Comprehensive Examination Research Proposal

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Abstract

The focus of this comprehensive research examination is to demonstrate the knowledge of all program outcomes as addressed in each core competency of the Master of Aeronautical Science (MAS) degree. This proposal also places emphasis on the MAS specialization of Education Technology. The main topics covered in this comprehensive examination include application of blended learning in aviation training and education, the importance of training fidelity in relation to human factors, the costs and benefits of using scanning technologies in comparison to profiling as part of the airline passenger screening process, application of human factors for aviation maintenance technicians (AMT), and the Instructional Systems Design (ISD) process. The demonstration of these topics should satisfy all program outcomes in terms of providing the appropriate recommendations and conclusions based on their findings.

Keywords: aviation, comprehensive examination, program outcomes, proposal, question, findings, recommendations, conclusion

Comprehension Question #1

Statement of the question

In recent years, advancements in technology have resulted in the ability for aviation students to aggregate from low to high levels of learning both in the classroom and field training. The focus of this study will be to examine the effects of blended learning methods in aviation training environments in terms of proficiency levels, task performance, criticality of tasks, and human factors. The assimilation of instructional methods in the training environment directly affects the decisions and skill capabilities made by workers in the air transportation system daily. Almost every decision that humans make on the ground or in the air may be a matter of life and death among passengers in the aircraft; therefore, training effectiveness is significant in both aviation flight and ground school education.

Blended learning has been shown to not only provide a combination of instructional methods in aviation training environments; it also accommodates the level of training required for successful transfer of learning to the operational environment. Blended learning is defined as a mix of delivery methods selected and formed to accommodate the various learning needs of a diverse audience in a variety of subjects (McSporran & King, 2005). An example of blended learning is delivering instruction to students using technology-based tools (e.g., computer tutorials, simulators, guided learning, etc.) combined with face-to-face instruction, which typically takes place in the classroom (e.g., small group facilitation).

In contrast, when students are receiving instruction primarily through one method, it is typically presentation-based or instructor-led. Presentation methods that are considered as instructor-led include lectures or direct demonstrations (Department of Defense Handbook, 2001a).

This comprehensive question will focus on examining the factors, in which applying a blending learning approach is crucial to the crewmembers' success in the aviation environment. Crew members in this study will include Air Traffic Controllers (ATC), pilots, and flight attendants in both commercial and military aviation. This question will address the conditions, if any, in which applying one method of instruction (MOI) is more beneficial to the students than blending – or combining - them. In aviation training and educational environments, the different MOIs will be addressed which are presentation, student interaction, and knowledge application (Department of Defense Handbook, 2001a). This question will also focus on the different forms of media which will be compared and analyzed based on the following considerations in commercial and military aviation training: progression level of students, task criticality (i.e., importance of completing a specified task successfully to mission), level of learning required to perform the assigned training task(s), and proficiency levels of learners. The importance of incorporating technology-based training tools such as simulation systems, tutorials, interactive courseware (ICW), and part-task trainers in aviation pilot and aircrew training situations will be examined in terms of curriculum development and design. In addition, the impact of applying interactive methods in the classroom environment, such as peer group and performance-based techniques (hands-on and/or small group exercises) will be examined.

Statement of how the Program Outcome will be met

Program Outcome #4

The student will be able to develop and/or apply current aviation and industry related research methods, including problem identification, hypothesis formulation, and interpretation of findings to present as solutions in the investigation of aviation / aerospace related topic.

Problem Identification. A qualitative research methodology will be used to determine whether the use of blended learning approaches delivers more benefits than one method in terms of measuring task performance and collaboration levels in the operational environment. The data will consist of studies and reports in which task-based/blended learning is applied for pilots, Air Traffic Controllers (ATC), and flight attendants during flight training.

Hypothesis Formulation. 1) It will be hypothesized that pilots and crewmembers exposed to blended methods in training will report higher levels of performance in the operational environment; 2) It will be hypothesized that pilots and crewmembers exposed to blended methods in training will report higher levels of collaboration in the operational environment.

The research questions are addressed below:

Primary Research Question:

- Are there situations in which applying certain adult teaching and learning technique(s) are more effective than others in terms of learning outcomes?

Secondary Research Questions:

- How does applying each of these adult learning techniques affect the learners when blended approaches are used in comparison to one method?
- During the curriculum development process, does applying a mix of learning approaches result in a more diverse selection of instructional media? If so, how does this benefit the learners?
- Are there any training situations in which applying one instructional method (lecture) benefits more greatly than a blending learning approach? If so, in what context?

Program Outcome #6

The student will investigate, compare, contrast, analyze, and form conclusions to current aviation, aerospace, and industry related topics in education technology, including computer-based instruction, simulation systems, education foundations, curriculum development, continuing education, adult teaching and learning techniques, and memory and cognition.

Computer-Based Instruction. Blended learning involves the use of various media delivery systems such as *Computer-Based Instruction (CBI)*. CBI will be addressed by comparing and examining the different categories of interactivity between the student and the subject matter, known as Interactive Courseware (ICW). Each ICW category varies based on the way information such as text, audio, and graphics is presented on the computer and the level of control the student has in terms of information recall and presentation. This aspect will also address any situations in which CBI is or is not a preferred delivery system.

Simulation Systems. Simulations are some of the different training tools offered for blended learning. *Training simulators* may be defined as a "group of training devices that can range from simple procedures trainers to high fidelity devices, all capable of simulating various aspect of reality" (Department of Defense Handbook, 2001b, p. 135). This aspect will discuss the common types of simulation systems used in commercial and military aviation training which include: 1) interactive computers, 2) part-task trainers, 3) full motion simulators, and 4) full flight simulators.

The ***actual equipment aspect*** will address the advantages and disadvantages of training with actual equipment (aircraft) for aviators/pilots as a part of blended learning. Training with the use of actual equipment in this context will be in lieu of using full flight simulators. The issues addressed for this aspect will be safety (such as risk of death) and cost-effectiveness (such as damage to equipment).

As a part of the ***curriculum development*** process, it is important that instructional designers select the best teaching methods and media delivery types in terms of availability, cost effectiveness, and learner accommodation. The different types of media (print, audio, handouts, CBT, simulation, equipment) will be examined based on the appropriate instructional setting, method(s) of instruction (MOI) used, and diverse needs of the audience. The above stated factors have a huge impact on learners as blended approaches are applied in aviation environments.

The ***adult teaching and learning techniques aspect*** will address the different types of teaching technique(s) applicable in blending learning methods and how some are more effectively used in terms of learning outcomes. This aspect includes small group facilitation, instructor-led, and practical exercises (written or hands-on). This study will address the types of techniques, which pertain to blended learning. The importance of identifying learning characteristics of the target audience will also be examined as it applies to blended learning.

Memory and Cognition. This aspect will not be covered in this study due to not having taken this class.

Continuing Education. This aspect will not be covered in this study due to not having taken this class.

Comprehension Question #2

Statement of the question

Although accidents may occur as a result of error, it has been stated that, "80 percent of maintenance errors involve human factors" ("Human Factors," n.d., p. 1). Therefore, human error is a major contributor to aviation accidents. As mentioned in FAA Human Factors

Awareness Course (n.d.), human factors is defined “as a multidisciplinary effort to generate and compile information about human capabilities and limitations and apply that information to equipment, systems, facilities, procedures, jobs, environments, training, staffing and personnel management for safe, comfortable, effective human performance” (Introduction section, para. 3). Examples involving human factors are fatigue, unsafe acts by pilots and aircrew, lack of collaboration among crew members, and unsafe supervision.

To eliminate or reduce the chance of accidents resulting from human or mechanical error, the focus of this research is to examine fidelity and its impact on simulation training in commercial and military aviation. Fidelity in simulation training is defined as “the degree to which an instructional system task, equipment, or training device represents the actual operational task, equipment, or device in terms of performance, characteristics, and environment” (Department of the Air Force, 2002, p. 235). The different types of simulation systems along the importance of each will be addressed, which include computer-based tools, part-task trainers (PTTs), full flight simulators, and virtual immersive tools. Simulation systems along with other training devices will be compared and examined based on the following factors: target learner progression, task criticality, level of difficulty, and interactivity levels (i.e., between training equipment and learners). These three factors should be addressed since the training effectiveness from using simulation systems may determine the extent to which certain ones replicate the job environment. Pilots in the commercial and military aviation industries will be measured in terms of job performance, safety, and teamwork based on the simulation used during flight training.

Program Outcomes that will be addressed by this question:

Program Outcome #3

The student will be able across all subjects to use the fundamentals of human factors in all aspects of the aviation and aerospace industry, including unsafe acts, attitudes, errors, human behavior, and human limitations as they relate to the aviators adaption to the aviation environment to reach conclusions.

Unsafe Acts. In order to avoid accidents as a result of ***unsafe acts***, it is important that training takes place to the highest degree possible. It needs to be determined which level(s) of simulation effectively prepares student pilots the most in making informed decisions in the operational environment. The benefits of including high cost, full flight simulation systems as part of flight school training will be examined in terms on how their features and capabilities may reduce or eliminate unsafe actions in the aviation environment.

Attitudes and Human Behavior. The categories of ***attitude*** will also be addressed in this study, which is overconfidence, complacency, and lack of motivation. This aspect will also address the training conditions and simulation fidelity levels that tend to aid in shaping attitudes in learners. High fidelity simulators, low fidelity simulators, and virtual immersive environments (computer-aided) will be addressed in terms of shaping learners attitudes and examining ***human behavior*** in the operational environment.

Human Limitations. This aspect will address the limitations that human factors places on training effectiveness. The ***human limitations aspect*** discusses the extent that use of full flight simulators increases safety, performance, and collaboration; therefore, increasing training effectiveness. Some examples of physical and mental limitations include insufficient reaction time, visual limitation, incompatible aptitude/intelligence, and physical incompatibility (Shappell & Wiegmann, 2000).

Errors. The *errors* aspect will discuss the level of interactivity provided in simulation training; in this context, interactivity is the level of interaction between the learner and subject matter. The importance of integrating learning levels in order to increase proficiency and reduce error (both human and mechanical) will also be addressed in terms of simulator capabilities.

Program Outcome #4

The student will be able to develop and/or apply current aviation and industry related research methods, including problem identification, hypothesis formulation, and interpretation of findings to present as solutions in the investigation of aviation / aerospace related topic.

Problem Identification. A qualitative research methodology will be used to determine levels of training fidelity in simulation systems and their effects on human factors (performance and safety). Since it is ideal that simulators may be equipped in providing training based on circumstances replicating the operational environment, the conditions in which both high and low cost simulators are typically used and/or provide the most benefits to the learners will be addressed. The data will consist of studies, relevant literature, and reports in which simulators are applied for student pilots during flight training.

Hypothesis Formulation. 1) It will be hypothesized that applying high fidelity during simulation training result in less aircraft accidents and incidents attributed to human error; therefore, increasing safety levels in commercial and military aviation, 2) It will be hypothesized that applying high fidelity during simulation training result in better task performance of pilots in commercial and military aviation.

The research questions are addressed below:

<u>*Primary Research Question:*</u>

- Does the level of fidelity play a role as to how pilots respond to a variety of situations; therefore reducing the chances of aircraft accidents attributed to human error?

Secondary Research Questions:

- What types of simulators prepare pilots and crew members to effectively respond to emergency situations once they approach the operational environment?
- Does fidelity help shape human behavior and attitudes and limitations in terms of decision-making in the operational environment?
- What factors may contribute to unsafe acts and error in the aviation environment?
- Does simulation training effectively prepare pilots and crew members to make effective and informed decisions?

Comprehension Question #3

Statement of the question

In recent years, additional security measures have been placed at airports in the US with screening passengers and cargo. Some screening measures include providing of x-ray machines for all carry-on bags and luggage, body scanners, cast and prosthesis scanners, and bottled liquids scanners. In addition, random body searches are conducted by Transportation Security Administration (TSA) workers. The implementation of these measures has faced much criticism within the last few years as a result of the safety and privacy of passengers. Another criticism of body scanners is their effectiveness in terms of cost and safety detection.

