NATURALISTIC OBSERVATION OF AIRPORT INCIDENT COMMAND

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In this paper we provide a set of observations, recorded in the context of incident command operations at an airport mass casualty exercise, that emphasize the need for cognitive engineering in the design of socio-technical systems such as this one. Observations of inadequate communication resources, insufficient leadership, and malfunctioning equipment were made. These shortcomings appeared to hinder team decision making and team communication capabilities. Our observations also revealed potential areas for improvements in the operation of airport incident command systems.

INTRODUCTION

In this paper we report observations of an airport mass casualty exercise. The domain of airport incident command and incident command in general, presents a host of interesting challenges for cognitive engineering theory and practice. Like other command-and-control tasks, incident command involves a complex and distributed system of technology and people operating in a high-tempo environment. Also, like some command-and-control situations incident command teams are *ad hoc*. It would be rare to assemble the same team of individuals for any two incidents. Further, incident command tasks, by their very nature, are unexpected and thus, are also *ad hoc*. Airport incidents range from security breaches and snowstorms to terrorist threats and plane crashes. Homeland security issues have highlighted the importance of emergency response. How can cognitive engineers train *ad hoc* teams or design technology for rapid adaptation to a wide variety of incidents? How do current incident command systems fare in terms of human-centered design? Are there any commonalities among incidents or incident command tasks that can be leveraged for design and training principles? How do airport incident command centers compare to other emergency operation centers external to airports? Where are the most challenging problems in the system and can we identify promising areas for cognitive engineering? These are some of the questions that we have begun to address through our initial observations of airport incident command.

The observations reported here focus on individual and team behavior as well as environmental constraints in a simulated emergency situation. Through our observations we planned to gain an understanding of the complex tasks that are encompassed in airport incident command operations, identify potential areas for system improvement, and suggest possible areas in need of further investigation that may lead to improvements in the airport incident command system. The airport's main objectives in conducting this mass casualty exercise were to meet Federal Aviation Administration (FAA) regulatory requirements for periodic incident command center simulations, train airport personnel on the airport's emergency operations plan, and to practice inter-departmental and inter-agency coordination and communication. In addition, a previous simulation at this airport had resulted in communication problems and inadequate response times. The current simulation was an attempt to correct those problems.

In the observations that follow there are a number of examples of what has often been called "clumsy technology." This is technology that is designed without consideration of task factors or the human elements involved. As a result, the technology can create new burdens for practitioners, rather than facilitate work. In fact, clumsy technology 1) diverts attention away from the task and toward the technology itself, 2) places new knowledge requirements on the users, and 3) creates the potential for additional errors (Norman, 1988; Woods, Patterson, Corban, & Watts, 1996). At the team level, clumsy technology can interfere with communication

and coordination, which can ultimately hinder situation awareness and decision making (Hutchins, 2001). It is therefore unsurprising, given the complexity of the incident command domain, that there are so many examples of clumsy technology.

METHOD

The observation of airport incident command operations in its natural state is a useful first step in developing an understanding of the domain. Converging methods (i.e., field observations, unstructured interviews) and the use of multiple observers were employed in order to broaden the set of observations and promote an unbiased interpretation of the situation (Roth & Patterson, in press).

Participants

The mass casualty exercise was conducted at a major U.S. airport. Individuals from the following agencies participated in the exercise: National Transportation and Safety Board (NTSB), Federal Bureau of Investigation (FBI), airport operations, airport security, American Red Cross, FAA, airline representatives, local fire departments, county medical examiners office, and local police departments.

Three observers participated, two of whom made observations in the Incident Command Center (ICC). The third observer was located at the site of the incident (i.e., runway and friends/family area).

Materials

Observations were collected through written notes, still photos, and video recordings. Additional information was obtained via unstructured interviews and review of printed documents.

Procedure

The naturalistic observations were structured to target specific issues, such as environmental constraints, team issues, and cognitive issues. However, because this was the first set of observations, observers were instructed to record all interesting events. Observers were briefed prior to the exercise by airport operations personnel and were allowed access to all phases and all locations in the exercise. The exercise was carefully scripted by airport operations, such that all participants were aware of how the simulation would unfold.

The Simulation Exercise

The simulation was organized into three phases. In the Emergency Phase, a runway incursion was simulated by placing two buses (representing two aircraft) perpendicular to one another as if they had collided. An old car (representing aircraft debris) was ignited, after which the fire department extinguished the fire. Finally, emergency service personnel de-boarded the passengers (volunteer participants) and tended to the injured. During the Investigatory Phase, evidence was preserved, two deceased parties (simulated with mannequins) were transported, and contact information for the victims' friends and family was gathered. The Recovery Phase consisted of the clean up of the crash site and the re-opening of the runway.

