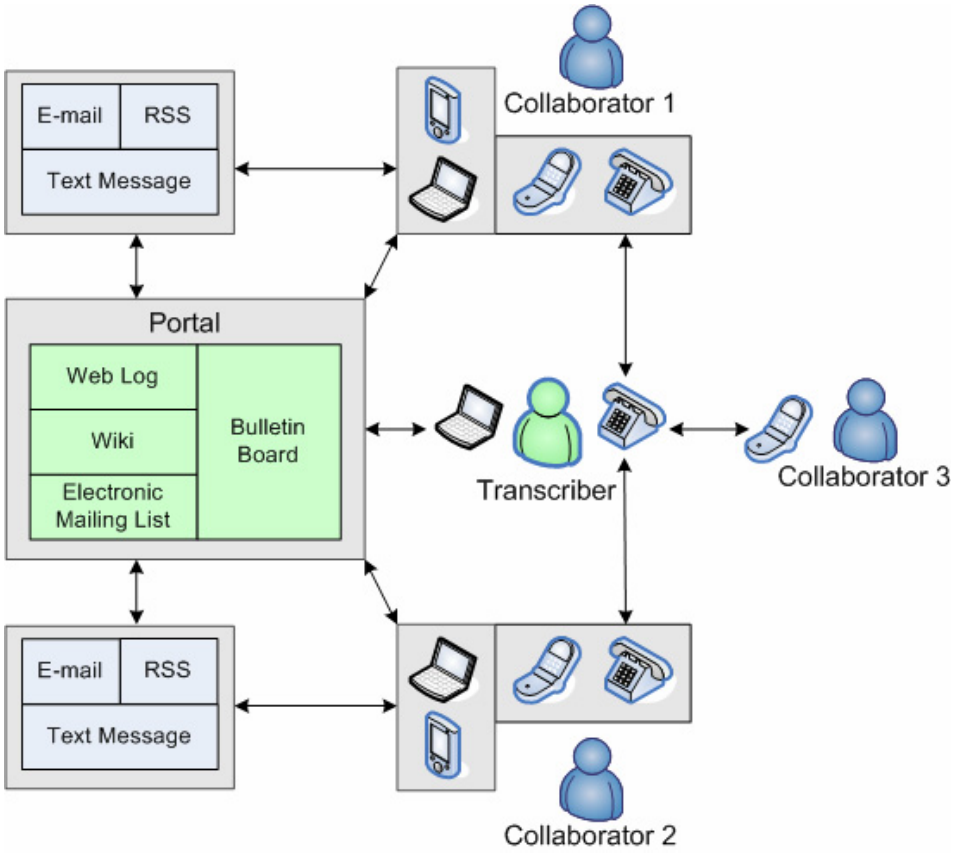

Figure 5 - Application Framework

The bulletin board is the most critical application in the framework because it is both the communication tool and the archive. At a basic level, the bulletin board provides the "pull" access necessary for the different place, different time type of communication (see

Table 4 for how the framework fills each need in the time-place matrix). Once using the application, users can view, reply to, or post new messages. In addition, they can search the bulletin board by keywords to find information more quickly. Bulletin boards would also be useful because they also provide inherent organization of messages into forums and threads; the software is fairly mature, scales well to multiple servers, and is well tested in high volume environments; it is likely to be familiar to many of the potential collaborators; and because several bulletin board applications are available open-source, it would not be as time-consuming or expensive to develop and multiple organizations could use the software.

Table 4 – Technology Support for Time / Space Collaboration Matrix

	Same Time	Different Time
Same Place	Transcription of face-to-face conversations (secretary); dialog mapping	Not needed
Different Place	Transcription of telephone and audio conferencing; bulletin board	*Pull:* Bulletin board *Push:* Email, list-server, RSS

It is often desirable to have the desired information "pushed" to one's e-mail address. For example, single forum applications such as Yahoo! Groups (groups.yahoo.com) often tie the forum to an electronic mailing list, such that any message posted to the forum can also be sent via e-mail. In addition, users can reply to messages that they receive through e-mail, without having to navigate to the bulletin board website through a Web browser. In bulletin board software, integration between electronic mailing lists and individual forums or threads is limited at best. For example, some bulletin boards allow users to automatically have e-mails sent when someone has posted to a thread that they started (or posted to). Providing more comprehensive integration could be very useful for people too busy to continually monitor bulletin boards for new information. Thus, this framework would use existing electronic mailing list software to tie each forum and some important threads to a mailing list. Users would be able to subscribe and unsubscribe in one step, or they could subscribe simply by posting in the thread.

Now reconsider the transcriber, who was described in detail in the previous section. The transcriber records a conversation between two or more people. Since the transcriber knows the identity of at least one of the people and the topic that was discussed, he or she can place the conversation in the appropriate forum and thread (either existing or new). If the information was critical, the discussion could be flagged to attract attention, or to be sent to more people. Once posted, the information becomes immediately available to everyone with access to that forum. For people who have subscribed to the mailing list for that thread or forum, the message could be pushed to them immediately.

The other communication methods listed in the framework include text messaging and RSS (Real Simple Syndication). These components are not as critical to the framework, but they provide additional options for community members. Text messaging is a technology supported by cellular phones which allows users to send and receive short textual messages through their phones. Text messages can be sent from one cellular phone to another by using their phone number, and they can also be tied to an e-mail address. Since cellular phones are highly portable, supporting text messages will allow users to send important updates to the bulletin board when they do not have access to the internet.