The TSA's passenger screening process at U.S. airports include 1) personnel who screen airline passengers along with their carry-on items; 2) standard operating procedures to conduct screenings by personnel, and 3) technology uses (Government Accountability Office, 2009). Each of these security measures will be measured in terms of airline safety and cost effectiveness in comparison to alternative screening methods such as passenger profiling. Also, the differences in primary and secondary screening versus profiling all passengers prior to boarding will be examined. The roles and responsibilities of the Department of Homeland Security (DHS) will also be addressed pertaining to research and development of deploying various screening technologies.

Program Outcomes that will be addressed by this question:

Program Outcome #1

Students will be able to apply the fundamentals of air transportation as part of a global, multimodal transportation system, including the technological, social, environmental, and political aspects of the system to examine, compare, analyze and recommend conclusion.

Fundamentals of Air Transportation as Part of a Global, Multimodal Transportation System. This aspect will address the challenges in which imposing additional security measures affect global, multimodal transportation – mainly air cargo.

The Aviation and Transportation Security Act (ATSA) established the Transportation Security Administration (TSA) to screen all passengers at checkpoint areas and cargo transported to and from the United States (Government Accountability Office, 2012a). These types of screenings occur in commercial aircraft only.

This ***technological aspect*** will address the types and investments of passenger and cargo checkpoint screening technologies researched by the Department of Homeland Security Science and Technology Directorate (S&T) in which the Transportation Security Administration (TSA) deploys. Also, the ***technological aspect*** will address the cost-benefit analysis along with vulnerabilities of each type of screening technology provided in major U.S. airport checkpoints.

The ***social aspect*** will address the impact of Transportation Security Administration (TSA) and passengers as a result of enhancing security at major airports. Also, the ***social aspect*** will address the screening methods taken by TSA workers, such as evaluation and/or monitoring of these methods in comparison to profiling all passengers.

This ***environmental aspect*** will address the environmental and safety concerns with the DHS recommendations for placing x-ray machines and other scanning technologies as a part of the checkpoint screening process. A main concern is the amount of radiation exposure passengers receive as a result of being x-rayed. This data will be examined by the U.S. Environmental Protection Agency (EPA).

The ***political aspect*** will address the recent actions taken by Department of Homeland Security (DHS) to improve the checkpoint screening process and how they impact the air transportation system in terms of passenger traveling and cargo transport. These process actions include implementation of advanced imaging technologies (AIT), x-ray screening on all passengers who enter metal detector areas along with their carry-on items (primary screening), secondary screening that is conducted randomly on passengers along with their carry-on items, and enhancing air cargo security. The ***political aspect*** will also discuss the auditing standards placed on DHS to provide evidence of operational testing and sufficient research in deployment of these technologies to Transportation Security Administration (TSA). The political issues in terms of privacy and regulations imposed on airports will also be addressed.

Program Outcome #2

The student will be able to identify and apply appropriate statistical analysis, to include techniques in data collection, review, critique, interpretation and inference in the aviation and aerospace industry.

Data Collection Techniques. Surveys information will be used upon check-in and conducting of security screening procedures along with observations of passengers upon being profiled. A Likert Scale will be used. Survey questions will be based on the stated measures:

- What are the perceptions and experiences of passengers at check-in when conducting security checks?
- What are the passengers' experiences and immediate reactions following conducting of security checks?
- What are the passengers' perceptions of being profiled at airports?

Review. The factors associated with the profiling process at checkpoint areas will be addressed in terms of passenger safety, cost effectiveness, and privacy. This study will provide further review on the primary responsibilities of TSA at TSA-regulated airports which consist of establishing and implementing measures to improve security operations at U.S. commercial airports, overseeing of airport security operators, securing inaccessible areas, and monitoring workers screening procedures (Government Accountability Office, 2010).

Critique. Data will be gathered on the few cases associated with using both scanning technologies and profiling as primary screening methods in comparison to other airlines that profile passengers. The cost-benefits along with the disadvantages associated in using advanced imaging technologies (AIT) and profiling will be examined and critiqued.

Statistical Analysis. A t-test statistical analysis will be used to examine if there is a statistically significant relationship between the safety perception, satisfaction level of passengers, and the type of passenger screening method. The independent variable is the passenger screening method. The dependent variables are the safety perception and satisfaction levels based on the type of screening method used.

Groups. This group includes an airport that conducts screening by profiling all passengers (e.g., conducting background checks. Certain groups of passengers have been addressed in this particular study based on the type of screening method being used (profiling).

Program Outcome #4

The student will be able to develop and/or apply current aviation and industry related research methods, including problem identification, hypothesis formulation, and interpretation of findings to present as solutions in the investigation of aviation / aerospace related topic.

A qualitative research methodology will be used to collect, analyze, and interpret the types of screening methods along with the vulnerabilities and capabilities of deploying advanced imaging technologies (AIT) versus profiling all passengers at security checkpoints. These measures will be based on cost-benefit analysis, safety detection, and operational testing data gathered from Transportation Security Agency (TSA) and Department of Homeland Security (DHS) reports/sites along with Israeli airport security reports. In addition, data will be gathered on interviews and reports conducted and researched by the Government Accountability Office (GAO) with TSA officials addressing the advantages and disadvantages of deploying these technologies.

The data gathered will be used to determine whether to accept or reject the *hypothesis* that there is a statistically significant relationship between the number of commercial airline security incidents and the type of passenger screening methods at airports.

Primary Research Question:

- What is the cost-benefit analysis and safety levels of providing TSA required screening technologies at airport checkpoints in comparison to other screening alternatives, such as profiling?

Secondary Research Questions:

- How do checkpoint screeners currently conduct random searches and use scanning technologies to detect potentially hazardous items?
- What is the comparison of features for each checkpoint security measure, such as primary and secondary screening methods versus profiling and/or administering pat downs?
- What are the capabilities, threats and vulnerabilities of deploying AIT as an aviation security measure versus profiling all passengers at checkpoint screening areas?
- Do the screening process requirements and methods vary based on the size of the airport and/or volume of passengers?

Comprehension Question #4

Statement of the question

Technicians who work in aviation maintenance are expected to perform without error. However, it is stated that “80 percent of maintenance errors involve human factors” (“Human Factors,” n.d., p. 14-1). Factors that may attribute to errors in aviation maintenance are poor working conditions, lack of detail for certain maintenance tasks, lack of productivity (e.g., time of day working on maintenance tasks), fatigue, and lack of motivation. An example of fatigue would be if an aviation maintenance technician (AMT) is called in to perform maintenance work on an aircraft in the very early morning versus late morning hours; therefore, their attention to detail may be less and productivity level would decrease. This proposal will address the most common types of maintenance errors that are detected as a result of human error, such as human conditions. Also, the elements of human factors will be addressed for aviation maintenance technicians to ensure quality improvement, reduce deficiencies, and increase job performance and productivity. In addition, the psychological concepts of human factor disciplines will be examined which are clinical, organizational, educational, and experimental (“Human Factors,” n.d.).

Program Outcomes that will be addressed by this question:

Program Outcome #3

The student will be able across all subjects to use the fundamentals of human factors in all aspects of the aviation and aerospace industry, including unsafe acts, attitudes, errors, human behavior, and human limitations as they relate to the aviators adaption to the aviation environment to reach conclusions.

Although there are two types of errors (human and mechanical), a majority of aircraft maintenance errors result from human error. This study will also address the conditions that likely contribute to errors made by aviation maintenance technicians (AMTs), such as poor working conditions and low productivity levels. The conditions surrounding AMT workers may result in problem areas with *all* aspects of human factors, which include; ***unsafe acts, attitudes, errors, human behavior,*** and ***human limitations***. The elements of human factors from multidisciplinary fields will be addressed, stressing their importance to ensure quality improvement in aviation.

Program Outcome #4

The student will be able to develop and/or apply current aviation and industry related research methods, including problem identification, hypothesis formulation, and interpretation of findings to present as solutions in the investigation of aviation / aerospace related topic.

The research methodology used will produce information on the various elements of human factors impacting aviation maintenance technicians (AMTs). The data gathered will relate to studies conducted on AMT on human factors awareness. The outcome measures will be based on worker productivity and motivation, and cognition. In addition, data will be gathered on studies and reports addressing issues resulting in maintenance errors along with examples of aviation accidents that have resulted from errors.

Hypothesis Formulation. 1) It will be hypothesized that exposure to human factors training will result in higher levels of worker productivity and motivation for aviation maintenance technicians (AMTs). 2) It will be hypothesized that exposure to human factors training will result in higher cognitive learning levels for aviation maintenance technicians (AMTs).

Primary Research Question:

- Will exposure to human factors training result in higher worker productivity, higher cognitive learning levels, and increased motivation for AMTs?

Secondary Research Questions:

- What elements of human factors are considered as most critical to aviation maintenance technicians (AMTs) in terms of quality?
- What types of conditions contribute to human and maintenance errors?
- Will human factors awareness in multidisciplinary fields result in improvements of the following outcome measures: worker productivity, motivation, team performance, cognition, and training effectiveness? Which factors, if any, will not necessarily contribute to these improvements

Comprehension Question #5

Statement of the question

In curriculum design and development, the Instructional Systems Design (ISD) process plays a major role for ensuring the quality and effectiveness of delivering training products and processes. Although there are several models used in producing training support packages (TSPs) in the military, the model that will be addressed in this proposal is the Instructional Systems Design/Systems Approach to Training (ISD/SAT). The ISD/SAT model is described as "a systematic approach to developing instructional materials by integrating the processes of analysis, design, development, implementation, and evaluation" (Department of Defense Handbook, 2001b, p. 4). A version of the ISD/SAT model examined in this paper will be the ADDIE process, which is also known as *A*nalysis, *D*esign, *D*evelopment, *I*mplementation, and

Evaluation (“Instructional System Design,” 1995). ADDIE also addresses the five phases which apply to the curriculum development process as stated above.

Due to the recent Department of Defense (DoD) budget cuts, the ability in producing and delivering military training products may be limited in terms of resources. Some resources used producing training products consist of funding, facilities, equipment, time, and human resources/people (Department of Defense Handbook, 2001b). For example, if instructional design teams are given far less time in developing TSPs for courses designed specifically for Air Force personnel, then the quality and delivery of training may be negatively impacted for the learners and/or users. It will be determined as to whether applying the ISD/SAT model will remain beneficial to instructional designers and students in terms of design and delivery of training courses. The ISD/SAT process will also be examined, applying the five phases of ADDIE. This proposal will address the limitations placed on military personnel and instructional designers in terms of time, cost, people, resources, and output. The benefits of the ISD/SAT process will also be examined in terms of cost effectiveness, training effectiveness, quality, and flexibility aside from recent budget cuts.

Program Outcomes that will be addressed by this question:

Program Outcome #4

The student will be able to develop and/or apply current aviation and industry related research methods, including problem identification, hypothesis formulation, and interpretation of findings to present as solutions in the investigation of aviation / aerospace related topic.

The research methodology used will produce information on the five phases of ADDIE (Analysis, Design, Development, Implementation, and Evaluation), impacting the input, process, and output (IPO) of military training products. The importance of planning will also be addressed in terms of its relationship with IPO. Data gathered from other studies will be examined to determine the value of the ADDIE model in terms of time allotted for different phases, client needs, costs, and processes.

Hypothesis Formulation. The hypothesis is that resource limitations will result in decreased performance of Air Force personnel in the operational environment.

The research questions are addressed below:

Primary Research Question:

- Will resource limitations result in decreased performance of Air Force personnel in the operational environment?

Secondary Research Questions:

- What are some of the flexibilities involved in producing TSPs using the ADDIE model given the following constraints, such as lack of sufficient time, lack of sufficient resources (i.e., subject matter experts and instructors), and shortage of staff?
- Due to recent military budget cuts, will the ADDIE model still be considered as a useful tool in producing training support packages (TSPs) in Air Force education?
- Is flexibility of the ADDIE process solely dependent on the clients' needs? How does this impact its uses along with the quality of training products?

