User-Centered Design Guidelines for Collaborative Software for Intelligence Analysis

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***Abstract*—In this position paper we discuss the necessity of using User-Centered Design (UCD) methods in order to design collaborative software for the intelligence community. We discuss a number of studies of collaboration in the intelligence community and use this information to provide some guidelines for collaboration software.**

***Index Terms*—Intelligence community, collaboration, user-centered design, metrics, evaluation**

I. Introduction

Collaboration in todays' intelligence community (IC) presents some potential benefits and many difficult challenges. Installing off the shelf collaborative software, in many instances, only serves to exacerbate problems given the specific requirements and structure by which the IC operates. However, this domain exhibits characteristics that lend themselves well (or even require) collaboration from many users across many domains. Therefore, understanding the challenges specific to this domain through a user-centered design methodology can enhance the community's understanding of how to design and build such capabilities.

Todays' intelligence community has an incredible task as our world is the most complicated in history due to globalization and the need to cooperate with many foreign countries, although under severe constraints at times. Challenges include:

- "Our ongoing 20 year struggle with information overload has been further complicated by the challenges of dealing with foreign and domestic information.
- Virtually all subjects of any significance are a complicated mosaic of social, economic, political, military, and technical components.
- Individual bad actors have it within their grasp to take actions that can have strategic consequences. Barriers to entry are low and, in effect, these individuals use globalization against us.
- And as the roles and responsibilities of our Executive Branch Departments blur, we find seniors across the government interested in the same information. Everybody wants their organic intelligence elements to replicate the same analysis many times over [1]."

Is adding more intelligence agencies into the mix and using social media and the wisdom of the crowd a sensible way to approach this? The problem is that while it is estimated that over 80% of the relevant information is NOT classified, this varies widely by subject. "Game-changing" information in critical areas is usually small and the most problematic to locate and verify [1]. This information may also be on the borderline between agency responsibilities and access and have a very limited, sensitive distribution. Thus, collaboration is one approach to aiding in this challenge.

In order to design software that overcomes many of the obstacles in collaboration, it is necessary to look at current practices and workflows and produce guidelines for software that preserves or enhances current facilitators while reducing obstacles. It is also essential to realize that insertion and adoption of any collaborative software will eventually change the workflow in an organization. Therefore the collaborative software needs to be flexible enough that analysts are able to manage the change in a non-obtrusive fashion.

Additionally it is essential to measure the impact of the collaboration software (i.e., evaluating the effectiveness). The number of agencies doing intelligence analysis of some sort is in the double digits and their tasks and work practices are extremely varied from quick turn- around asks to long, complex strategic analysis. Collaboration efforts may focus on teams within an organization, organizational collaboration, or between agency collaboration. Therefore, how can various agencies decide which collaboration tools would even be feasible to try in their organization and how can they measure the success? Analysts must perceive a benefit in using the tool in order to continue (or begin) using it.

In this paper, we first present lessons learned from studies of analysts and collaborative software tools. We use these studies to derive some high level guidelines for collaboration software within the IC. We also present methods of measuring the impacts of collaborative software. Finally we present

features for future collaborative software that can be investigated.

II. Lessons Learned from Prior Work

The lessons detailed in this portion of the paper are presented as results from prior studies, observations, and interviews with analysts. We organized them in terms of the lessons learned and then present the evidence along with the references to the studies.

A. Collaboration Through Social Media Technologies

A report by McKinsey Global Institute claims that business employees spend 28 hours per week answering, writing or responding to email, tracking down information, and collaborating with co-workers [2]. In addition, social media is becoming an acceptable (and at times preferred) method of collaborating. A 2013 Pew Research study showed that 72% of adults use social media, with 89% of those aged 18 – 29 and 78% of those aged 30 – 49 [3]. As we replace the aging analyst population with younger analysts, there will be an expectation for the same computing resources and communication tools at work as they have at home.

The IC started their Intellipedia effort in 2005. Based on the success of Wikipedia for the general public, this was an effort designed to allow individual analysts to create pages to share information within the IC. As of 2009 Intellipedia had some 100,000 user accounts [4]. In the IC not all users should have access to all content. While sometimes just knowing that the information is there is useful, collaborative tools need to take into account security issues in accessing content. Currently three versions of Intellipedia exist based on the classification of the information. As many agencies do not use Intellipedia as an official conduit for information, analysts move content from Intellipedia to an official data repository in their agency for use. This only increases the analysts' work as information is now duplicated on many sites. Analysts are often apprehensive about contributing information on Intellipedia as this reduces the control they have over how information is used.

