A Situation Awareness Design Approach to the Position of Airline Maintenance Control in a Simulated Operations Control Center

Durant Camron Bridges III

A SITUATION AWARENESS DESIGN APPROACH TO THE POSITION OF AIRLINE MAINTENANCE CONTROL IN A SIMULATED OPERATIONS CONTROL CENTER

Durant Camron Bridges III
Middle Tennessee State University
Murfreesboro, TN

Research is being conducted at mid-sized public university regarding the collaborative team efforts of aviation students in a simulated airline control center. The students employ coordinated problem solving efforts toward disruption management and schedule optimization. Although the focus of this research is communication of the decision support systems, the design of the Maintenance Control position is discussed at length. The Maintenance Controller(s) communicate with all positions, as well as departments located outside the center's physical location that may and may not be accessed by other participants. This position is one of the most vital and engaging in the simulation, and its details help illustrate the myriad of research areas and opportunities that a center of this magnitude represents.

The university performing the research has recently established a training center project, which places students in a simulated airline flight operations control center. In the center, students are arranged in teams and represent the roles of the departments running an actual airline operations control center. Students from the five aviation specializations interactively complete a simulated work shift fulfilling the responsibilities of dispatchers, pilots, ramp controllers, crew schedulers, weather briefers and aircraft maintenance controllers. The teams are given realistic scenarios throughout their shifts that require the students to work together to resolve issues quickly and effectively. Each team works to meet organizational goals by focusing on safety, on-time performance, customer satisfaction, and disruption management. In order to achieve this efficiently, coordination across disciplines is required. The design of the aircraft maintenance department was designed around the role of the Maintenance Controller and the components that may expose their level of situation awareness. This design is discussed pertaining to the three levels of perception, comprehension and projection (Endsley, 1988).

Situation Awareness

"Situation awareness (SA) is the detection of the elements in the environment within a volume of space and time, the comprehension of their meaning and the projection of their status in the near future" (Endsley 1988). Team situation awareness is defined as "the degree to which every team member possesses the situation awareness require for his or her responsibilities" (Endsley 1989). Figure 1 illustrates the overlap of shared information from multiple team members and furthers the importance of good team SA as more than one member may require correct information in order to perform their functions within the team (Endsley, 1989).

In an article in *The International Journal of Industrial Ergonomics* about aircraft maintenance team situation awareness, Mica Endsley and Michelle Robertson (2000) describe the parameters used to measure and design a training program geared toward increasing the situational awareness of aircraft maintenance technicians and their counterparts. Endsley and Robertson began by pointing out four (4) key issues in the domain of human error that can be identified in aircraft maintenance:

(1) Shortcomings in the detection of critical cues regarding the state of aircraft or subsystems
(2) After perception of symptoms, difficulties interpreting meanings or significance regarding associated information
(3) Shared tasks of multiple individuals on one aircraft
(4) Coordination of information across shifts and between maintenance departments

The university conducting the research attends, in part, to the fourth issue of departmental cross-coordination and this paper utilizes previous research on situation awareness to describe the design on the components therein (Endsley & Robertson, 2000). The design of the aircraft maintenance department in the simulation follows the team situation awareness context analysis, which is divided into two areas: SA Requirements Analysis and SA Resource Analysis (Figure 2). The SA Requirement Analysis is comprised of three parts: SA requirements, decisions, and goals. SA Resource Analysis is composed of personnel and technology components that combine to form SA Resources.

Situation Awareness Resources: Personnel and Technology

The simulated airline maintenance department consists of two aircraft maintenance hubs with tooling, equipment and personnel (Figure 3) available to perform scheduled maintenance tasks, as well as help respond to unscheduled maintenance problems that may occur in the fleet of 30 aircraft operating over one hundred flights during work shifts. These resources are at the disposal of the student playing the role of the aircraft Maintenance Controller, who is responsible for the short-term planning of line maintenance activities during aircraft downtime between flight legs, also known as turn-around time. Additionally, they respond to operational disruptions and make GO/NOGO decisions based on aircraft physical condition assessments and additional information concerning financial and operational limitations of the fleet. Depending on maintenance task eligibility, students may elect to handle issues at the time of discovery or defer them for future addressing.

In order to perform his or her duties, the Maintenance Controller must communicate directly with each department to disseminate which information is pertinent to consider for decisions in the aircraft maintenance department. Figure 4 illustrates all possible communication paths to and from the Maintenance Control position. Several positions are located offsite and include a Pseudo Pilot that operates the majority of scheduled flight as part of a flight tracking software package, a pair of pilots operating a level 5 CRJ simulator, and representatives for the airline and airports the two aircraft maintenance hubs.

The Maintenance Control position, like all positions in the simulation, follows a paperless design that utilizes virtual applications. The primary technologies used for passing information include a commercial information system for logging maintenance activities and a commercial direct-connection application for interdepartmental VOIP calls and instant messaging. Additionally, all aircraft maintenance manuals and the minimum equipment list are provided in pdf format. Additional departments utilize a multitude of technical software packages that monitor aircraft flight tracking, weather, crew resources, and airline flights schedules.