Program Outcome #6

The student will investigate, compare, contrast, analyze, and form conclusions to current aviation, aerospace, and industry related topics in education technology, including computer-

based instruction, simulation systems, education foundations, curriculum development, continuing education, adult teaching and learning techniques, and memory and cognition.

The importance of selecting each topic of education technology will be examined in relation to the instructional systems development (ISD) process: c***omputer-based instruction, education foundations, simulation systems,*** and ***curriculum development*** and design. In ***curriculum development***, it is important that instructional designers (IDs) select the best methods and media available in terms of training needs and cost effectiveness, especially during the midst of recent military spending cuts. The importance of media and method selection in ***education technology*** will be examined in relation the ADDIE model. Also, the types of ***adult teaching and learning techniques*** will be addressed along with their importance to the instructional setting. The types of techniques will also be compared and contrasted. The importance of each phase in the ADDIE process will be examined along with identifying the roles and responsibilities of the ID during each of these phases.

The ***continuing education*** and ***memory cognition aspects*** will not be addressed on this comprehensive examination question due to not having taken these courses.

Final Comprehensive Exam Project

Question #1

Statement of the Question

Blended learning is described as the combination of delivery methods used to accommodate the training needs of learners (“Blended Learning,” 2010). A blended learning environment may involve combining individual-based learning, such as a self-paced computerized tutorial, along with live interaction in a classroom. In fact, “a blended course has anywhere between 30 to 79% of online content delivery with the remaining content delivered in a non-web based method such as face-to-face instruction” (Kenney & Newcombe, 2011, p. 47). Some forms of live interaction in a classroom environment consist of role-plays, practical exercises, instructor lectures, and group discussions. Blended learning is typically applied in adult learning environments since adults tend to learn best when they are able to relate it to their daily experiences. Simply, the merging of new information along with existing knowledge in particular learning environments tend to work best for adult learners (“What is Blended Learning,” 2012).

The focus of this examination question is to address the methods of instruction (MOI) applicable to aviation training environments in terms of blended learning. This question will also address any learning situations in which applying one MOI is considered the most beneficial to learners. A research study will be examined addressing whether blended learning results in enhanced learning for crew members along with the cost-benefits to the training organization providing that approach.

Research and Analysis of the Question

In training development, the use of blended learning is also known as accelerated learning, which is described as the combining of traditional and nontraditional techniques in order to increase instructor and student motivation (Department of the Air Force, 1993). In addition, accelerated learning encourages more creative and team-based learning, along with the combination of media and instructional methods.

Although blended learning environments typically involve the use of technology, it does not necessarily mean that high tech computerized games are applied. In fact, the main focus of blended learning is the integration of technology and teaching methods which allow students to fully master content and skills, at the pace that's right for them ("What is Blended Learning," 2012). Also, an ideal blended learning environment includes the integration of *multiple* objectives in which learners are exposed to a combination of verbal information, intellectual skills, and cognitive strategies; therefore, all of these strategies are intended to relate to a common training goal (Department of the Air Force, 1993). In blended learning, research has shown that instruction intended to appeal to a variety of students learning styles increases their interest in subject matter, makes learning more enjoyable to them, and increases their desire to study other subjects; therefore, learning should not just reflect the teacher's style (Franzoni & Assar, 2009).

Blended Learning Combination Strategies. The ***adult teaching*** and ***learning techniques aspect*** addresses the most common activities and instructional methods used in blended learning. According to Rossett (2002), the different ways of combined (blending) learning are based on the following strategies:

- ***Strategy #1*** - self-paced online instruction combined with classroom instruction. These are instructor-led lectures combined with computer aided instruction (CAI) or computer-based training (CBT);
- ***Strategy #2*** - on-line instruction with access to a coach/faculty member (there may also be a facilitator in this classroom);
- ***Strategy #3*** - the use of simulation with structured courses;
- ***Strategy #4***- on-the-job training (OJT) combined with informal sessions. These sessions include discussions on the topic in an informal setting, such as during a scheduled break; and
- ***Strategy #5 -*** managerial coaching with e-learning activities. An example is applying virtual gaming techniques or other computer-based learning activities with a human coach.

Strategy #1. Within this learning context, self-paced instruction is typically known as ***computer-based instruction (or CBT)***. The ***CBT aspect*** involves different levels of interactivity between the student and subject matter. Also, in a CBT learning environment, computer workstations are typically provided to each student. Based on the actual subject matter, CBT consists of online quizzes, exams, videos, graphics, guided learning, and students' level of progress. Self-paced online instruction for this blended learning strategy typically falls under an Interactive Courseware (ICW) Category Level 2. ICW is typically applied for learning situations in which students can work individually and view learning material in the form of both text and graphics (Department of Defense Handbook, 2001b). In an ICW Category Level 2 presentation, students have increased control over the subject matter and more graphics are used (Department of Defense Handbook, 2001a). In addition, immediate feedback is received among submitting answers to quizzes and/or checks on learning performed online.

Classroom instruction typically occurs when it is instructor-led or teacher-centered. Another word for instructor-led is traditional instruction. This type of instruction involves the use of a single individual (or lecturer), who typically leads the discussion (Department of Defense Handbook, 2001b). In this learning context, students take the passive role and listen to information presented to them. As stated in the Department of Defense Handbook (2001b), the media most commonly used in traditional instruction include chalkboards, overhead projectors, PowerPoint slides, and video tapes/DVDs. This type of blended learning strategy is best used when the lesson involves knowing the basic fundamentals. For example, in an aircraft mechanics course, CBT along with classroom instruction would be sufficient only if the end state for learners was to describe aircraft maintenance tools of the CH-53 Helicopter.

Strategy #2. The second blended learning strategy which also addresses the ***CBT aspect*** is online instruction with access to a coach/faculty member, commonly known as a classroom facilitator (Rossett, 2002). This learning strategy is also best used for basic fundamental lessons, such as learning about the basic parts and components of an aircraft engine; not performing the actual repairs. The benefit of this learning strategy is not only it is technology-driven; it also includes the expert guidance of a facilitator (Department of the Army, 2011).

Strategy #3. The ***simulation systems aspect*** pertains to the third blended learning strategy which is the application of simulation systems in structured courses**.** Part-task trainers (PTTs) as a simulation (or training) tool are typically used for this particular strategy and are recognized as training devices or simulators providing instruction only on primarily a part of the whole job or task (“FAA Human Factors Awareness Course,” n.d.). An example of PTTs in a training environment is when the instructor presents a lecture pertaining to how a particular aircraft component work and then students have the opportunity to “play with it”; that is, perform operations/tasks on that particular component, not necessarily the whole system itself. In other words, the student will learn how a subsystem applies to the whole system without overwhelming them with high fidelity situations.

Strategy #4. The aspect of ***actual equipment*** applies for OJT training since students will be presented with learning tasks that they are expected to perform on this job. Training with the use of actual equipment is the real system itself, such as an aircraft. An example of OJT is an experienced pilot training with a single student at a time and using the actual equipment in the job environment as the ultimate instructional strategy and media (Department of Defense Handbook, 2001b).Informal sessions include discussions on the subject matter in an informal setting, such as during a scheduled break or during a small group conservation.

Strategy #5. An example of managerial coaching with e-learning activities is when the learner has exposure to the lesson material with the form of CBT (e-learning). Each student will have an individual computer workstation. Lesson content will then be presented to the students. Also, small groups are formed and then provided with a small scenario(s) and/or a classroom discussion based the lesson topic. The facilitator for the blended learning group does not instruct the class; rather he or she listens to each participant’s input and along with their discussion points.

Blended Learning Environments. This section examines the benefits of applying blended learning approaches in a classroom, simulation, and e-learning environment. The topics included in ***education technology, curriculum development,*** and ***education foundations*** are also addressed in terms of instructional methods and media used in both blended and traditional learning environments.

In a classroom environment, learners are typically placed into a social context in order to increase interactivity among peers. In order for learning enhancement to occur, classroom activities may include scenarios, role-playing, games, and skits (Department of the Air Force, 1993). The methods and scenarios applied during training should replicate the job environment as closely as possible (realism) in of behavior of the learners. Applying realism in adult learning environments not only accommodates their preferred style of learning; it also recognizes that adults process new information best when it relates to their own personal experiences (Department of Defense Handbook, 2001b). A benefit of applying a social context in a classroom is that it allows students to strengthen their intrapersonal skills. Also, on-site interaction results in the creation of a community of learners.

The ***education foundations aspect*** stresses that instructors/facilitators in a classroom are able to focus more on teaching higher level skills rather than just knowledge-based since students have the ability to work in a self-paced manner using CBT prior to classroom instruction. Also, instructors have the ability to monitor student progress data regularly along with implementing small group learning in the classroom more efficiently. As a result, instructors are able to personalize instruction in an aviation training environment. Blended approaches also allow for learning activities to occur prior to instruction and results in increased student participation in the classroom. Active learning is another advantage since it improves retention in a classroom in the form of peers exposing students to different viewpoints along with ways of interpreting and applying course material (Kenney & Newcombe, 2011).

Blended Learning in an Online Environment. In an online environment, students have the ability to work individually and view learning material in the form of text and graphics (Department of Defense Handbook, 2001b). Another benefit is that immediate feedback is provided to students individually, as in the practice of online quizzes and drill and practice. As described in Department of Defense Handbook (2001b), drill and practice methods are applied when users are requested to select certain items with the click of a mouse (also known as 'drag and drop'). For example, students who are taking a CBT lesson in aircraft mechanics may be asked to 'drag and drop' the engine component to its appropriate location. Immediate feedback is provided in the context of drill and practice. Also, students are able to learn at their own pace when using CBT. Another advantage is that instructors are able to better manage student progression levels since it is stored electronically in one primary location.

The ***curriculum development aspect*** examines the types of MOI and media that instructional system developers (ISDs) analyze when designing aviation-related training products to accommodate blended learning techniques. In order to effectively design aviation-related training products, the proper MOI and media type(s) should be customized based on the training needs of the target audience (students), length of course/lesson, and instructional intent.

The MOI (or instructional method) is defined as the approach used to present instruction (United States Marine Corp, 2004). MOI can also be defined as the process used to retain the required knowledge and skills and delivery of the learning content (Department of Defense Handbook, 2001b). The three types of MOI are presentation, student interaction, and knowledge application (2001b). They are examined in further detail based on the type of learning considered most applicable to the training environment.

In ***curriculum development***, ISDs identify the most appropriate (or cost-effective) MOI to use based on the learning needs; in other words, the learning outcome. The types of student interaction (learner-centered) methods are listed below:

- *Questioning*. This type of MOI typically involves an instructor and/or courseware controlled interactive process used to emphasize a point, stimulate thinking, check understanding, or review material content (Department of Defense Handbook, 2001a). The most common way this is done is through CBT. The medium of film and television can also be utilized in questioning methods (2001a).

- *Programmed Questioning*. This method involves an instructor and/or courseware controlled interactive process used to systematically demand a sequence of appropriate student responses and may be used directly. Can be done by a classroom instructor or computers – at individual workstations (Department of Defense Handbook, 2001a). This can take place in a classroom or via distance learning.

- *Student Questioning*. When students have the opportunity to search for certain information based on questioning by a classroom instructor, tutor, mentor, or a programmed computer (Department of Defense Handbook, 2001a). An example of this is when the students conduct research on additional information regarding a question through the Google search engine. This can be instructor or facilitator-led and can take place by distance learning or in a classroom.

- *Discussion.* This type of method is instructor-controlled and typically takes place in a classroom (Department of Defense Handbook, 2001a); however it can also be done via distance learning, such as Blackboard. This interactive method also involves the process of sharing information and experiences in order to achieve a learning objective (2001a).

The knowledge application methods applied in blended learning are:

- *Performance.* When students interact with objects, data, equipment, other persons, gaming, simulators, actual equipment. Typically supervision takes place by a classroom instructor or a coach (Department of Defense Handbook, 2001a).

- *Case Study.* A description of a problem situation is given which provokes discussion among students (Department of Defense Handbook, 2001a).

