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# Development of an Alternative Methodology for Implementation of SAGAT During Task Performance

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DEVELOPMENT OF AN ALTERNATIVE METHODOLOGY FOR IMPLEMENTATION OF SAGAT DURING TASK PERFORMANCE

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Situation awareness (SA) has been linked to performance in a variety of disciplines to date, but originated in the aviation arena. Situation awareness derives from attention and working memory being used toward acquiring and interpreting information from the environment (Endsley, 1995). The most revered objective method of measuring situation awareness is the Situation Awareness Global Assessment Technique (SAGAT). This technique employs random freezes of participant interfaces during simulations to query participants and assess the level of knowledge of what is happening at the time of the freezes. A discussion of applications using an alternative approach to SAGAT for operators in a high-fidelity simulation of a regional airline control room will be discussed.

An aviation department within a midsize university in the southeastern United States has built an airline operations control simulation. The simulation uses students as the operators inside the simulation. The students employ coordinated problem solving efforts toward disruption management and schedule optimization of a regional airline. Students from the department's 5 aviation specializations interactively complete a simulated work shift fulfilling the responsibilities of dispatchers, pilots, ramp controllers, crew schedulers, weather briefers, and aircraft maintenance coordinators. While it any participation in a simulation can be beneficial, their experiences may be enhanced by improvement to simulation design. Systems designed to enhance situation awareness could improve student performance as operators within the simulation. From this, they may realize the richness and full potential of participation in such a high fidelity simulation.

The focus of this paper is to establish situation awareness measurement as an integral process in the instructional design cycle of the airline control room simulation. By taking an in-depth look at student situation awareness within a high fidelity aviation simulation, we can begin to understand student perceptions of their environment as they participate as operators in human-machine systems. We can also learn what may be necessary in order to make adjustments to training parameters and system design to exploit all available resources for their benefit. As a part of an ongoing analysis cycle, we can revisit each element of the design process and make improvements that increase operator situation awareness (SA). Although the issues of situation awareness are applicable to virtually any complex system or vehicle, I will discuss the domain of airline simulation control room operators because that is the focus of this study.

## Research Design

The purpose of this quantitative experimental study was to examine situation awareness levels of junior and senior-level collegiate aviation students at a mid-sized Southeastern university, as they participate in a high fidelity airline control room simulation playing the role of aircraft maintenance coordinators. A quantitative methodology was used for this study. Endsley (1995) established that the

> Situation Awareness Global Assessment Technique (SAGAT) was developed to assess SA based on operator SA requirements. As a global measure, SAGAT queries about SA requirements, including level 1, 2, and 3 components and considers the system functioning in status and relevant features of the external environment (p. 70).

The SAGAT was used to collect data regarding the participant's levels of situation awareness and varying points during simulations.

The SAGAT developed for the study was a 15-item variable question type set of queries. It was based from an analysis of situational awareness goals and requirements determined by the aircraft maintenance coordinator position 1 and 2 responsibilities. The SAGAT was administered twice during each simulation intervention. Known as a one-group pretest-posttest design, this study investigated whether or not lab simulation exposure affected situation awareness levels in subsequent lab simulations.

## Selection of Participants

The participants came from a convenience sample of a 60-student and 30-student roster in two collegiate aviation capstone upper-division level courses at a mid-sized university in the Southeast. Data was collected across two semesters, with 6 teams participating during the first semester and 3 teams participating during the second semester. The students were subdivided into 9 teams of 10, and a total of 9 students took situation awareness measures. Student-participants were representative of the sample and population. There were a total of 90 student participants at the facility throughout the study, 9 of which were participants available for the study. Nine teams each consisted of 2 pilots, 3 dispatchers, 2 aircraft maintenance coordinators, and 1 of each ramp, crew scheduling and weather personnel. The two aircraft Maintenance Coordinator positions 1 and 2 were referred to as "Aircraft Maintenance Control" and "Aircraft Maintenance Planning and Scheduling", respectively.

The participants were all within their final 4 semesters of study in the undergraduate Aerospace curriculum. While all of the airline simulation positions required a general understanding of how an airline functions, some of the lab positions required certain specific skills that students must have learned prior to entering the lab training. Pilots and dispatchers were the two positions that required additional training for their specific tasks and roles. Beyond these certain skill requirements, students were randomly assigned to teams. If the random assignments did not meet the basic needs of the skill positions, adjustments were made to accommodate for the need. Of the 10 student-participants, those assigned to the Aircraft Maintenance Coordinator 1 or "Aircraft Maintenance Control" position were tested for situation awareness measures.

## Situational Awareness Requirements: Goals and Decisions

Specific goals of the Aircraft Maintenance Control position are shown in Table 1. They are based upon those of the aircraft maintenance technicians in the team situational awareness study but limited by the role in the simulation from performing physical tasks on the aircraft

(Endsley & Robertson 2000). 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 progress and system functionality.

