Chapter 15

Future Applications

The efforts of the present project generated materials and methodologies that can be used in a number of applications. Several examples of future application are described here.

15.1 Telemedicine

Telecommunication advances enable remotely located individuals to collaborate on problem-solving with expertise unavailable locally. Increasingly telecommunication systems have become an integral part of many professions. Interesting and challenging research issues arise in the use of telecommunication systems in decision making and problem solving, many of which have been discussed in the context of distributed decision making and computer supported cooperative work (Kiesler *et al.*, 1984; National Research Council, 1990; Rasmussen *et al.*, 1991; U.S. Congress, Office of Technology Assessment, 1995). Little empirical data have been reported on how people can assess dynamically changing situations and problems through telecommunication links. Therefore little empirical basis exists to guide the design of telecommunication systems in support of distributed decision-making in this regard.

The videorecordings made during the current project provide multimedia data which can be used in experimentation on the value of various information to be transmitted in distributed decision making and in development of principles for designing telemedicine systems. For example, recently we used the audio-video data of real patient resuscitation in a NASA-funded project examining remote Diagnosis for Trauma Patient Resuscitation. This project addresses the cognitive demands of distributed medical decision making as it pertains to the treatment of acute trauma patients. We planned to use this database: 1) to investigate what information a remote medical decision-maker requires to supervise management of emergencies and how effective remote management is at producing appropriate and timely diagnoses and intervention; 2) it is also not known how different types of medical SME's (surgeons, anesthesiologists, nurses) function as independent remote decision-makers; 3) how the response of the on-site trauma patient managers affects the remote decision-maker is also uncertain; and 4) determine whether decision-making aids could improve the efficacy of remote decision-making.

In the first phase of the project, six anesthesiologists, all experienced in trauma patient care, attempted a remote diagnosis task, in which the subjects were presented with audio-video case segments of trauma patient resuscitation and were requested to report their knowledge of patient and resuscitation status. The major findings of the data analysis include (1) critical visual and auditory cues were often missed by the subjects (2) the subjects seemed to be overloaded by multiple-activity threads contained in the audio-video scene (3) patient history information was critical for the subjects to understand audio-video scenes (4) secondary cues (such as facial expressions visible from the video scenes) were used to determine patient resuscitation status (Xiao & Mackenzie, 1996). In the second phase of the project (Xiao *et al.*, 1997), 4 attending trauma surgeons and 4 experience trauma nurses attempted the same remote diagnosis task. Combined with the data collected in the first phase, the three groups of experts (surgeons, nurses, and anesthesiologists) differed in their abilities to detect critical cues and offer diagnostic suggestions. It appears that experts were bounded by their own regular roles in a resuscitative team. For example, the anesthesiologists were able to understand airway management related patient and resuscitation status better than the surgeon and nurse subjects. The findings suggest that to provide consultation of dynamic, multidisciplinary team oriented activities, either an assembly of teleconsultants or special training are needed to provide effective consultation.

15.2 Evaluation of Performance and Procedures

A problem with establishing performance and decision-making during a life threatening event is that such events are rare and recall is often incomplete. Video taping of trauma patient resuscitation enables life threatening situations to be documented and allows events to be objectively recorded and subsequently analyzed. Certain systems errors (such as lack of training, workplace layout, and work process design) are difficult to identify with current documentation and analysis methods (Mackenzie *et al.*, 1996a).

For example, in our analysis of videotaped airway management resulted in the identification of performance flaws in the use of end-tidal CO2 analysis, which is the gold standard in determining the correct placement of endotracheal tubes. Further, it was determined that such performance flaws were frequently induced by the lack of means for the anesthesia care providers to easily attach CO2 analyzers into the ventilation circuit when the patient was ventilated through manual ventilation resuscitator bags. A solution was to insert a connector (which costed a few cents) in the ventilation circuit to make the use of CO2 analyzer possible. Since that time, no undetected esophageal intubation has occurred. As another example, the task of auscultation (listenting with a stethescope) after the placement of the endo-tracheal tube was often delegated and such delegation was found to be a cause of errors in confirmation of the tube position. A recommendation was made to modify the work process, to specify that the person performing intubation should listen to the patient's chest, thus avoiding delegation and making the task less error-prone.