During the emergency exercise, activity was distributed across three main areas:

1. Incident Command Center (ICC). The ICC handles all airport incidents including emergencies as well as non-emergencies. Examples of incidents include weather problems, crashes, and screening incidents. The ICC housed representatives from airport security, local fire department, local police department, public affairs, etc. In addition, an ICC coordinator was present.
2. Accident Site. The incident in this exercise occurred on the runway. A mobile command post was present on site as well. Those present on site included the NTSB, coroners, emergency services, etc.
3. Friends and Family Area. A section of the airport was partitioned off for victims' friends and family to congregate. Airline representatives as well as American Red Cross volunteers were present.

The exercise and observation lasted approximately three hours, after which the observers met to give an immediate debriefing of their individual observations.

RESULTS

The observations presented are organized first by location, followed by observations pertaining to environmental constraints, team issues, and cognitive issues.

Observation by Location

Incident command center. The overall design of the ICC appeared to be a causative factor in performance limitations of emergency operations.

- The main table is used as a work area by all of the group leaders and also serves as the heart of the ICC command and control operation (see Figure 1). However, the table is not ideal. First, the center of the table rises to reveal computer hardware and phones and in the process of raising or lowering the table center, the equipment could be easily damaged (see Figure 2). Second, computer monitors mounted on the table top remove the utility of using the table for conference purposes and, combined with the rising center, serve as a visual blockade to other team members or objects in the room. Its design affords two possibly conflicting functions: 1) a group discussion and 2) individual communications and information processing tasks. Finally, there were not enough seats or equipment at the table to accommodate all of the necessary participants.

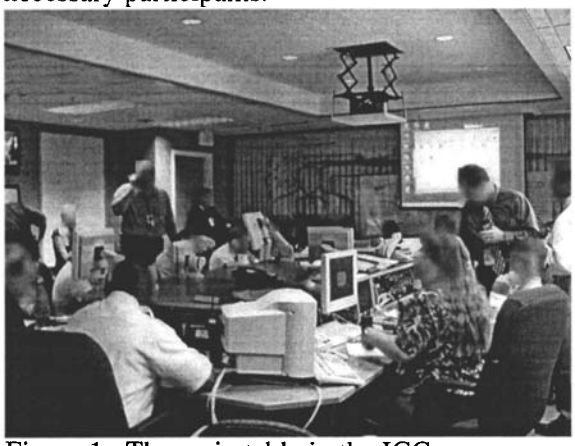

Figure 1. The main table in the ICC.

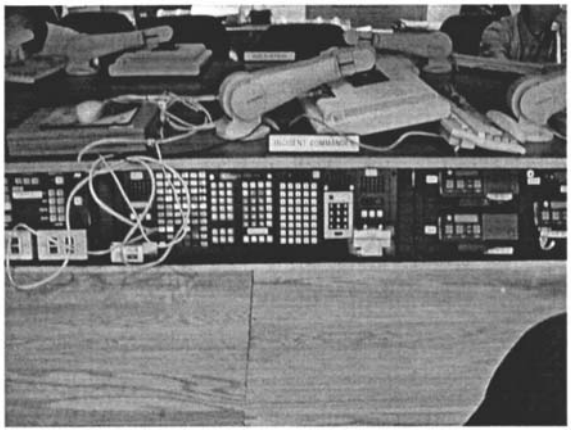

Figure 2. The center of the main ICC table raised to reveal computer hardware and phones.

- It took more than ten minutes for all participants to situate themselves in this well-scripted simulation. For example, participants spent time searching for a laptop cable or an extra phone.

- Five potential communications problems were evident. First, there appeared to be excessive reliance on cell phones and radios as a means of communication with those outside the ICC, greatly increasing the ICC noise and overloading radio channel capacity. Second, a projector, which was lowered from the ceiling, malfunctioned and required ICC personnel to stand on the main table in order to repair it. Once the projector was operational, it was not used to display any meaningful information (e.g., real-time information, status reports, etc.). Third, at several instances, the ICC coordinator stood on a chair to write a status report on a white board (see Figure 3). Due to the limited size of the white board, information from the previous status report had to be erased in order to update the information. Furthermore, the status reports did not appear to be recorded before being erased. The ICC coordinator was the only person using the white board to display information. Fourth, computer screens were also not used for information sharing. Finally, the landline phones for each agency at the main table were neither labeled as dedicated lines nor used. Overall, a lack of reliance on non-oral communication modes (i.e., text) was observed. Consequently, the level of noise was extremely high. We suspect that using the projector to display information from multiple team members would serve as a more effective mode of team communication as well as a documented source of critical information.

Figure 3. ICC coordinator writing status report on white board.

- Identification of the various agency representatives seated around the main table was difficult. A few positions were marked with small placards but there did not appear to be

provisions for any ad hoc team members (e.g., a bio-weapons expert if the incident was a biological attack).