The most common MOI applied in traditional-based instruction include presentation methods, as listed below:

- *Lecture-Based (formal).* Instructor presentations and instructor-led discussions that most commonly take place in a classroom setting. Formal lectures involve one-way communication primarily intended for reaching a large audience and typically in a classroom setting. (United States Marine Corp, 2004).

- *Demonstration (direct and indirect):* For demonstrations that are conducted directly, the instructor will verbally explain along with showing the procedures, techniques, or operations of handling certain systems or pieces of equipment

(Department of Defense Handbook, 2001a). If conducted indirectly, then presentation is conducted by video, clip, or film (2001a).

Traditional-Based Instruction. The ***education foundations*** and ***curriculum development aspects*** address traditional-based instruction. In traditional-based instruction (or teacher-centered), lectures are the primary source of obtaining student knowledge. Traditional-based learning typically takes place in a classroom environment with the instructor taking control of the subject matter. In addition, students receive instruction in a passive manner, with communication being one-way (from the instructor to students). In a typical instructor-led environment, students take notes by writing on a piece of paper while the instructor talks.

There are situations in which traditional-based instruction may be preferable to learners in a training environment which are: 1) students who do not wish to be called on more likely may remain anonymous; 2) the instructional materials used are prepared to support lecture, conference, and discussion (Department of Defense Handbook, 2001b); and 3) students who are unfamiliar with the subject matter, lectures may provide more structure in their learning.

The challenges of applying computer-based technologies are the resources (time and cost) it takes to develop and redesign courses in order to accommodate blended learning in the form of CBT. CBT needs to operate effectively in order for students to easily locate deadlines, on-line quizzes, checks on learning, and posting discussion questions. Also, since e-learning mostly involves the use of computer-based technology, the lack of instructor feedback and self-discipline makes it challenging for instructors to provide one-on-one relationships with their students.

A study was conducted at the University of Wisconsin, in which traditional courses in the areas of social sciences, engineering, humanities, and professions were transformed into a blended learning course (or known as a hybrid approach) (Aycock, Garnham, & Kaleta, 2002).

Method

Methodology

Hypothesis Formulation. It is ***hypothesized*** that exposure to blended learning methods will result in higher levels of performance, cost effectiveness, and collaboration in the job environment.

Research Design. An action research study was conducted at the West Chester University of Pennsylvania for an Educational Psychology course. The focus of this study was to determine whether blended learning was more effective than a traditional classroom setting in terms of student participation, performance, and motivation. Out of three course sections, one of them randomly selected courses for the experimental group consisted of 60 students (class size); the control groups had class sizes of 60 and 30 (Kennedy & Newcombe, 2011). Most of the students in each group – control and experimental – were similar in terms of grade level and major. The split was 50/50 between males and females.

The below groups were used in this study:

- Control Group (non-blended): class size of 30 students
- Control Group (non-blended): class size of 60 students
- Experimental Group (blended): class size of 60 students

Problem Identification. The class was *originally* structured in a traditional setting and consisted of instructor-led lectures; however, student participation was much lower and students were attending class less prepared. This passive style of learning was negatively affecting students' test scores too. In fact, test performance was below average for a number of students taking this course.

As a result, the instructor wanted to test-pilot this course using a combination of learning techniques or methods to examine whether this approach is more effective for the students in terms of motivation, learning levels, engagement, and test performance. Also, class size was accounted for in terms of how learning should be applied. Although blended learning may be defined in several ways, it can best be described as a "combination of face-to-face and online learning activities and has been found to increase understanding, interaction, and involvement in the learning process" (Kenney & Newcombe, 2011, p. 46). Blended learning is also known as a hybrid approach and uses active versus passive techniques in teaching students new material. Active learning focuses on improving learner retention, improves application of course content, and allows students to expose other to different viewpoints and ways of interpreting course content (Kennedy & Newcombe, 2011).

The procedures used in this study was intended to measure student and instructor perceptions of the hybrid (or blended) approach in the form of a test pilot. That way, any modifications can be made prior to implementation on lessons learned and student feedback. During the pilot study, students in the experimental group were closely observed since a majority of them have never been exposed to blended learning. In order to effectively measure their experiences, the focus centered on these following areas (Kennedy & Newcombe, 2011):

- Did the blended approach improve student learning?
- Did the blended approach increase students' active involvement in the course and engagement in the course material?

- Did the students feel more prepared for in-class activities after learning the content online?
- Did the blended approach increase student participation during the face-to-face classes?
- Did the blended approach increase student interest in the material and overall satisfaction with the course?

Data Collection. Four types of ***data collection*** were used to measure the study areas mentioned above (Kennedy & Newcombe, 2011):

- *Unit Examination*. The same unit exam was given to both groups (blended and nonblended). The questions were structured in a multiple choice and short answer format.
- *Survey.* A survey was administered to the blended group to measure student perceptions on learning interest, satisfaction, perception, and level of learning.
- *Observation.* Information observations were conducted in the classroom to determine their level of participation when exposed to blended learning.
- *Tracking Statistical Information for Blended Group*. This statistic was used to track the level of learning through online scores and level of participation through Blackboard discussions.

Interpretation of Findings. It was discovered that students perceived hybrid instruction as being weak if they perceived a poor integration between the face-to-face and the online components or if they felt the online components merely increased the course workload making it beyond one course.

This study demonstrated the ***findings*** for each focus area:

1) *Did the blended approach improve student learning?* Based on the study findings, it was determined that students who were exposed to blended learning in their Human Development course had a slightly higher average test score than ones in traditional settings. The findings also based scores on class size.
   - The control (non-blended) group with a class size of n=30 had an average score of 47.40 out of 60 (Kennedy & Newcombe, 2011);
   - The control (non-blended) group with a class size of n=60 had an average score of 44.34 (Kennedy & Newcombe, 2011);
   - The experimental (blended) group with a class size of n=60 had an average score of 47.46 out of 60 (Kennedy & Newcombe, 2011);

A total of 56 students responded to the survey voluntarily. The ***interpretation of findings*** showed that 48% of students were males and 52% were females. Based on the number of respondents, 75% agreed that the blended approach contributed to their learning (Kennedy & Newcombe, 2011).

2) *Did the blended approach increase students' active involvement in the course and engagement in the course material?*
   - Out of the total number of survey respondents, 64% felt more engaged with the course material. Therefore, hybrid approach was shown to increase students' involvement in the material (Kennedy & Newcombe, 2011).
3) *Did the students feel more prepared for in-class activities after learning the content online?* Based on the total survey responses, 66% of them stated they felt

more prepared for in-class activities based on the hybrid approach (Kennedy & Newcombe, 2011).

4) *Did the blended approach increase student participation during the face-to-face classes?*
    - *Blended Learning Group*. The survey showed that 48% of the students perceived their level of participation increased as a result of self-paced, on-line learning prior to in-class activities (Kennedy & Newcombe, 2011).
    - *Non-blended Group with 30 and 60 Students*. Based on informal observations, it was shown that the smaller group (or class section), demonstrated higher participation levels than the blended and larger non-blended groups with 60 students (Kennedy & Newcombe, 2011).
5) *Did the blended approach increase student interest in the material and overall satisfaction with the course?*
    - Based on the blended learning options provided (i.e., Blackboard/on-line discussions, self-paced, and supplemental course materials being offered), it was shown that 59% of the students perceived an increased interest in the content (Kennedy & Newcombe, 2011).
    - Also, 75% of the students stated that the hybrid approach helped them go into more depth with the content (Kennedy & Newcombe, 2011).

Additional features of blended learning reported on the survey included convenience of online learning (90% of respondents liked the convenience), ability to work independently and self-paced manner (88% of respondents liked this feature), comfortable with expressing themselves in class due to self-paced preparation (68% of respondents liked this feature), and promoting of a community of learners (65% of respondents perceived this to be true) (Kennedy & Newcombe, 2011).

Summary

This study focused on the benefits and challenges of implementing a blended learning approach to a university-level course taught previously in a traditional setting. Although the survey and informal observation results have shown that blended learning is more beneficial to the learner in terms of increased motivation, learning satisfaction, collaboration, and performance, it is important that this approach is carefully designed and structured prior to implementation. For example, if the learning content is too difficult for students to work independently and in a self-paced manner, then it has not served its purpose. Also, the challenges of offering blended learning courses is the funding required for development such as hiring curriculum designers and/or instructors attending workshops to develop the knowledge, skills, and abilities (KSAs) to performing the tasks required in developing on-line courses and restructuring classroom activities. In addition, resources were very limited in restructuring of the course, such as the number of tech-savvy faculty members to design e-learning in terms of funding, people, and time. Resources should seriously be taken into consideration prior to planning for and implementing any aviation training course.

Although this study was conducted in a higher educational setting, rather than aviation, the same considerations should apply prior to implementing a restructured course in an aviation training environment. Further studies should consider the methods and processes involved with restructuring a course from one type of learning approach to another. Another consideration prior to pilot testing any blended learning course is that organizational readiness should occur in order for organizations and institutions to support online teaching. That way, online instruction is not created so poorly that it produces a poor integration between the face-to-face and the online components and/or the components contained in e-learning increase the course workload making it a “course and a half” (Kennedy & Newcombe, 2011).

Question #2

Statement of the question

Research has shown that the use of technology-based tools in aviation training has resulted in a safer/risk-free training environment, increased learner control, increased learner involvement, time reduction in training, and improved transfer to the job environment. Although the benefits of advanced technology have enhanced safety in flight, applying simulator fidelity in aviation training environments also reduces the potential dangers associated with aircraft damage and loss of life due to flight training accidents. Fidelity is described as “the degree to which a task or a training device represents the actual system performance, characteristics, and environment” (Department of the Air Force, 1993, p. 105). Therefore, if instructional fidelity for a particular task is high, the most effective training method(s) to apply may include part-task trainers (PTTs), full flight simulators, actual equipment, or Interactive Courseware (ICW). The appropriate types of media used for training depend on the type of task being taught in terms of task criticality, level of interactivity, learning progression, and task difficulty. Training fidelity considerations will be further examined in this question along with the different types and features of simulation systems.

Research and Analysis of the Question

According to the FAA Human Factors Awareness Course (n.d.), studies have shown that the use of simulation and interactive courseware (ICW) in aviation training results in the number of “up to 30% fewer on-the-job errors” (Training section, para. 3). Also, studies from the Naval Air Warfare Center Training System Division (NAWCTSD) has shown that about 50% less time is spent in training with the use of simulators and ICW as compared to instructor-led methods (“FAA Human Factors Awareness Course,” n.d.). Due to the challenges that pilots - both military and commercial - encounter in the operational environment, flight simulators have shown to be more effective and less risky to use than actual equipment (aircraft). Simulation is described as “a technique whereby job environment phenomena are mimicked, in an often low-fidelity situation, in which costs may be reduced, potential dangers eliminated, and time compressed. Another way to describe simulation training is the “focus on a small subset of the features of the actual job environment” (Department of the Air Force, 1993, p. 107).

An important factor to consider when designing learning environments is the fidelity of each training situation. For example, learners who are being taught the *basic* fundamentals of performing aviation maintenance troubleshooting procedures should receive instruction at the knowledge level (lower level), compared to ones who are being evaluated for *performing* a troubleshooting procedure at the performance level (higher level). Therefore, the training fidelity situation should take the learners’ (audience) experience into consideration.

Types of Learners – Fidelity. The ***human behavior*** aspect addresses the fidelity levels of simulation systems considered as appropriate to the training situation. It is important to take learner experience into consideration since ***human behavior*** (or learner behavior) may be affected based on the complexity level of the training task. The three learning progression levels are novice, expert, and experienced (Department of the Air Force, 1993).

Novice learners generally have less experience with the subject matter; therefore, a lower level of fidelity may apply for learning (i.e., ICW). In order to shape the ***attitudes*** of beginner learners with the subject matter, it generally is “better to teach a novice in a simplified context, so that the amount of information and noise is reduced to a manageable level” (Department of the Air Force, 1993, p. 41). For example, the aspect of ***human behavior*** may include a negative perception of the simulation device if novice learners are placed in a full flight simulator prior to receiving more hands-on experience with lower fidelity ones. The reason is that the use of highly complex systems prior to learning parts of them might be more intimidating to learners.