B. Synchronous vs. Asynchronous Approaches

Understanding the IC is critical in understanding whether to design for synchronous or asynchronous collaboration tasks. For example, Kang and Stasko observed students at Mercy Hurst College in intelligence courses. They found that teams of students did collaborate but not so heavily on content as on status. They termed this loose collaboration [5], [6]. Similarly, Scholtz and Steves observed analysts at the United States Army Intelligence and Security Command Center (INSCOM) working on RFI taskings using the chat facility of a collaborative tool more than setting up shared spaces for collaborative work – which was the intended collaborative functionality of the tool [6]. They had other mechanisms for sharing content and as their tasks were often very quick turn-around, the overhead of setting up a shared space for working on the task was extremely burdensome. Additionally, Nolan found in her interviews of National Center for Counter Terrorism (NCTC) analysts that they also found the chat system very useful [7].

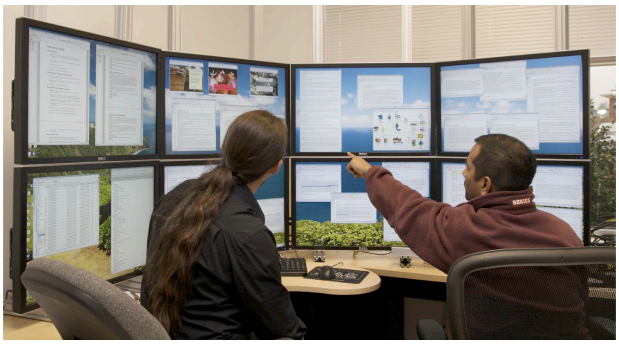

Figure 1. A pair of users collaborating on a large, high-resolution display.

The idea of cooperation may be more acceptable in many agencies [4]. The difference between collaboration and cooperation is subtle. Both rely on technology tools but in cooperation each analyst would do her own work but would share with other analysts the tools and other resources available.

C. Merging Shared or Opposing Perspectives

When collaborating, each collaborator stems their insights regarding a topic from a potentially different domain experience and dataset. For example, this issue is illuminated within Intellipedia as a duplication of content, or more generally on Wikis when content is changed or overwritten by a group of authors with opposing opinions [cite, I think there's some work in that area].

In co-located settings, prior studies found that roles emerge organically in collaborative analytic tasks performed synchronously on large displays [8], [9]. They found that a difficulty in such organic emergences of roles is coming to a common perspective that both collaborators could agree upon. However, the ability to reflect on these perspectives using a common, shared externalization of their process (a common spatial organization) helped illuminate moments of disagreement between the collaborators. Figure 1 shows a pair of users discussing a point of contention regarding the placement of a specific document. Fink et al. found that analysts collaborating on such a display can also use "physical brushing and linking", where one user points to an area of a display, while the other points to another to show the connection [10].

Collaboration around a tabletop display can produce a similar effect. Isenberg et al. showed how co-located collaboration using a tabletop can show implicit signs of information ownership based on the rotation of the information [11]. Further, their work discusses how collaboration can be measured by the sharing of information both within the visualization as well as socially between collaborators.

D. Pull versus Push

Intellipedia relies on pull – the analysts must search for the information they need. Information is often difficult to find as

analysts' sometimes use agency-centric tags for their information [4]. One way to overcome that is to use push technology. That is, to integrate a mechanism for users to become aware of information that others are performing in order to advance their task. One immediate challenge in such an approach is the understanding of what information is relevant to the task of the individual, and how to control the amount of information that one may be made aware of.

Nolan interviewed many analysts at the NCTC and while all of them expressed a desire for more pull systems, they were stymied to understand how it would be practical given the security levels and stove piped information that currently exist [7].

E. Sharing of process

Kang and Stasko found in studies of students in intelligence analysis that the critical aspect of intelligence analysis is figuring out how to answer the question. Determining the frame, the knowledge slots that need to be filled in to accurately address the question, is the critical part of the process [5], [6]. Of course, this frame needs to be flexible as the information located during the research may cause the analyst to change direction during a task.

