Designing Tabletop Interfaces for Asymmetric Distributed Collaboration

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Abstract

Complex task domains such as emergency response and command and control often involve collaboration between operational personnel in the field and tactical personnel in a central command centre responsible for coordinating the efforts of those operational personnel. The asymmetry in their respective work environments, job responsibilities, available information, and situation constraints produce distinctly different technological requirements for potential support systems for these different personnel. This research focuses on the use of a tabletop display to support the planning and coordination duties of the tactical personnel. A primary goal is to address the inherent challenges of designing large-screen tabletop interfaces that support synchronous interaction, data sharing, and coordination with remote collaborators who have significantly diminished technological capabilities, particularly in terms of available display size.

1. Asymmetric Distributed Collaboration

Various domains, including emergency response and command and control, involve coordinating a distributed team of people from a command centre. Operational personnel are those people situated in the field, responsible for performing the physical work such as gathering information or material items, or providing services. Tactical personnel are those people in a command centre coordinating the actions of multiple operational personnel. The difference between these roles leads to several forms of asymmetry.

Operational personnel execute physical tasks (often while traversing the field setting), have detailed knowledge of the immediate situation around them, and receive information about new tasks from the tactical level. In contrast, tactical personnel perform the higher-level functions of planning for future tasks, and coordinating the various operational personnel to ensure that the team satisfies the overall mission goals. They must remain aware of the state of all relevant personnel and resources, and consider information from many sources.

These different task activities and environmental constraints lead to different technological requirements for any support systems developed for these tasks.

Operational personnel, who tend to be mobile and can experience physically demanding situations, would need an extremely portable and robust device, such as a small handheld computer. In contrast, tactical personnel have few such environmental constraints, and thus can exploit stationary, large display systems. Large displays, such tabletop displays, provide benefits for productivity [1] and spatial awareness [4]. Additionally, a tabletop system could display the maps, schedules, documents, and other information necessary to support the tactical role. Advances in networking will enable data sharing between the devices used by the operational and tactical personnel, in addition to standard voice communication (Figure 1).

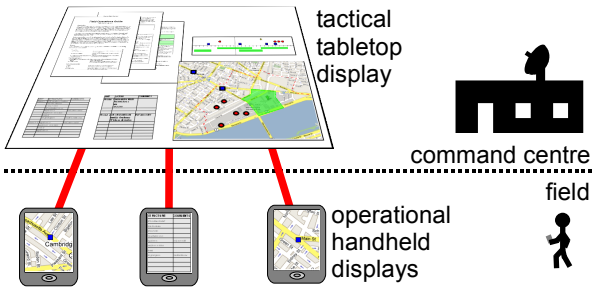

Figure 1. Asymmetric distributed collaboration.

We are designing interfaces for linked tabletop and handheld devices, to support real-time collaboration in a shared visual space. We will study how people collaborate in a test scenario to characterize the techniques they use and to inform design recommendations. In particular, we are interested in how the collaborators deal with the asymmetry in hardware and roles, which communication strategies they use to deal with the mismatch of information visibility, and how activity awareness between collaborators should be supported.

2. Design Challenges

Many existing design approaches for supporting distributed collaboration assume fairly symmetric situations between participants in their work environments, technological capabilities, and their roles and responsibilities during collaboration. In asymmetric collaboration, however, people tend to have complementary job roles with different technological requirements. Research indicates that such role asymmetry and platform heterogeneity can negatively impact remote collaboration [5]; thus, careful design is required for our envisioned system of networked tabletop and handheld computers. Providing a shared visual space between distributed collaborators facilitates communication by supporting conversational grounding. However, a vast difference in display size provides an obvious challenge to offering standard shared visual solutions, such as a WYSIWIS (What-You-See-Is-What-I-See) interface design. Thus, new visibility techniques may be required to support workspace awareness [2].

To develop technologies that address these issues, we are developing an experimental platform involving a representative asymmetric distributed collaboration task scenario: urban search and rescue (USAR).

3. Urban Search and Rescue Scenario

Our USAR scenario involves two types of distributed collaborators: search units (operational personnel) and a tactical coordinator. The search units navigate around a city, searching buildings and reporting victims found and unexpected events. They will have handheld displays with which to view maps and task schedules, and they may speak to the command centre via a voice channel. The tactical coordinator is situated in the command centre. This person monitors and coordinates the search units, in addition to other units that comprise the team. The tactical coordinator will have a tabletop display to support the coordination of the team's spatial activities (with maps) and their temporal constraints and progress (with schedules and timelines).

4. Designing a Tactical Tabletop Display

To identify the display requirements for the operational and tactical support systems, a cognitive task analysis (CTA) specifically designed for futuristic task scenarios [3], was conducted. A key part of this CTA process is the creation of an event flow diagram that represents the temporal constraints between the decisions and processes that may occur during the task scenario. Figure 2 shows an extract of this diagram for the tactical coordinator's scheduling work. The diamonds indicate decisions and the boxes indicate processes. Thick-edged boxes indicate that collaboration with a search unit is required to complete the process.

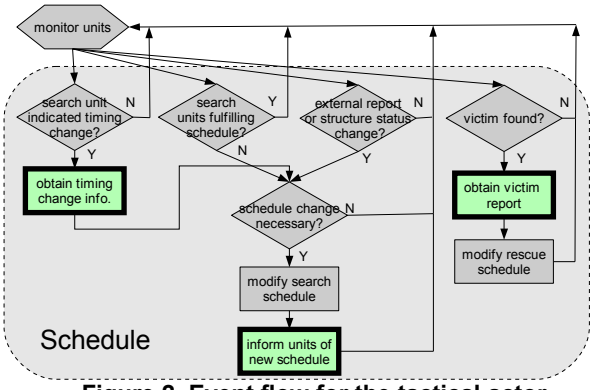

Figure 2. Event flow for the tactical actor.

The CTA results in a set of information and functional requirements, but leaves considerable scope for the specific design of the interface. Since the large horizontal surface and direct input of a tabletop display make it qualitatively different from conventional interfaces, new interaction techniques may be required, especially for supporting synchronous collaboration with maps and schedules.

5. Conclusion

Our poster will present initial CTA results, focusing on the design requirements for the tabletop display. We hope to gain feedback from the community on the implications of these requirements for the design of the subsequent tabletop interface, and to discuss more general issues regarding using a digital tabletop to support asymmetric distributed collaboration.

6. References

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