Experienced learners have acquired previous exposure to the subject matter, are more equipped to handling greater information loads, and able to disregard noise easier. In this case, the training context should be more lifelike, yet not full-fidelity. To accommodate experienced learners, training aids with integrated subsystems are often used so the student can learn how they work together and how procedures involving more than one subsystem are performed.

Expert learners are capable of learning tasks of complexity more quickly than experienced or novice learners (Department of the Air Force, 1993). Learners are typically considered as experts once they are able to perform successfully in high-fidelity environments. Also, experts have the ability to transfer their knowledge from other similar environments (Department of the Air Force, 1993). Below is an example of how an expert learner applies new information into a familiar situation:

1. If you are training an F-14 pilot to fly an F-16, you don't have to go back over what is already known; the learner simply has to know the differences between the planes that will affect how they are flown (Department of the Air Force, 1993, p. 41).

Instructional Media, Fidelity, and Functionality. The table below shows the types of media that should be selected based on the levels of fidelity and functionality. Examples of learning activities to accommodate each type of learner are provided.

Table 1 - Fidelity

Learning Activity	Type of Media	Level of Fidelity / Functionality	Type of Learner
Describe the procedures for takeoff	Interactive Courseware (ICW)	Low/Medium	Novice
“Play around” or “test” the components of an aircraft engine.	Part-task trainer (PTT)	Medium/High	Experienced

Perform takeoff procedures at night	Full Flight Simulator	High	Expert

Training Fidelity Considerations. As stated in FAA Human Factors (n.d.), the importance of transfer of training is defined as the "extent to which the learned behavior from the training program is used on the job." (Training section, para 1). In other words, the assigned tasks along with type(s) of media used (taught) in the training environment should replicate the aviation environment in terms of fidelity. If training is provided to accommodate as many realistic scenarios as possible to the operational environment, then the chances of ***human error*** occurring as a result of ***unsafe acts*** will be reduced. An association between the fidelity dimensions of a simulator and knowledge and skills elements do exist when effective training takes place in the aviation environment. Therefore, when delivering training, considerations need to be made to determine the proper fidelity levels of simulators, which include progression level of the learners, how critical the outcome is when the task is performed unsuccessfully, the level of interactivity required in assigned tasks, and the level of difficulty in teaching the task (e.g., high level of complexity).

The three types of instructional fidelity that are applied in flight training include physical, functional, and psychological. They are addressed below in further detail:

- Physical fidelity is defined as the "degree to which physical simulation resembles the operational environment" (Department of Defense Handbook, 2001a, p. 92). Some examples of physical fidelity in a simulation system include visual scene simulation, sound effects, communication simulation, and body motion.

- Functional fidelity is defined as the "degree to which internal mental models correspond to the actual cognitive nature of the task" (Alexander, Blueggel, Estock, Gildea, & Nash, 2006, p. 4).
- Psychological fidelity is defined as "degree to which simulation produces sensory and cognitive processes within the trainee as experienced in the real world" (Alexander et al., 2006, p. 4).

The training or instructional fidelity considerations are examined below in terms of task criticality, interactivity levels, target learner progression, and difficulty of learning. These items determine how training should be delivered in regards to fidelity level and type(s) of simulation utilized.

- *Task Criticality.* In determining the criticality of tasks, two major factors need to be considered: 1) whether the task is performed under emergency conditions and 2) how serious the outcome is if the task is performed incorrectly (Department of the Air Force, 1993). If task criticality is low, then the application of ICW or CBI (computer-based instruction) may be ideal. If task criticality is high, then the use of simulators which presents a wide array of scenarios would be most beneficial for the students along with OJT. This may include full flight simulators that require tasks such as performing flight procedures in weather terrain or at night.
- *Target Learner Progression.* See earlier section on *Types of Learners.*
- *Level of Interactivity.* The level of interactivity required depends on the level of instructional fidelity. For example, if a learning process requires low interactivity levels, then ICW may be used. For higher interactivity levels, classroom

instruction and/or small groups are more ideal (Department of the Air Force, 1993).

- *Learning Difficulty.* A highly complex task is more difficult to teach. Therefore, instructional fidelity will be higher in order to apply the knowledge and skills required to successfully be trained on a difficult task. For example, if students in maintenance technician training are required to *perform* a functional check on a single-point cargo hook system, the most effective instructional media to use would be actual equipment (i.e., aircraft) or aircraft system maintenance trainer (ASMT). However, if students are to describe the procedures to perform a functional check, then CAI may be ideal to use since students are exposed to lesson content with the use of illustrations, graphics, and text pertaining to performing functional checks. Computer aided instruction has a lower level of fidelity than the ASMT.

Flight Simulators. Depending on the learning context, simulation systems should contain the features, situations, behaviors, and other instructional tools which replicate the operational environment. The replication of systems accounts for reducing ***errors*** made due to ***unsafe acts*** in the aircraft helps maintains learner control as opposed to limiting it, and helps shape ***attitudes*** and ***behaviors*** during flight training. This section of the paper provides an overview on the features and types of high, medium, and low fidelity simulators commonly used in flight training:

Computer-Based Instruction (CBI). CBI (also known as CBT) is best used for initial task training and education. Computer-aided instruction (CAI) is defined as the "use of computers to aid in the delivery of instruction" (Department of Air Force, 2002, p. 233). This low-cost simulator may be a desktop computer training device or courseware used to *teach*, not necessarily *perform* assigned tasks. Also, students typically have more interaction with the computerized training device versus instructor-led slides, for example.

Interactive Computer (Virtual Reality [VR]) Simulator. This type of simulator provides operational-based scenarios/situations on a personal computer. VRs are also lower in cost and risk than full flight simulators. The features and examples of VR are addressed below:

- Learner ability to view graphical displays (commonly in 3-D).
- Learner ability to react to realistic scenarios in the form of a keyboard, mouse, or joystick.
- Learner ability to apply decision-making skills that will transfer to the flight or job environment.
- Less risk to damage and .loss of life compared to training with actual equipment.
- Low-fidelity simulator which meets the safety needs of the user (Department of the Air Force, 1993).
- This simulator is measured as cost-effective and beneficial to the user since VRs tend to “focus on a small subset of the features of the actual job environment” (Department of the Air Force, 1993, p. 107).
- VR simulators are best used for novice learners.

Examples of VR systems applied in flight training are listed below ("FAA Human Factors Awareness Course," n.d.):

- *Hazardous Environments and Hazardous Tasks***.** A VR simulator is ideal for novice pilots since they have the ability to learn the processes involved with performing emergency landing procedures. Another type of task using VR is air-to-air combat, for example, which contain no risk to the trainee.
- *Training Situations Involving Disturbance and Maneuver Cues***.** A disturbance cue occurs when changes occur in the environment / aircraft and outside of control loop (i.e., turbulence). Maneuver cues are flight control inputs by the pilots (Alexander et al., 2006).
- *Complex Environments*. The FAA Human Factors Awareness Course (n.d.) example includes training with the use of virtual towers. As shown in the FAA Human Factors Awareness Course (n.d.), a Virtual Reality Tower is used for both National Aeronautical and Space Administration (NASA) and Federal Aviation Administration (FAA); it consists of computer-generated images which is stated to create "a realistic, 360° external view that simulates time-of-day, seasons, weather conditions, and the movement of up to 200 aircraft and ground vehicles" (Training section, para. 5).

Part-Task Trainer (PTT). These types of systems are commonly used for procedural knowledge in novice learners. The features and examples of PTTs are listed below:

- Provide accessibility at a lower cost. PTTs are often used as an alternate approach to full flight simulators.

- Are more common for novice learners to retain their skills based on learning the parts of the task/job prior to getting exposure to the whole task/job (Smith, 1996).

- During training sessions, PTTs are normally set up in a separate operator stations along with simulation hardware and computers.

- Although the training tasks are not typically as complex for PTTs, this type of simulator helps prepare the student pilots in performing complex tasks involving motor and decision-making skills.

- The advantage of PTTs is when learning is aggregated from a desktop trainer and provides more interactivity and a realistic learning environment.

Full Flight Simulators. These systems replicate what is encountered in the operational environment ("FAA Human Factors Awareness Course," n.d.). The scenarios in a full flight simulator typically reflect the training conducted in a realistic setting. When students are given the ability to perform tasks in the most possible realistic situations, it reduces the chances of accidents occurring due to ***unsafe acts*** and ***human error***. Although full flight simulators are more costly and less accessible than PTTs or VRs, they serve the advantage of giving students the ability to perform practice scenarios in a realistic environment. Another advantage of full flight simulators are that they provide a much safer method for practicing flying procedures in abnormal or emergency conditions as compared to using actual equipment ("FAA Human Factors Awareness Course," n.d.). Full flight simulations are best practiced in, but not limited to, the following situations:

- Flight procedures in bad weather

- Night flying
- Performing emergency landing procedures
- Flying in abnormal conditions
- Performing takeoff procedures

Method

Methodology

Hypothesis Formulation. There is a strong relationship between the level of simulation fidelity offered in aviation training and transfer of learning to the operational environment.

***Problem Identification*.** A quantitative research study was conducted to determine whether a relationship exists between the fidelity level in simulators and learning transfer for novice pilots (Noble, 2002). The primary research question to be examined, "what is the effectiveness of learning transfer of simulation device to actual aircraft and how is it determined"?

Two groups were compared and examined to determine whether novice pilots would demonstrate a higher level of proficiency during flight training if low-fidelity simulators were used before. To examine this, more than one experimental group was used to test the number of hours spent training in low fidelity simulators prior to flying the aircraft.

The sample size consisted of 65 novice pilots who have received their aviation training through an aviation-related 101 course (Noble, 2002). A private jet was used in this study, called the Piper Cherokee PA-28-140B. A low-cost simulator called the Link ground-based general-aviation training (GAT)-1 was used as a simulation device for these three experimental groups. There was unequal amount of students used in the control group.

- Experimental #1: three hours spent with GAT-1 simulator prior to flight training.
- Experimental #2: seven hours spent with GAT-1 simulator prior to flight training.
- Experimental #3: eleven hours spent with GAT-1 simulator prior to flight training.

Although the control group did not receive training in the GAT–1 device, both groups received flight training in the aircraft.

Interpretation of Findings. In terms of measure performance, participants in flight training were evaluated by instructors who verified their readiness to fly the aircraft. The performance evaluation instrument used on participants was called the Illinois Private Pilot Performance Scale, which consisted of incremental 10-hour flight evaluations in the aircraft. In addition, both primary and secondary flight instructors were used (Noble, 2002). The observer-to-observer reliability was at r=.80 (Noble, 2002).

Training Effectiveness Measure. The total time spent training for each device was the determining factor of transfer effectiveness.

The scores of each maneuver were pooled by instructors. As demonstrated in the study, the "passing scores were tallied by the maximum amount of deviation made from the predefined parameters for each of the 10 maneuvers" (Noble, 2002, p. 5).

An analysis variance (ANOVA) was used to determine the number of flight time hours which successful students for both treatment groups (no training and training) accumulated to pass their terminal check-rides. The study findings showed that the average flight times in order to pass terminal flight checks between both groups differed by a probability of (p =.0014) (Noble, 2002). Therefore, results showed that the difference between the mean times calculated for participants (pilots) of both groups to reach performance criterion for transfer to the Piper Cherokee aircraft was *not* statistically significant.

The table below demonstrates the following flight training completion rate results as cited in Noble (2002).