This is a place where collaboration (or cooperation) would be helpful. Junior analysts might want to collaborate with senior analysts as they are learning the trade. In the case of complex problems that need information from different domains (political, military, religious, etc.) an analyst could reach out to experts in those areas.

F. Sharing Explicit Representation of Context

Bier and colleagues conducted a study to examine a collaboration tool designed especially for analysts [12], [13]. Their hypothesis was that a tool designed around entities and that provided analytic support for an analyst would be easier to use as collaboration and analysis could be accomplished in the same tool. The researchers developed five guidelines that they tested in their study: create features to support processing of entities; make it easy to collapse but still located information; provide features for organizing evidence by the story; use subtle cues to notify analysts of additional information so as not to disrupt their work unnecessarily; and support the sharing of collections of documents. In an experiment to assess the five guidelines, they found positive support for all except the subtle cues as they were not able to test this

Goetz et al. looked at information gathering and the analysis process as a means for gathering information about how intelligent user interfaces could be used [14]. They looked at the use of an explicit representation of content, both from the starting point of analysis and also in picking up a task in midstream. They found that information gathering and analysis were tightly coupled. They observed analysts moving back and forth between background information and evidence for hypotheses. Most importantly, software tools for analysts need to support the building of explicit models that capture the content of the research.

III. Guidelines for Collaborative Software

Based on the previous section we have extracted some guidelines for use in designing collaborative software. In addition, basic usability guidelines should also be consulted [15]–[18]. The guidelines extracted from the studies in section II are at a much higher level than usability guidelines, such as a guideline that says to use recognition rather than recall for accessing functionality.

Our extracted list includes:

- Collaboration tools need to accommodate context at various levels of classification.
- Analysts should be able to reference content from collaborative spaces such as Intellipedia rather than having to duplicate this information. Scientific papers now allow web based references which include the URL and date accessed.
- Collaboration tools can provide both communication and content sharing. For any given team one mode may be more important than the other.
- Collaboration tools can support asynchronous use, synchronous use or both. Team preferences should be aligned with the mode supported by the tool.
- Collaboration spaces need to support an integration of individual analyses and the discussion used to produce a holistic product.
- Analysts are concerned that total information integration could result in security breaches and leaks.
- An intelligence-wide communication tool would help analysts keep in touch with other analysts they meet while on assignment at other organizations.
- As information gathering and analysis are tightly coupled, a collaborative analysis tool needs to support both tasks.
- Collaboration tools that support status of individual users facilitates coordination of tasks.
- Create features to support processing of entities.
- Make it easy to collapse but still located information.
- Provide features for organizing evidence by the story.
- Use subtle cues to notify analysts of additional information so as not to disrupt their work unnecessarily.
- Provide support for analysts to use their long-term standing queries for accessing information.

Software used in the US Government needs to also adhere to the 508 Accessibility Guidelines. Much research software does not support accessibility and these are issues that will definitely need to be addressed prior to purchase for use. This is an issue that will not be discussed in this paper.

IV. Evaluation of Collaborative Software

Both quantitative and qualitative metrics are useful for evaluating collaborative software. In addition, interpretation of these metrics is different if the evaluation is done in a laboratory setting where outside issues can be carefully

controlled. Such is not the case in real-world settings and as such care must be taken to understand the context and situation during the study to determine what additional outside influences may have impacted the metrics

Basic usability metrics are concerned with measuring effectiveness, efficiency and user satisfaction. In usability evaluations this is usually done with respect to various tasks that can be completed with the software. In evaluating the use of a complex system such as a collaboration product, measuring the perceived utility of the software is an appropriate indicator of future use. To do this it is necessary to understand the metrics from the user's point of view. For example, productivity is a concern of most analysts. This can be broken down into the relevant number of documents retrieved per unit time, the number of documents read, the number of pieces of evidence retrieved, etc. Most importantly, these metrics should be established in conjunction with the user community.

Steves and Scholtz developed a framework for evaluation based on the goal of the system [19]. A collaborative system might have as its' goal, to enable analysts to produce reports that contain more breadth. So if we gave an analyst the task of examining a situation and its impact on multiple domains within a country, measures might be the number of experts who contributed to the report, the time needed for collaboration and the breadth of the analytic product. This scenario could be used with the collaboration tool and without the collaboration tool by two groups and compared. By designing metrics from the top down, it is easier to compare two or more software systems at the goal level.