RSS is a promising new technology that can be used in conjunction with the portal to make it easier to pull information from various information sources. Many news sources today use "RSS feeds" which are simple XML pages that update regularly when

new information is available. Users can setup an RSS reader to automatically check those feeds for new information. If an RSS reader is the user's portal, then they can stream information from many different sources and view them all from the same page. For example, RSS could be used to track forums that a person has posted to (or occurrences of the term "sensemaking"), their e-mail "inbox", CNN news, a military blog, and the weather in the area. While the user still has to pull the information, the burden is significantly reduced because they only have to visit one page to see the latest slice of the information.

In addition to the bulletin board and electronic mailing list, the framework contains both wiki and web log applications. Wiki's are generally defined as, "simple to use, asynchronous, web-based collaborative hypertext authoring systems" (Desilets, Paquet, & Vinson, 2005). The wiki fulfills the knowledge database functionality by providing a place to store documents, terminology, concepts, and acronyms. Wikis are ideally suited for this task for several reasons. First, they provide simple methods to support each of the knowledge management processes. For example, to create a new entry in a wiki, one only has to search for a term that is not contained in the wiki and click a link to create the page. To edit a page, one only has to click "edit" on a tab and the page becomes editable. The syntax is relatively simple and easy to learn.

As noted earlier, the typical knowledge management bottlenecks are reduced or eliminated in the wiki. Since anyone can edit pages, the "bandwidth" to create new pages is nearly unlimited. Similarly, it is very easy to correct mistakes and inaccuracies, and for people contributing to the wiki to review one another's work. Most wiki applications provide a version control system that allows people to roll back to previous versions if necessary.

Integration between other applications and the wiki is critical. A simple algorithm could easily be developed to search the wiki database for relevant terms any time that a new message is posted to the bulletin board. In addition, suppose that each wiki entry contains a short description or definition of the relevant term (followed by an in-depth definition or document). The final message would then contain links to the wiki for the terms that it finds. If users hover over the link, then the brief definition would appear much like a tooltip.

Of course, the wiki will need to be populated with information and it may require that collaborators find a way to transfer knowledge from their current knowledge repositories. These are admittedly not trivial tasks, but because wikis offer organizations advantages for both internal and external processes, it is possible that more and more organizations will be transitioning their documents to wikis anyway. Like bulletin boards, several different open source wiki applications are available. These applications can give organizations the functionality they need with very little development time. Because the applications are not proprietary, and because the software is meant to scale over several servers, it is possible to create wikis that support multiple organizations in collaborations.

The web log (or "blog") can provide a useful way for people to learn about interests that they may have in common with others. Integrating a blog with a bulletin board requires coupling the user information for both applications. Once this information is coupled, users could control what information they wish to share about themselves, and they could post content relevant to their own interests, and this information would be accessible from both applications. Like the wiki, if the blog contains a small amount of

standard information, the bulletin board could query the blog's database to retrieve information such as job position or rank, organization, number of posts, professional affiliations, favorite quotes, avatars, or small pictures such as a portrait. While some of this information may seem unnecessary, it can be a useful way for the bulletin board to support common ground among seemingly different users.

THE FRAMEWORK IN USE (A SCENARIO)

A squad of National Guard troops is working in California after an earthquake. They have been attempting to stop looting in one section of Los Angeles, where people have been without food, water, or electricity for several days. Two hours ago, the squad's leader, Staff Sergeant Barron, placed a request to the platoon leader, Lieutenant Smith, to have another squad or platoon of troops come to the area, but recently the looting has stopped in the area and seems to be under control.

Staff Sergeant Barron knows that this information could be potentially important to many people, so he calls the transcription hotline by dialing #777. He tells the transcription service that he wants to reach Lieutenant Smith of the National Guard. The transcription service dials Lieutenant Smith's primary number but he does not answer, so they try his cellular phone, which he does answer. The transcriber briefly informs Lieutenant Smith that the call is being recorded and then Barron tells Smith the situation. Smith decides to deploy the additional troops elsewhere.

Meanwhile, the commander of another platoon, Lieutenant Park, has seen a large group of people walking in the general direction of the looting near Barron's squad (though he does not know Barron is there). He calls in the information to the transcription hotline. The commanding officer for both platoons has an assistant that is monitoring the reports through the bulletin board. The CO gets the new information and calls Lt. Smith to order him to abort the new mission and to continue towards the looting area.

Both the mayor and the Red Cross director also have an assistant subscribed to the forum, so they are notified by e-mail about the messages. The mayor decides to issue a warning to citizens to stay out of the area. The posts in the bulletin board refer to the area as District 11. Since the Red Cross director is new to the area, she does not know where this is. Fortunately, District 11 has been defined in the wiki, so she clicks on it and finds a map. She calls her field personnel to delay sending people into the area until the area is secure.

CONCLUSION

Many organizations today are faced with "wicked" problems that are difficult to understand, change over time, and involve stakeholders who have different views of the world. This research looked at one way of solving such problems, the process of collaborative sensemaking. Since sensemaking is retrospective and highly personal yet social, a framework for collaboration was needed that enabled people to converse while also supporting their ability to learn from one another.

Several domains of knowledge which are relevant to these issues were evaluated. Sensemaking literature gave insight into the types of issues that needed to be addressed. Knowledge management literature revealed key processes that needed to be supported as

well as bottlenecks. Communities of practice literature revealed key social issues that can arise when people attempt to converse with one another through technology. Research into existing applications and technologies yielded many useful applications and features, and also helped form the technological boundaries of a solution which leveraged non-proprietary software.

With this knowledge, a framework was developed to support inter-organizational collaboration. The proposed framework integrated multiple communication tools and a knowledge database in order to support knowledge transfer between the organizations involved. Such a framework may be useful in any number of circumstances and domains, including command and control and business.

The next step is to implement the core of the framework, and to test it both in the laboratory and in real world case studies. Through such studies, key points and problems can be learned and used to improve the system, both through new software development and through improvement of the points of integration between each of the tools.

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