Table 1 – Experimental Group Pass Rates

Flight Training Completion Rates – Experimental Group (65 total participants for both groups)	
Experimental #1: 3 hours in GAT-1 – 14 participants	Pass rate was 93% (13 out of 14 passed flight checks)
Experimental #2: 7 hours in GAT-1 – 14 participants	Pass rate was 64% (9 out of 14 passed flight checks)
Experimental #3: 11 hours in GAT-1 – 17 participants	Pass rate was 59% (10 out of 17 passed flight checks)

Table 2 – Control Group Pass Rates

Flight Training Completion Rates – Control Group (65 total participants for both groups)	
Control Group (no SIM training) - 20 participants	Pass rate was 70% (14 out of 20 passed flight checks)

Study Findings. The findings also presented the number of flight hours needed in order to pass the final flight checks. Based on these findings, it showed on average that more hours were needed for participants who did not receive training using the GAT-1 (the control group). However, it also showed that the least amount of flight hours was needed for Experimental Group #3, which contradicts the pass rate of participants who spent 11 hours with the GAT-1 simulator.

The tables below demonstrate the following average flight hours needed to pass as cited in Noble (2002):

Table 3 – Experimental Group

Average Flight Hours Needed To Pass – Experimental Group GAT-1	
Experimental #1: 3 hours in GAT-1	Hours: 40.26
Experimental #2: 7 hours in GAT-1	Hours: 38.62
Experimental #3: 11 hours in GAT-1	Hours: 37.93

Table 4 – Control Group

Average Flight Hours Needed To Pass – Control Group No Training	
Control Group: No SIM training	Hours: 45.42

Lastly, the findings studied the number of flight hours that are needed to reach proficiency criterion. Proficiency criterion is based on the total number of hours spent with the GAT-1 and Piper Cherokee aircraft. The findings showed that the more hours spent in a GAT-1 results in less number of flight hours to reach proficiency.

The tables below demonstrate the following average flight hours needed to reach proficiency criterion as cited in Noble (2002).

Table 5 – Experimental Group

Average Flight Hours Needed To Reach Proficiency Criterion Experimental Group GAT-1	
Experimental #1: 3 hours	Hours: 39.90
Experimental #2: 7 hours	Hours: 38.27
Experimental #3: 11 hours	Hours: 37.30

Table 6 – Control Group

Average Flight Hours Needed To Pass – Control Group No Training	
Control Group: No SIM training	Hours: 44.49

Based on the ***interpretation of findings***, the fact that unequal numbers were applied in the experimental group might have flawed the percentage of students who did not pass the flight checks. For example, if 20 students were equally distributed for each experimental group, then the pass rate might have been higher for the 11-hour group.

Summary

The use of simulators was shown to provide more measures of importance for pilots than for novice ones. Therefore, the study may confirm that the learning stage of each participant is more important in examining the relationships (Noble, 2002). Based on the analysis and research studies, learner progression plays a major role in determining the training effectiveness of simulation systems in terms of fidelity and uses. It is important to acknowledge that as one's skill level improves or proficiency level increases, the low fidelity training devices becomes less effective (Noble, 2002). Therefore, the level of simulator fidelity should accommodate the learning stage of the pilot. Also, it needs to be examined further in how critical the tasks are to the job, difficulty level of each training task, and the level of interactivity involved. To determine which type of simulator to use along with fidelity levels, it involves performing a job and task analysis by instructional designers and subject matter experts (SMEs). Also, it is important to determine the funds available to produce higher fidelity simulators versus training efficiency since accessibility and cost-benefits of this equipment may be limited.

Question #3

Statement of the Question

The September 11, 2001 attacks have changed the ways in how Americans conduct their daily lives. As a result of the devastating events, the Transportation Security Administration (TSA) was established into law by The Aviation and Transportation Security Act (ATSA) in order to tighten security measures at U.S. airports. Although TSA has taken tremendous steps to heighten security at U.S. airports, this comes without criticism and controversy by members of the public and various civil liberty groups. Due to the installation of high-tech scanners and x-ray machines at checkpoint areas, some issues have come into play regarding implementing these technologies in terms of cost effectiveness, passenger safety, and health effects. Although the number of terrorist attacks contributes to about 8% of aircraft fatalities, the security measures taken to reduce this number are high in terms of budgeting and technology usage (Hasisi & Orgad, 2010).

This examination question addresses the challenges of TSA screeners and airports in terms of providing a cost-benefit analysis of body scanners along with addressing the actions taken to enhance security of both passenger and all-cargo carriers. Body scanners are defined as "a means by which to examine an individual using either x-ray or radio waves, which provides security personnel images of the individual under their clothing and checks for potential weapons / other threats" (Goodwin, 2010, p. 1).

This question will also compare the benefits and drawbacks of profiling versus screening using advanced imaging technologies (AIT). The roles and responsibilities of security officers will also be examined for airports which conduct two different types of screening procedures –

1) profiling only *versus* random screening and 2) profiling only with the use of scanning technologies.

Research and Analysis of the Question

The term airport security "involves the process of protecting public transport by aircraft, as well as the terminals from which passengers of these aircraft arrive and depart" (Goodwin, 2010, p. 1). Although the acts of 9/11 resulted in implementation of TSA, the deployment of body scanners derived from the bombing attempt made on Christmas Day in 2009. This event occurred on Northwest Flight 253 by al-Qaeda terrorist Umar Farouk Abdulmutallab, otherwise known as the "Underwear Bomber". In fact, the TSA hopes to have obtained over 1,800 body scanners at U.S. airports by 2014 (Mueller & Stewart, 2011). As of July 2010, the number of airports operating with body scanners was at 142 (Auerbach, 2010).

Background on TSA. The ***review aspect*** of this question examines the roles, responsibilities, and common TSA procedures. *S*ince the 9/11 events occurred, some strategies by TSA have been implemented in order to increase on all-cargo aircraft and cargo passenger aircraft are below:

- The initiation of Air Cargo Advance Screening (ACAS) pilot by the Department of Homeland Security (DHS).The intent of this strategy is to detect high-risk cargo for additional screening *prior* to departure from foreign airports to the US (Government Accountability Office, 2012b);
- More detailed screening measure procedures on high-risk shipments;
- Enhanced security procedures for all cargo carriers;

- Air Cargo Security Working Group, established by The Secretary of Homeland Security. The intent of this group is to recommend actions (or standards) pertaining to cargo screening technology (Government Accountability Office, 2012b).

The ***global multimodal transportation system aspect*** addresses the challenges and procedures involved with screening cargo and passengers at airports. The screening procedures at major U.S. airports were enacted by the 9/11 Commission Act and involves various screening technology methods such as x-ray systems, explosive detection systems (EDS), explosive trace detection (ETD), explosives detection canine teams, physical search and manifest verification. Manifest verification involves the scanning of documents such as the identity of the cargo shipper and information on the contents contained in passengers' luggage (Government Accountability Office, 2012b).

The role of TSA for both domestic and foreign air carrier operations is screening passengers at checkpoint areas. TSA is also responsible for screening cargo shipped within, to, and from the United States. Goods may be secured on passenger or cargo (commercial) aircraft and are screened daily by TSA workers. In addition, this federal agency is responsible for establishing security requirements which administer both domestic and foreign passenger air carriers that transport cargo and oversee implementation of cargo security requirements by air carriers (Government Accountability Office, 2012b). This is done through compliance inspections conducted by TSA security inspectors.

Controversies / Challenges with Scanning Technologies. The implementation of scanning technologies at airports has resulted in numerous challenges and controversies relating to the efficiency and safety of the air transportation system overall. For example, in terms of cost, the amount of dollars invested in deploying advanced imaging technology (AIT) was over

$795 million as of October 2009 (Government Accountability Office, 2009); however, these technologies have the potential to "add up to $2.4 billion over its expected service life" (Government Accountability Office, 2010, p.1). It also has been reported that the new technologies implemented in screening passengers at checkpoint areas was not being fully tested in the operational environment, such as the explosives trace portal (ETP) and AIT (Government Accountability Office, 2009).

SPOT Program. Prior to boarding, the TSA provides a screening procedure called the Screening of Passengers by Observation Techniques (SPOT) (Government Accountability Office, 2011). The emphasis of the SPOT program is to identify individuals posing as a security threat to aviation and the behaviors and characteristics of that individual who appear to be suspicious (Government Accountability Office, 2012a). These members are also known as Behavior Detection Officers (BDOs). The role of the BDO is to engage passengers who are being screened into a casual conservation to determine any suspicious behaviors. This "conservation" will occur upon receipt and verification of travelers' documents. In addition, if the BDO questions any abnormal behavior, then that officer will refer the passenger to a second BDO for a more thorough interview (Government Accountability Office, 2012a).

As of September 2011, there were approximately 446 TSA-regulated U.S. airports and 3,000 BDOs were in 160 of those airports (Government Accountability Office, 2012a). The DHS defines high-risk passengers as "travelers who knowingly and intentionally try to defeat the security process, including those carrying serious prohibited items, such as weapons; illegal items, such as drugs; or fraudulent documents, or those who were ultimately arrested by law enforcement" (Government Accountability Office, 2012a, p. 7).

Cost-Benefit Analysis and SPOT. Based on the ***research study*** conducted in Government Accountability Office (2012a), no cost-benefit analysis was conducted prior to beginning of the SPOT program. A cost-benefit analysis is used to "assess the extent to which a strategy reduces or mitigates the risk of terrorist attacks" (Government Accountability Office, 2012a, p. 9). This analysis includes comparing the SPOT program with other security screening programs (e.g., random screening and/or other current measures in place) and can determine future growth in the program. Based on the study results the program's budget increased from $198 in fiscal year 2009 to $227 million in fiscal 2013 (Government Accountability Office, 2012a). According to the risk-assessment reports contained in Government Accountability Office (2012a), the full-body scanners were shown to not fully being utilized at some airports, although they are available. As of March 2012, the number of scanners totaled to be 640 to 165 TSA-regulated airports (Government Accountability Office, 2012a). Some were not regularly used or being used at all; therefore, the actual cost-effectiveness of these machines was in question.

Based on data collected within the dates of March 2010 to February 2011, AIT technologies being used were stated to be occupied for less than 5% of the days of availability (Government Accountability Office, 2012a). A study was conducted on 12 U.S. airports. Based on the ***research findings***, one airport terminal consumed about 230 passengers per day; yet two of those three AIT units were not being used regularly (Government Accountability Office, 2012a). The cost-benefit factor plays a major role given the approximate cost of *each* AIT unit including installation and maintenance is $250,000 (Government Accountability Office, 2012a). Another factor with cost-effectiveness is that five full-time TSA personnel are budgeted for each AIT provided, regardless of its use.

Research Example on Passenger Safety. The ***human behavior*** and ***attitudes aspect*** addresses that passenger safety may be affected if suspicious behavior goes undetected prior to passenger boarding, which in turn may result in incidents due to human factor errors. A prior study was conducted by the Government Accountability Office (GAO) examining whether the SPOT program is more effective than random screening in terms of validity and reliability; that is, whether the program is more effective at identifying security threats and the behaviors associated with high-risk travelers. One of the key issues taken from the GAO study was the SPOT program was implemented nationwide by TSA *prior to* it being tested for its scientific validity (Government Accountability Office, 2012a). The testing of validity includes using behavior and appearance indicators as a means for identifying passengers posing as a high-risk to the U.S. aviation system.

Although the study results determined that SPOT was more effective than random screening, the findings were based on different degree levels:

- SPOT was not used to reliably identify individuals.
- Bias in the study. The individuals screened were already aware of the process and knew the program indicators (e.g.., characteristics of high-risk passengers).
- The number of passengers who were referred to additional screening by the SPOT program in fiscal year 2010 was 50,000; however, a total of 3,600 SPOT referrals were made to law enforcement officers in (Government Accountability Office, 2012a).
- The number of arrests resulting from SPOT referrals was about 300 (Government Accountability Office, 2012a).

- Out of the 300 arrests made in 2010, 27% were illegal aliens, 17% drug related, and 14% fraudulent documents, 12% outstanding warrants, and 30% other offenses (Government Accountability Office, 2012a).
- Six of those 300 were stated to be planned terrorist plots (Government Accountability Office, 2012a).

More resources are needed along with a refined list to conduct a *full* validation of SPOT. An example would be a list of the program's behaviors and appearances along with a scoring system (Government Accountability Office, 2012a). However, BDOs are being further tested at Boston-Logan and Detroit International Airport.

