Technology, Technology, Everywhere!

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ABSTRACT
The domain of Advanced Collaborative Environments (ACE) is rapidly evolving. Advanced computation, display, storage, sensor, interaction, and networking technologies provide us with a wealth of mechanisms with which to explore complex scientific phenomena. This is especially true in the academic research community where large-scale computational consortia [13][14] provide an extensive range of advanced technologies to their researchers.

In order to provide an effective collaboration environment, it is critical that we step back from the technology and ask ourselves the question "What are we trying to accomplish?" This question needs to be asked at all levels, from the highest level when exploring how to design an ACE environment for an emerging scientific community through to the lowest level when considering how to implement a tool for a specific type of collaboration task. Without asking such questions, we are simply throwing technology at a problem, hoping for success.

1. INTRODUCTION
Scientific research is rapidly becoming a global endeavor. Today's complex scientific problems not only require a wide range of technologies to solve them, but they also require a wide range of expertise. More and more often, researchers are working with collaborators at institutions that are across the country and/or around the world. In addition, the increasing amount of scientific data that is available to scientific researchers, using high-resolution instruments and/or complex computational simulations, means that collaborative scientific visualization is becoming an important tool to the scientific research community.

Scientific communities form through two fundamental mechanisms, from pressure due to the needs of a group of scientists exploring a specific research area or from pressure due to general community need. Examples of research area based communities are the Network for Earthquake Engineering Simulation (NEES) [11] and Atlas (a global particle physics research effort) [2]. It is worth noting that many of these communities have evolved naturally over time, primarily because of a *need* for that community to collaborate.

The community approach is driven by a need to provide a research computing infrastructure (advanced computational, storage, network, visualization, and collaboration technologies) to a range of scientific communities. The community approach typically results in computational consortia [13][14] that provide computational environments that service a wide range of users and communities. Their formation is often driven by the fact that a consortium can provide a wider range of services without duplicating the cost and effort that would be necessary if the individual institutions attempted to provide those same services for their local users. These consortia are often based on regional geographies.

Most of these communities are formed through ad-hoc mechanisms that meet an immediate need rather than from rigorous planning from a social perspective. Scientific communities are social networks of people, typically working at a distance, that are trying to accomplish a common goal. It is through an understanding of the needs and goals of these communities that we will be able to build successful advanced collaboration environments.

2. TASK AND TECHNOLOGY
In the computer supported collaborative work (CSCW) community, it is acknowledged that understanding the collaborative task being carried out is important to delivering a successful collaboration environment [9]. Research has been performed to create frameworks and methodologies in which task helps to identify the needs of the collaboration environment [5][8][10], and yet little of the research in the CSCW literature is classified against any of these taxonomies.

We believe that only through understanding the collaboration task can one recognize the information needs for that task (the information that needs to be communicated for the collaboration to be successful). Through understanding the information needs, it is then possible to determine how to communicate that information through a set of communication modalities (audio, video, gesture, applications, etc.). In this manner, it is our hope to be able to deliver a high level of Quality of Experience (QoE) for specific collaboration tasks [5].

The importance of the human component of scientific communities is receiving increased attention from a number of research groups. In particular, the Collaboratory for Research on Electronic Work (CREW) at the University of Michigan has been working towards this goal for some time [6][12]. The CREW is working towards defining, abstracting, and codifying the underlying technical and social elements that lead to successful collaboratories. Although this is an ambitious goal, we believe that this work is critical to the ACE community to deliver usable solutions. The importance of understanding scientific communities from a social perspective has reached the level of the US National Science Foundation, which recently held a workshop on cyber-infrastructure and the social sciences [7]. One of the key findings from this workshop was the need to "... involve social and behavioural scientists in the design of organizational frameworks, incentive structures, collaborative environments … and other social aspects of cyber-infrastructure" [3].

2.1 Technology, technology, everywhere!

One of the problems that we face in the area of advanced collaborative environments is our focus on the technological aspects of the research we perform. The technology we use is changing rapidly. Advances in computation allow us to perform computational tasks that were impractical a short time ago. Display technologies are becoming ubiquitous, with collaboration rooms in the ACE community commonly having two to four display surfaces (if not more). These displays are often included as part of the collaboration space in novel ways (e.g. tabletop, high-resolution, or 3D displays). Sensors and other interaction technologies allow us to work within these environments in increasingly rich and complex ways. Touch sensitive displays, 3D tracking of devices and people, and RF ID tags that identify people and objects all add to the capability, and the complexity, of our collaboration environments. Last, but certainly not least, networking technologies provide us with the ability to connect these devices together in novel and exciting ways. Wireless networks allow laptops and handheld devices to be integral parts of a collaboration environment, while optical networking allows us to connect remote locations together with multi-gigabit networks that can be dedicated to the collaboration task.