- The wall space appeared to be poorly utilized. Two interior walls were all glass with an overlay of the airport map displayed on them. The wall space seemed to be wasted in that the maps were of little use and the glass walls provide limited protection in the event of a natural disaster or explosion. Using the space for real-time information sharing might be a better use of the space and also lead to better team situation awareness. Another interior wall of the ICC displayed video from on site cameras and other public TV stations on five separate screens. However, this wall of video seemed to have little utility. The video was rarely attended to and it appeared to have limited resolution. In fact, one knowledgeable participant could not identify a vehicle as a bus or fire truck that pulled alongside the accident wreckage.
- There did not appear to be any audio/video recording of the ICC operations itself. Records of a simulated or actual operation could be extremely valuable for training or debriefing.

ICC coordinator. The ICC coordinator acted in a very professional manner. However, he only weakly established a command presence, making it difficult to identify him as the coordinator. He seemed to get his information from outside sources (e.g., via the telephone) and then brief a small subset of the ICC personnel. In one case he was observed briefing the fire department representative in the ICC on the status of the fire and rescue operation. It was anticipated that information would flow in the opposite direction. He was never observed soliciting information from any of the group leaders.

The ICC coordinator was not observed gathering or distributing information necessary for group members to maintain an accurate "big-picture" mental image (i.e., team situational awareness). Furthermore, he did not seem to coordinate any team planning or decision making.

On site. The Mobile Command Post (MCP) was not most effectively utilized. It appeared to be a valuable meeting place for on-site command personnel (see Figure 4), but contained virtually no supporting technology. It had mounted radio systems, though the sign on the door indicated no handheld radios to be used inside. The MCP had an obsolete police data terminal that was no longer used and no fax machine, or internet access. The MCP also seemed to lack weather sensors potentially valuable for plume dispersal or fire propagation information.

Figure 4. Mobile Command Post

Friends and family. Observations in the friends and family area were minimal. First, the airline's sign-in sheet was unprofessional, difficult to read, and exposed private information of those signing in. Further, there was no psychological assistance available to rescuers and on-site personnel. Finally, there were no evident provisions for people outside of the airport to obtain information via phone lines from the personnel in the friends and family area. In general, there were no phones observed in this area.

Environmental Constraints

Some additional constraints, which have the potential for adversely affecting team behavior and decision making, were observed in the environment surrounding the airport. First, the response team in place at the airport was on its own until outside help could arrive, which could take up to thirty minutes in good weather. Moreover, although the airport field terrain was varied (e.g., irregularities, bumps, ditches, swampy areas), this information did not appear to be incorporated into planning. Another observation of the overall emergency management system and ICC was that it appeared to be designed to handle a single (accident-initiated) event and unable to handle multiple, simultaneous events.

Team Issues

The team that came together for the simulation was a large *ad hoc* response team. The team was heterogeneous with members coming from different organizations and with different positions within organizations. It is likely that the same set of individuals would probably never work together a second time. This makes familiarity and experience with team members an issue. Although team members appeared to coordinate

well with their own organizations, there was little observed coordination or communication across the different agencies.

Workload in the ICC seemed relatively high, but especially so for the ICC coordinator. Also, workload seemed to change over time. For example, emergency services experienced the highest workload early on and the NTSB later in the investigatory phase.

Cognitive Issues

Information sharing among team members in the ICC was limited. Furthermore, there was no central repository of information. In general, there was minimal cognitive processing taking place at the team level (e.g., situation assessment, decision making, planning). For instance, during a breach in security at this airport, a single individual (i.e., Airport Operations Manager) has 10 minutes to make a decision that can affect the entire country (e.g., shut down airport).

Team members seemed to understand their individual tasks fairly well and bring associated background knowledge to the task. However, they seemed to have minimal understanding of the larger task (i.e., taskwork knowledge), of the team (i.e., teamwork knowledge), or of the immediate situation. Furthermore, there appeared to be confusion over roles and responsibilities.

DISCUSSION

Design for incident command at airports and emergency operations in other arenas presents a growing and timely challenge for cognitive engineers. The observations of an airport mass casualty exercise reported here exemplify poor system design and potential repercussions. Designing complex environments, such as command and control environments, without adequate emphasis on the users or without an understanding of the nature of the task can pose severe consequences to team performance. In particular, clumsy technology (e.g., table with rising center, broken projector, etc.) can interfere with human-machine or human-human interaction and ultimately lead to an ineffective system.

These observations are a first step toward addressing our initial questions. They suggest several areas in which further investigation and human-centered design are warranted. Additional research is needed to further explore the causes of observed limitations in this airport incident command setting and to address the generality of these observations.

This observational study also serves as a concrete example of the need for a cognitive engineering approach to the design of complex, socio-technical environments. Too often, cognitive engineering methodology is a peripheral afterthought rather than fundamental force behind design specification. Technology should not drive the nature of the task. Methods such as cognitive tasks analysis and exploratory observation followed by experimental research are paramount to user-centered design.

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