The challenge of TSA is the ability to provide performance measures based on outputs. Although TSA provided the number of SPOT referrals to law enforcement along with the number of arrests made as a result; no information was provided as to the number of individuals possibly posing as a threat to air transportation system (Government Accountability Office, 2012a).

Cargo Transportation. The ***political aspect*** addresses some of TSA regulated programs for cargo air transportation along with its impact on budgeting**.** First, the Transportation Sector Network Management (TSNM) Air Cargo Division is "responsible for developing air cargo regulations, establishing program regulations for the development of technological solutions, and policies that enhance the security of the air cargo supply chain while maintaining TSA's commitment to ensure the flow of commerce" (Government Accountability Office, 2012b, p. 11). The implementation of TSA-regulated program has resulted in the following budgets:

- In fiscal year 2011, the budget was approximately $115 million (Government Accountability Office, 2012b).
- To further break down the budget, $26 million was domestic inbound air cargo security efforts; $74 million to air cargo inspectors and proprietary canines, and $15 million to National Explosives Detection Canine Team Program (Government Accountability Office, 2012b).
- In fiscal year 2012, the budget amount was increased to $124 million (Government Accountability Office, 2012b).

Also, the ***political aspect*** addresses several controversies of body scanning as a violation to passengers. For instance, the acts of profiling and monitoring have come under scrutiny from the ACLU (American Civil Liberties Union), an organization which focuses on individual civil rights of Americans (Goodwin, 2010). Another issue is that extensive searches are being conducted randomly; also classified as a violation by the ACLU. As for the body scanners, this violation is a growing concern for many American citizens, especially since images are taken, accessible by screeners, and stored, although TSA claims that these images are not stored permanently.

In terms of privacy, body scanners are shown to provide detailed images of body images, including private areas. This process begins once passengers step into the scanner and "the TSA member assisting them sends a signal via radio to another TSA member, who is in a separate location behind a wall" (DiLascio, 2010, p. 7). The main question of privacy is who is actually viewing the scanners and images.

As stated in Government Accountability Office (2009), there are two efforts in screening with the use of additional scanning technologies (TSA).

- The Standoff Detection is "intended to display images to detect anomalies concealed under passengers' clothing" (Government Accountability Office, 2009, p. 37). In other words, body scanners are able to detect beneath the clothes for any weapons and other suspicious items otherwise not detectable from a metal detector (DiLascio, 2010).
- TSA plans to conduct an operational utility evaluation of test article units during fiscal year 2009 to evaluate the technology's feasibility within checkpoint screening operations.

Examples of Terrorist Attempts Resulting in Scanning Technologies. Below are stories relating to attempted terrorist acts in which additional screening regulations have resulted:

- In December 21, 2001, a British citizen attempts to ignite shoe bombs on an American Airlines flight from Paris to Miami. This event resulted in passengers being required to take off their shoes and prohibit carry-on fluids.
- In 1999, Ahmed Ressam was caught at the US-Canadian border in the state of Washington with a carload of explosives using a false passport (Auerbach, 2010). The intent was using explosives at Los Angeles International (LAX) airport.
- The September 11, 2001 terrorist acts resulted in implementation of the TSA passed by the Bush Administration in late 2001.
- In 2009, Umar Farouk Abdulmutallab (also known as the "Underwear Bomber") attempted to ignite a bomb hidden in his underwear during a Christmas Day flight from Amsterdam to Detroit. The substance that was in Umar's possession consisted of explosive powder. This near-tragic event again brought up the issue of applying

body scanning technologies, although scanners were being introduced in some airport terminals.

Studies have also shown that “DHS has publicly mischaracterized the findings of the National Institute of Standards and Technology (NIST), stating that NIST ‘affirmed the safety’ of full body scanners (Mercola, 2012, para. 9). Also, NIST has stated that the Institute did not test full body scanners in terms of safety and does not produce testing (Mercola, 2012).

In regards to efficiency of airport and airline operations, TSA-regulated scanning technologies have resulted in more delays at check-points areas, subjecting millions of non-threatening individuals to body scans (DiLascio, 2010). Since body scanners are not standardized for each passenger, they operate more slowly during the detection process; therefore, resulting in passenger delays at checkpoint areas. The process involved with scanning passengers is stated below (DiLascio, 2010):

- The traveler is set in an upright position;
- Images are read by security personnel;
- Results are communicated back to security checkpoint personnel;
- Although TSA members have stated otherwise, “the scanning process will take 45 seconds for each passenger, which would create between two- and five-hour flight delays” (DiLascio, 2010, p. 9).

Although passengers have the option to request pat-downs in lieu of scanners; it is shown that “98 percent of passengers prefer scanners to pat-downs” (Gulli, Henheffer, Mendleson, & MacDonald, 2010, p. 16).

The ***environmental aspect*** addresses the possible health hazards associated with body scanners. Studies have shown that cancer clusters have been identified which are apparently linked to radiation exposure in x-ray machines and body scanners (Mercola, 2012). Another concern is that the Department of Homeland Security (DHS) has failed to issue TSA workers dosimeters, which are safety devices that provide warning of radiation exposure (Mercola, 2012). Although the intent of x-ray machines is to emit only a narrow beam of high-intensity radiation, an overexposure of radiation may result if the machine were to malfunction (Mercola, 2012).

Research has also shown that the safety of backscatter x-ray machines has not been scientifically tested. In addition there are scientists who believe the high quality images produced are not unlikely used with the low levels of radiation as described. In fact, it has been stated by scientists that the actual level may be 45 times higher than what the machine manufacture is claiming (Mercola, 2012). Therefore, it is not entirely clear how much cell damage occurs as a result of low-dose radiation.

Challenges with TSA and Cargo. The ***social and technological aspects*** address the challenges that TSA-regulated technology screening places on cargo goods. First, TSA has regulated that cargo previously exempted from being screened is now required to be checked; this includes air cargo departing from foreign entities at the last point of departure. As a result, the concern is that a 100% cargo check will cause "disruptions" in the air cargo supply chain process. Six out of 19 foreign air carriers have opposed this due to insufficient time and disruption of the ***air transportation*** operations (Government Accountability Office, 2012b).

In the ***social aspect***, another challenge with TSA is that all pallets and containers will be screened; these are the primary means of transporting air cargo on inbound and domestic aircraft (Government Accountability Office, 2012b). The reason for the inefficiencies is that major disruptions results from having to unload screened cargo from unit load devices (ULDs), rescreen it, and then reload it (Government Accountability Office, 2012b). In addition, this results in increased risk to damage with the cargo itself. With inbound passenger cargo, the required levels of screening are not 100% verified. This is due to lack of having certain processes in order to conduct additional data verification.

Although TSA has recognized two countries as providing a commensurate level of security standards as the United States, the challenge is continuing to get the same level of standards for other countries. As a result, the screening percentage for air carriers is approximately 80% (Government Accountability Office, 2012b). Although most inbound cargo is shipped into the US by all-cargo carriers, there is no set requirement for them to report data comparable to passenger air carrier screening data. Inbound air cargo are types of cargo transported to the US from foreign locations. In 2010, the number of pounds transported for inbound air cargo and to the US from foreign entities was approximately 7.2 billion and 3.6 billion pounds, respectively (Government Accountability Office, 2012b).

Security Enhancement. This section addresses the benefits of implementing TSA screening procedures in terms of enhancing security measures. In late 2010, TSA implemented risk-based security measures on all-cargo and cargo passenger aircraft. These security measures include prohibiting transport of air cargo on passenger aircraft from Yemen and Somalia due to bomb threats (Government Accountability Office, 2012b). However, the pitfalls of these measures are with security. For instance, there was a case in which suspected packages were screened multiple times at different locations; however, the items in question were discovered only after officials came across them due to a tip made from Intel Source. TSA defended this by stating that detection focused mainly on the explosive already made, not necessarily the components used to construct it. Also, according to DiLascio (2010), scanners are unable to detect items of low-density such as materials resembling skin or placed internally, powders, and liquids. In terms of security screening, it is important to determine whether the sacrifice of privacy offsets a sense of safety given that scanners still leave some hazardous items undetected.

In terms of screening passengers, the ***technology aspect*** addresses that the main concern with using technology as a primary screening tool is too much emphasis may offset human judgment. For example, the "No-Fly" list should be examined further and used more properly in lieu of implementing new technologies. Therefore, it is stated that the emphasis of ensuring safety of the aircraft should be placed on recognition of suspicious behavior rather than implementing new technologies (DiLascio, 2010).

Passenger Profiling: Challenges and Benefits. One of the main challenges in profiling passengers includes the question of ethics. For example, a number of court cases have taken place, challenging that racial discrimination has occurred as a result of profiling at airports. Ben Gurion airport in Israel will be used for this study to examine the relationship with profiling passengers and the safety perception of passengers, number of incidents, and cost-benefits associated with it. When it comes to ethics, the main question is using profiling against its own citizens, as it occurs in both U.S. and foreign airports. Prior to 9/11 and TSA, when nonracial profiling factors were being used for commercial flights (e.g., age, purchasing history, payment method), passenger screening was shown to be more effective in terms of the low number of occurred hijackings. In fact, between 1968 and 1972, there were124 cases of hijackings at Ben Gurion; however, down to one in 1973 (Hasisi & Orgad, 2010). In 1973, the FAA dropped profiling and relied solely on metal detectors. By 1976, the number of hijackings went down dramatically. Therefore, it is questioned whether the dramatic drop in hijacking events was due to metal detectors along with inspecting baggage or based on profiling.

At Ben Gurion airport, the screening procedures are exclusively based on profiling passengers. It also takes well-trained security personnel to detect behaviors and characteristics deemed suspicious while holding a “causal” conservation with these passengers. Their screening process consists of early detection based on four circles of security zones: outside airport zone, inside the airport zone, in the terminal, and in the airport (Hasisi & Orgad, 2010).

- *First Zone.* Outside of airport. This involves screening of passengers before arrival to the airport. It is stated that 21% of all terrorist attacks were prevented in this zone after 1968 (Hasisi & Orgad, 2010).
- *Second Zone.* Inside of the airport. This involves screening of passengers inside the airport. It stated that 0% of all terrorist attacks were prevented in this zone after 1968 (Hasisi & Orgad, 2010).
- *Third Zone.* This involves screening passengers inside the terminal of the airport. It is stated that 61% of all terrorist attacks were prevented in this zone after 1968 (Hasisi & Orgad, 2010). In this zone, high-risk travelers are identified by three areas: 1) from the passenger list prior to their arrival, 2) The Computer-Assisted Passenger Prescreening System (CAPPS) database which is used to evaluate passengers prior to boarding plane. This database is stored to maintain information about the passengers’ background (e.g., flight history, itinerary, flight habits, payment method of ticket, etc.), 3) Special questioning. This type of questioning is about 30 seconds and asks questions such as “did you pack alone?”, “when did you pack?” and “who packed your bags?” This zone also involves a metal detector to detect any suspicious items. Especially during the third stage, the following behaviors and activities are most detected by:

  - Behaviors that are evaluated the most: lack of cooperation, nervousness, and avoidance of answering questions
  - Documents do not match person (i.e., ID, passport)
  - Payment method
  - Traveling history
  - Country of Origin
- *Fourth Zone.* Detection in the aircraft. It is stated that 11% of all terrorist attacks were prevented in this zone after 1968 (Hasisi & Orgad, 2010).

Since 1968, the number of airplanes hijacked is zero (Hasisi & Orgad, 2010). However, this number does not factor in the percentage of terrorist acts in airports or sabotage.

Technology and Social Aspects. There is much less technology involved with profiling passengers. For instance, the questions and analysis of passengers start as trained officials try to detect danger in physical signs and other suspicious clues (Gulli, 2010). In addition, travelers are assessed as they enter the terminal, and then greeted by interrogators in a polite manner. The following measures are taken for suspicious travelers (Guillo, 2010):

- Travelers are directed to an electronic booth in which additional questions are asked such as, "what is your mother's maiden name?" or "How many years ago did you graduate from high school?"
- In the meantime, the computer reads the person's body temperature along with eye movement to watch for indicators.
- Bags considered as suspicious or 'in question" are placed inside a "bomb box" and fled away by explosives squads.