2.2 OK, so now what?

Given the above technological environment, as someone who wants to collaborate with another individual at a remote site, what do I do? The typical solution for many researchers, when presented with the capabilities of the technological environment described above, would be to shrug, shake their head and either pick up the telephone or send an email. The environment is too complex, and the average user has no idea how to apply these capabilities to the collaboration problem that they have. So how does one determine what tools to use and how to use them? There are a number of fundamental questions that need to be asked:

- What is the task that the collaborators need to perform?
- What are the communication needs (information that needs to be exchanged between collaborators) that are required to accomplish the task?
- Which tools meet the communication needs of the task?
- What is the relative importance of the communication needs for the task (so that we can make task specific compromises if required)?
- Do the sites that the collaborators have access to have the tools available? Does this include the technologies (display, interaction, etc.) that the tools require?
- If the tools are not available, are there alternatives that meet the needs to a lesser degree?
- Are the sites connected with networking that is adequate to perform the collaboration task?
- Are the collaboration tools ease enough to use such that the users can successfully complete the collaboration task?

We do not claim to have a solution to this very complex problem, although we are working towards this end [5]. What we are suggesting is that a concerted effort to answer these questions and to consider how to apply some of the taxonomies discussed above would benefit the entire ACE community.

3. WestGRID: A CASE STUDY

WestGrid [14] is a large-scale grid computing consortium that spans two provinces and seven research institutions in Western Canada. In addition to the high performance computing infrastructure that such a grid computing project would deploy, WestGrid institutions have also built an extensive collaboration and visualization (CV) infrastructure. Each institution has created an advanced collaboration room (GridRoom) that allows scientific researchers to collaborate with distant colleagues. Each room consists of two to four displays (projectors, plasmas, tabletop displays etc.), two or more cameras, high quality audio, and in some cases advanced interaction (touch screens, tracking) and visualization technologies (stereo displays). These GridRooms typically use AccessGrid [4] collaboration software.

The institutions are connected together by a dedicated gigabit network that enables high throughput, low latency data transfers. All sites connect to the worldwide academic research network, enabling scientists to collaborate on a worldwide basis. In addition, a number of WestGrid affiliated research projects are experimenting with dedicated optical networks, or user controlled light paths (UCLP), for deploying ACE's.

3.1 Guilty as charged!

WestGrid, like many computational consortia, has used the paradigm "build it and they will come". The design goal of WestGrid is to provide resources to a wide user community. With computing this paradigm works well, and rarely will you see a computational machine that is under utilized. This is partially due to the design team for WestGrid having a clear understanding of the needs of the user community and designing the system to meet those needs. It is also due to the relatively simple needs of the user community, in the sense that the users require computational cycles and WestGrid provides those cycles.

This is much harder to do in the CV domain. Although the needs of the user community were considered in the design of the CV infrastructure for WestGrid, they were considered at a high level only. Although the CV infrastructure that was built for WestGrid provides the CV researchers an excellent platform for carrying out ACE research, it falls short of providing an effective environment for building user communities because it is too capable. That is, it is too complex and sophisticated for most of the researchers to use for creating ad-hoc scientific communities. This is not because the

CV infrastructure is not useful, but primarily because the barrier to use is too high for most users.

3.2 The sentence…

We have learned a lot from our experiences in creating the CV infrastructure for WestGrid. We have a sophisticated environment for performing ACE research. We have also been successful in using the infrastructure for a wide variety of uses (e.g. seminars, meetings, training). At the same time, we recognize that we have not met the needs of our user community as well as we could have. Although it is clear in hindsight, a more effective human-centered design methodology was required for WestGrid to deliver on this requirement. Our sentence, for the transgression of not applying such a methodology in the past, is the requirement that we apply such a methodology in the future. It should be noted that the application of such a methodology is very time consuming and, without experience in the area of human-centered design, very difficult to do.

Fortunately, as result of our current development efforts for the WestGrid CV infrastructure, a somewhat ad hoc human-centered design process has emerged. Our current process for developing collaboration tools starts with our belief that task is a critical component of understanding how to create effective ACE tools. Based on this fundamental belief, our process consists of observing users during the performance of collaboration tasks, identifying needs that are not fulfilled using current tools, and developing tools to fill those needs. Over the past year, we have developed a number of tools using this approach [1]. These include:

- Collaborative visualization tools (AG VizServer)
- Collaborative desktop tools (AG SharedDesktop)
- Task specific meeting customization (AG Venue Customizer)

Moving forward, our goal is to formalize this process more rigorously. This includes:

- Analysis of specific scientific user communities in order to understand their collaboration needs.
- Analysis of specific types of collaboration to inform the development of better collaboration tools.
- The further development of a framework for creating and deploying task-centric collaboration environments (QoE framework).

It is our belief that only through such a human-centered design process can we deliver effective Advanced Collaborative Environments for scientific communities.

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