Bier et al. in their laboratory study used both quantitative and qualitative measures [12], [13]. They instrumented their software tool to collect such things as the number of entities created, the method used to create them, and the number of snap-together knowledge events created. They measured collaboration by the number of times analysts modified entries in notebooks created by other analysts. They also collected quantitative information by asking Likert –scale questions such as "on a scale of 1-7 where 1 is high and 7 is low, how easy was it to create an entity?" [12], [13].

V. User-Centered Design

Given the diversity of the intelligence tasks in the different organizations, we suggest a user-centered design approach be taken before collaboration tools are implemented or purchased. Various intelligence groups differ in the tasks they do and the procedures they do. For example, there is a considerable difference in responding to a request for information than there is doing a strategic analysis. A detailed user-centered design process with a specific group is necessary (but not sufficient) to ensure that the final product provides the necessary utility to the end-users.

User-centered design work takes on many forms but the goal is to understand current work practices of the users and what aspects of these are not currently adequately supporting the analysts' tasks.

User-centered design is an iterative process. It can start by observation of the analysts, interviews, or even workshop exercises. Often a design or a process description is the product of this. Analysts are then asked to provide feedback to make sure that this represents their work practices. As design work progresses assuming a new product is being designed, analysts will be frequently consulted for feedback. This may even result in modifying the original understanding/design. Iteration occurs as necessary. Analysts will need to provide feedback when an important design decision is being made. When the software is installed analysts should still provide feedback periodically for inclusion in new versions.

An example of features that might be used in a collaboration tool include:

- Lightweight chat or other social networking feature for communicating with other analysts.
- An area in the collaboration tool that supports explicit representations of analytic work.
- The ability to share this explicit representation with other analysts.
- An IC version of Google Knowledge Graph or similar capability, could be useful in building a repository of entities that can be continually updated [21].

A push facility that is able to learn what is new and relevant to the analyst. Let us look at the intelligence cycle and determine where collaboration could occur and how these features could provide utility. Data collection could certainly be collaborative. Analysts would collect information and insert it into the IC Google Knowledge Graph or similar capability. This would also be used in obtaining situational familiarity where analysts could check knowledge already there. In addition, if there were more questions they had, they could make use of the lightweight social network to chat with particular analysts or to find experts that could provide needed information. Obviously security classifications would be needed to determine who gets access to what information.

Analysts would use standing queries as well as new queries to get information from various sources needed for their task. The monitoring process would use these queries and additional information supplied by analysts to alert analysts of new information that seems relevant to their work.

Deep analysis would be performed in an area where the analysts could explicitly represent content and the relationships between different entities. If desired this information could be shared with other analysts. Newly discovered relationships could be easily moved into the Google Knowledge Graph.

These capabilities could be measured in increased situational awareness, the ability to obtain more relevant information with less effort, and more holistic analysis. The goal is to exploit unified awareness and communication capabilities and integrate with analytic tool suites. Continued unification of instant messaging, phones, video conferencing,

document sharing, desktop sharing and general presence information provides tremendous opportunity to foster awareness of and access to staff.

VI. Open Research Directions

The lessons learned (and presented in this paper) show promising directions towards applying against the needs of the IC with regards to collaboration. However, there are open areas and challenges for the research community to approach. These include:

- Incorporating any collaboration tool into official agency practice.
- Rewarding analysts for collaboration efforts and contributions to repositories.
- Supporting passive instead of explicit collaboration where feasible.
- Determining analytic coverage of the knowledge graph and status by team members.

It is essential that collaboration tools support the needs of all individuals on the team. Unlike individual software applications it is necessary to have a critical mass using a collaboration tool to make it useful. As teams, tasks and information sources change, collaboration support will need to be re-evaluated and modified as necessary.

VII. Conclusion

In this paper we discuss how lessons learned from prior work regarding collaboration can help inform collaborative environments for the intelligence community (IC). We present these lessons learned in context of the needs of the users in the community, providing approaches against these needs from prior work. In structuring the challenges in this way, we condense the work into a set of design guidelines, as well open research areas for the community.

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