Situation Awareness Requirements: Goals and Decisions

Specific goals of the Maintenance Control position are shown in Table 1. They are based upon those of the aircraft maintenance technicians in the team situation awareness study but limited by the role in the simulation from performing physical tasks on the aircraft (Endsley & Robertson, 2000). Table 2 illustrates the situation awareness requirements from the perspective of the role of the Maintenance Controller. This includes the goals, subgoals, major decisions and SA requirements. As stated earlier, these benchmarks may be used to determine individual SA levels, as well as the position's ability to contribute to team SA. Here, it becomes more evident the position's reliability upon relayed information pertaining to aircraft status in terms of troubleshooting and system functionality. They are also communicated a variety of information that would otherwise be automatically available in the case of a functioning part 121 operator.

Problems and Limitations

Unlike aircraft maintenance courses, which allow the student to familiarize themselves with aircraft systems and troubleshooting techniques through multiple channels, this simulation does not rely on the Maintenance Control position to personally resolve maintenance issues on the aircraft. Instead, the student is asked to make management decisions of whether or not to execute maintenance actions such as troubleshooting, deferment and scheduling/rescheduling maintenance tasks. Although some knowledge of aircraft systems is required, the subject matter involved in the simulation does not go beyond the scope of all aircraft maintenance participants, who have completed a variety of aviation maintenance courses and are at the ends of their academic programs.

References

Endsley, M.R. (1988). Design and evaluation for situational awareness enhancement. In *Proceedings of the Human Factors Society 32nd Annual Meeting,* Santa Monica, CA. 97-101.

Endsley, M.R. (1989). Final report: situation awareness in an advanced strategic mission. NOR DOC 89-32, Northrop Corporation, Hawthorne, CA.

Endsley, M.R. (1999). Situation awareness and human error: Designing to support human performance. In *Proceedings of the High Consequence Systems Surety Conference*, Albuquerque, NM.

Endsley, M.R. & Robertson, M.M. (2000). Situation awareness in aircraft maintenance teams. *International Journal of Industrial Ergonomics, 26,* 301-325.

Federal Aviation Administration [FAA]. Airworthy or unairworthy? Compliance and enforcement. Introduction to investigation and compliance-related tasks. 14-87(1). Retrieved on February 20, 2013 from http://fsims.faa.gov/WDocs/8900.1/V14%20Compliance%20&%20Enforcement/Chapter%2001/14_001_005.htm

Tables and Figures

Table 1.
Maintenance Control goals (Based upon Endsley & Robertson 2000).

1.0 Aircraft safety
- 1.1 Deliver aircraft in airworthy, safe condition
  - 1.1.1 Find potential problems
  - 1.1.2 Solve problems
  - 1.1.3 Make repairs
    - 1.1.3.1 Determine part availability
    - 1.1.3.2 Placard problem
  - 1.1.4 Service aircraft
  - 1.1.5 Provide quality workmanship

2.0 Deliver aircraft on time
- Prioritize tasks

Table 2.
Maintenance Control SA requirements (Based upon Endsley & Robertson 2000).

1.0 Aircraft safety
- 1.1 Deliver aircraft in airworthy, safe condition
  - 1.1.1 Assess reported potential problems
    - *Item within or beyond serviceable limits?*
    - *Item near limits needing preventive maintenance?*
  - 1.1.2 Solve problems
    - *Fix problem or defer?*
      - potential impact of problem on flight safety
      - time required to solve problem
        - time required to get part
      - length of time item can be deferred without repair (MEL category)
      - location(s) aircraft is going to
        - facility maintenance capabilities
      - today's load
      - problem deferability category (placardable, groundable)
        - minimum equipment list (MEL) status
    - *Problem requires extreme action?*
      - replace aircraft
      - cancel flight
  - 1.1.3 Make repairs
    - 1.1.3.1 Determine part availability
      - *How long to get part here?*
    - 1.1.3.2 Placard problem
      - *Can problem be placarded?*
        - type of problem
        - Minimum Equipment List (MEL) status
        - Deferred information placard (MEL number)
        - Open item list (OIL)
        - redundant systems available
        - flight number

1.1.4 Service aircraft

- *Service activities needed?*
  - Tasks to be done
    - scheduled maintenance (A checks/parts replacements)
  - Current status of job?
    - status of other tasks impacting own task
    - other tasks own task will impact
    - major problems encountered

1.1.5 Provide quality workmanship

- *Activities reported performed?*
- tasks performed
- paperwork completed

2.0 Deliver aircraft on time

2.1 Prioritize tasks

- *Best order for tasks?*
  - task time requirements
  - interdependence/sequencing requirements of tasks
  - problem deferability category (placardable/groundable)
    - Minimum equipment list (MEL) status
  - availability of parts
  - availability of personnel
  - availability of tools and equipment

Figure 1.
Team situation awareness (from Endsley, 1989).

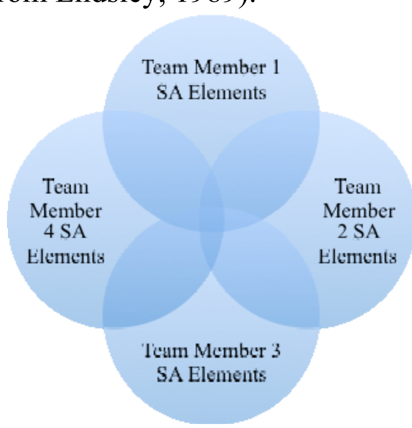

Figure 2.
Hub Maintenance Base Personnel (Based upon Endsley, Robertson 2000)

Figure 3.
Hub Maintenance Base Personnel

Figure 4.
Maintenance Control personnel SA resources.