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 Assess reported potential problems
    - 1.1.2 Solve problems
    - 1.1.3 Schedule repairs
      - 1.1.3.1 Determine maintenance issue eligibility
      - 1.1.3.2 Placard problem
    - 1.1.4 Schedule aircraft servicing
    - 1.1.5 Provide quality records
- 2.0 Deliver aircraft on time
  - Prioritize tasks

## Training

Prior to conducting the study, all participants were trained on use of the voice over IP communications software, aircraft maintenance activities tracking computer software, the minimum equipment list (MEL) for the CRJ-200 aircraft, as well as how to interpret the master schedule. The maintenance coordinators were instructed to utilize all available resources, including any other department to acquire the information needed to make informed decisions toward performing job functions.

As part of position training within the simulation, the participant in the role of the Aircraft Maintenance Coordinator 1 was presented with a set of questions that was to be used as the SAGAT query. They were asked to review each question and make inquiries on any questions they felt needed further clarification. All inquiries were addressed until the participant felt as though they were completely clear and understand every question with no ambiguity.

## Data Collection

Before each simulation began, participants read the instructions from the Aircraft Maintenance Control Job Aid, which provided participants with specific guidance on how to perform their job functions. An additional job aid addressed how to access and manipulate program software as a part of job function. All job aids were accessible to the participants throughout all simulations and training.

During each of the simulations, a Subject Matter Expert (SME) with access to all of the information that related to the situational awareness goals and requirements completed a set of SAGAT queries from the perspective of having perfect situation awareness. Immediately after completion by the subject matter expert, the Aircraft Maintenance Coordinator 1 participant was removed from the simulation temporarily in order to complete the SAGAT query. This process was repeated later in the simulation, for a total of 2 times per simulation. At no time was the participant removed for more than 5 minutes, which is consistent with the amount of time pilots were shown to be able to report relevant SA information following freezes in aircraft simulations without working memory decay (Endsley & Garland, 2000).

The SAGAT queries were contained within password protected Google Drive cloud storage software that could be accessed through any computer or mobile device. The queries were administered through both of these media, depending on availability and wireless internet signal strength. This method of data collection was administered to both the subject matter expert by whom the participant was compared, as well as by the participant.

**Freezing**

One of the most important features of data collection utilizing the objective measurement technique known as Situation Awareness Global Assessment Technique is simulation freezing. Specifically, the freezing technique was developed to overcome the limitations of memory decay in data collection upon completion of simulations (Endsley, 1988). Endsley (1995) stated, it may be possible to use the (SAGAT) technique during actual task performance if multiple operators are present to ensure safety. In a high-fidelity simulation that relies upon interdepartmental coordination of multiple teams for overall success, it may be difficult to utilize the SAGAT technique during actual task performance. The periodic "freezes" of the simulation may disrupt the performance of those participants whose situation awareness levels are not being tested. Originally developed for and practiced using fighter pilot simulations, an alternative method of querying allowed in two-pilot arrangements for one pilot to be verbally queried while the other controlled the aircraft (Endsley, 1995). Therefore, if multiple systems operators are participating in a single department with redundant responsibilities, this allows the possibility to query one operator while another temporarily assumes the position responsibilities. It is also recommended that interruption times for each SAGAT administration is delivered randomly, so that participants may not prepare in advance for the querying sessions (Endsley, 1988).

## Research Question

What is the effect of exposure to a high fidelity airline operations simulation on situation awareness levels while participating in subsequent simulations in collegiate aviation students at a university in the Southeastern United States?

## Hypothesis Sets

(T1 is session 1, T2 is session 2, and T3 is session 3)

Null hypothesis 1: There will be no statistically significant changes in SA Total Level SAGAT between T1 and T2.

Null hypothesis 2: There will be no statistically significant changes in SA Total Level SAGAT scores between T2 and T3.

Null hypothesis 3: There will be no statistically significant changes in SA Total Level SAGAT scores between T1 and T3.

Null hypothesis 4: There will be no statistically significant changes in SA Level 1 SAGAT scores between T1 and T2.

Null hypothesis 5: There will be no statistically significant changes in SA Level 2 SAGAT scores between T1 and T2.

Null hypothesis 6: There will be no statistically significant changes in SA Level 3 SAGAT scores between T1 and T2.

Null hypothesis 7: There will be no statistically significant changes in SA Level 1 SAGAT scores between T2 and T3.

Null hypothesis 8: There will be no statistically significant changes in SA Level 2 SAGAT scores between T2 and T3.

Null hypothesis 9: There will be no statistically significant changes in SA Level 3 SAGAT scores between T2 and T3.

Null hypothesis 10: There will be no statistically significant changes in SA Level 1 SAGAT scores between T1 and T3.

Null hypothesis 11: There will be no statistically significant changes in SA Level 2 SAGAT scores between T1 and T3.

Null hypothesis 12: There will be no statistically significant changes in SA Level 3 SAGAT scores between T1 and T3.

## Measurement of SA

According to Endsley and Garland (2000), the three main reasons for measuring SA are design evaluation, evaluation of training techniques, and investigation of the SA construct. It is necessary to determine the degree to which new technologies, design concepts, and training parameters actually improve or degrade operator SA. Through understanding these processes and products, we may further understand and improve upon instructional designs used in high-fidelity simulations.

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