- Although travelers go through metal detectors, the key is observing them prior to walking through the metal detectors (i.e., reaction).

For the ***political aspect***, there are civil rights activists that claim that additional attention on certain travelers' amounts to racial profiling although it has been stated that members of law enforcement should place increased vigilance on passengers who exhibit signs of dangerous intent (Auerbach, 2010). However, regardless of the views of privacy advocates, it is stated that 78 percent of Americans favor the full body scans on passengers at U.S. airports (Gallup, U.S.A., 2010).

Method

Methodology

Problem Identification. The data gathered will be used to determine whether passenger profiling as a screening method results in increased safety enhancements, more cost-effectiveness, and satisfaction than scanning technologies.

Hypothesis Formulation. This ***hypothesis*** will accept or reject that a statistically significant relationship exists between passenger safety, cost-effectiveness, satisfaction and the type of screening method at airports. This research study also addresses the following questions:

- How do passengers perceive the profiling process conducted at airports in relation to screening technologies?
- What is the number of aviation incidents in relation to airports that conduct screening with profiling only as compared to screening technologies?

This study examines the benefits of screening by profiling at Ben Gurion airport in Israel. The factors being measured are:

- Evaluating the costs of profiling versus using screening technologies at passenger checkpoint areas
- Safety perception of passengers based on profiling as a primary screening method

Data Collection Techniques. Surveys were distributed to passengers' immediately following check-in and security screening procedure along with observations of passengers upon being profiled. A 5-point Likert Scale was used ranking statements of 5=very much and 1=not at all. Surveys were also conducted over a four week period, which is high peak time in August. A total of 614 passengers were surveyed (308 Israeli Jews and 306 Israeli Arabs). Survey questions were based on the following stated measures:

  - What are the perceptions and experiences of passengers at check-in when conducting security checks?
  - What are the passengers' experiences and immediate reactions when security checks are being conducted at Ben Gurion airport?
  - What are the passengers' perceptions of Israel security procedures overall?

Review. Based on the data gathered, the total percentage of passengers traveling was 50% of Arab descent, who went through additional security checks, whereas it was only 10% of Jews that did. These findings may indicate that Arabs and Jews received 1) different treatment during security checks and/or 2) one group views privacy differently than another.

Statistical Analysis. The statistical analysis used was an analysis variance (AVOVA) with a significance level of <.001.

Review and Critique

Measure - Passenger Satisfaction. The significance level of <.001 indicates there is a "strong correlation between the passengers' satisfaction with security checks and their trust of the security procedures" (Hasisi & Orgad, 2010, p. 16). The correlation coefficient was r=.496 and r=.560, Arabs and Jews respectively (Hasisi & Orgad, 2010). However, no correlation existed between satisfaction with the security checks, trust of inspectors, and passengers' feeling of disparate treatment among Jews. The correlation coefficient was r=-.074 and r=-.066 (Hasisi & Orgad, 2010). This signified that no relationship existed between feelings of trust, disparate treatment, and security and type of screening method.

Also, the correlation coefficient was highly significant among Arab passengers. The correlation coefficient was r=-.306 and r=-.300 (Hasisi & Orgad, 2010). Therefore, a negative correlation existed between satisfaction with the security checks, trust of inspectors, and passengers' feeling of disparate treatment among Arabs.

Review and Critique

Measure - Cost -effectiveness. The costs associated with profiling were not measured in terms of budgeting in this particular study; rather the social and individual costs (Hasisi & Orgad, 2010):

- The percentage of passengers who felt a strong sense of invasiveness was based mainly on ethnicity for this study: 30% of Arabs felt their liberties were being violated based on the types of questions being asked; 13% of Jews felt the same way. In terms of humiliation/embarrassment, 19% of Arabs and only 5.5% Jews felt this way.

- Feelings of intimidation: 18% Arabs and 5% Jews felt intimidation by the screening procedures and questions.
- The trust placed upon security inspectors from passengers' results in a gap percentage of 64% for Arabs and 85% for Jews.

Interpretation of Findings. The profiling security procedures at Ben Gurion were shown to produce high benefits in terms of (Hasisi & Orgad, 2010):

- Increases in airport security
- High sense of security by passengers
- A low number of causalities
- Zero hijackings / air piracy events

Also, the ***findings*** indicated that there is a strong correlation between religion, nationality, gender, affiliation and propensity to commit air terror in Israel.

The study of Ben Gurion airport was different since unlike the United States, the extensiveness of profiling seems to lie on the type of religion and ethnicity, at least for Arabs and Jews. Based on the survey findings, below is the percentage of participant responses (out of 614) (Hasisi & Orgad, 2010):

- ***Courteous Treatment***. 75.2 % of Arabs and 87.6% of Jews reported they were treated with courtesy by the security inspectors.

- ***Fair Treatment.*** 96.1% of Jews reported that they felt the security checks were fair; however, only 62.4% Arab passengers felt this way. Based on the responses, this shows a different group of passengers perceive fair treatment differently.

- ***Justification of Security Measure:*** 81% of total passengers agree the context of treatment was justified. However, only 66% of Arabs feel this way, whereas 95% of Jews think this.

Survey questions were: “I am satisfied with the security check”, “The security inspectors treated me courteously”, and “The treatment I received during the security check was fair”. However, 23% of overall travelers responded that they felt their screening questions were different from other passengers based on their religion and ethnicity.

Summary

Although the research findings conducted at Ben Gurion airport were shown that 84% of passengers felt a sense of security at check-in (Hasisi & Orgad, 2010.), the system of profiling may be more complex in the United States due to the daily volume of passengers. Also, it is typically much easier to determine the enemy in Israel; not always in the US. On the other hand, Israel is one of the main targets for terrorism and has received zero plane hijackings since 1968, regardless of multiple attempts made (Hasisi & Orgad, 2010). Therefore, profiling is shown to produce a high benefit rates in terms of occurrences.

Additional factors should be studied when examining both types of screening methods: scanning technologies and profiling. The study of profiling at airports should also focus on the efficiency of operations and a cost-benefit analysis should be conducted. Also, the examination and comparison of both screening methods should place emphasis on all types of travelers, especially foreign travelers.

In relation to the overall TSA program, there needs to be additional research conducted that tracks the progression of benefits, such as researching areas where each of their programs is working well or poorly. This includes conducting a cost-benefit analysis along with performing scientific testing of body scanners and backscatter x-ray machines in terms of safety and effectiveness. Another shift that could be made at U.S. airports is to revamp / improve the SPOT program. This may in turn reduce the number of technologies needed to screen passengers. Although there are many controversies surrounding the use of profiling and technologies to screen passengers, studies did show an average of "24 percent error rate in weapons detection by baggage screening" (Hasisi & Orgad, 2010, p. 3). Therefore, the use of technologies alone may not always work. Several methods of screening will need to be scientifically tested prior to implementation.

Question #4

Statement of the Question

The percentage of aviation-related accidents attributed to human error is 70 to 80 percent (Shappell & Wiegmann, 2000). The concept of human factors largely contribute to the number of maintenance errors in terms of how these errors are actually detected, their classification types, and the consequences of not recognizing them ahead of time. This study focuses on the principles and elements of human factors applicable to aviation maintenance technicians (AMTs), along with how each factor plays a role in preventing aviation-related accidents.

The importance of human factors for AMTs should be stressed since some maintenance errors may not be recognized right away; therefore, these issues affect the safety of aircraft operations for longer periods of time (“Human Factors,” n.d.). Each field type along with its importance to human factors for AMTs is addressed in this examination question. A research study on maintenance errors contributing to commercial aircraft accidents/incidents will be examined in terms of a human factors principle, coordination. This examination question also focuses on the types of behavioral problems of workers and how they seriously impact safety procedures and communication effectiveness.

Research and Analysis of the Question

The concept of ***human factors*** is not only contributed from one type of discipline; it is multidisciplinary. The different elements of human factors include psychology (clinical, experimental, organizational, and educational), engineering, computer science, cognitive science, industrial design/safety engineering, statistics, industrial engineering, medical science, and anthropometrics (“Human Factors,” n.d.).

Human Factor Fields. The first field of human factors is addressed in terms of ***human behavior*** for both individual and groups along with associated psychological concepts**.** The field of psychology includes two disciplines which are clinical, experimental, and organizational. Clinical psychology focuses on the well-being and personnel development of the worker; whereas experimental psychology focuses mainly on behavioral and physiological processes ("Human Factors," n.d.). In experimental situations, behavioral processes consist of learning, perception, human performance, memory, language, communication, and motivation ("Human Factors," n.d.). Physiological processes include the ability for the worker to apply problem-solving skills to their job. Another important factor of identifying appropriate behavioral processes to the workplace is the ability to measure technician workers in terms of their "performance, productivity, and deficiencies" ("Human Factors," n.d., p. 14-3). Organizational psychology involves examining the relation between work and people (AMT). This psychological concept analyzes factors such as 1) which type(s) of incentives tend to motivate workers, therefore increasing their productivity levels?" or "what is the organizational structure of the business?" In addition, organizational psychology is concerned with two measures which are considered as work environment enhancements and productivity of the AMT worker.

The ***human limitations*** aspect is addressed in terms of anthropometry. Anthropometrics is another element of human factors which involves studying the dimensions of the human body along with its abilities ("Human Factors," n.d.). Since physical work space is a human factors consideration, it would be practical to address that a 5 foot 3 inch female AMT (or a worker who is shorter in height) could perform more efficiently than a male who is 6 feet 5 inches, for example. This example demonstrates why the tools and equipment involved in aircraft maintenance is not a one-size-fits-all; therefore, employing a diverse group of people does not necessarily mean applying the term “average person” when it comes to determining human body dimensions (“Human Factors,” n.d.).

The ***human errors aspect*** focuses on several human factors disciplines which largely contribute to aviation accidents or incidents. First, the discipline of computer science involves the ease of use by AMTs when it comes to computer-based testing equipment. As it pertains to human factors, computer science is technically defined as “the study of the theoretical foundations of information and computation and of practical techniques for their implementation and application in computer systems” (“Human Factors,” n.d., p. 14-4). If computer systems are unreliable and/or too complex to use, then the likelihood of maintenance errors increases.

Another human factors discipline that addresses the ***errors*** and ***attitudes aspect*** is cognitive science. Cognitive science involves the ability to apply decision-making processes which vary from low to high cognitive levels; therefore, may result in higher stress levels of AMTs. Recognizing the types of situations which create high levels of stress may improve the efficiency and productivity of AMT workers.

The ***unsafe acts aspect*** is addressed through safety engineering and medical science human factors disciplines. First, the safety engineering discipline addresses the importance of providing a safe and nonhazardous environment for crew workers. A few examples of safety engineering is the design of aviation maintenance facilities, heavy lifting of equipment, providing storage containers for toxic materials, and designing of floors to avoidance slipping (“Human Factors,” n.d.). In order to reduce the number of ***unsafe acts*** in the workplace, medical science involves ensuring that workers receive the proper medical treatment they need in order to perform their job effectively.

The "Swiss Cheese" Model of Human Factors Awareness. A major component of human factors awareness is known as the "Swiss Cheese" model of human causation which identifies the causes of aviation accidents (Shappell & Wiegmann, 2000). Examination of these failures also directly relates to all aspects of human factors which are ***unsafe acts, attitudes, errors, human behavior,*** and ***human limitations***. The "Swiss Cheese" model was implemented by James Reason and also provides a four levels of human failure in which one level of failure may influence the next. The four levels of human failure addressed in this examination are unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences (Shappell & Wiegmann, 2000).

Four Levels of Human Failure

- *Unsafe Acts (First Level)*. This level involves the actions or inactions of operators with the aircraft and can be determined as causal factors during an accident investigation. Unsafe acts can be one event or a series of events leading to the accident (Shappell & Wiegmann, 2000).
- *Preconditions for Unsafe Acts (Second Level).* This level involves the action of aircrew as it affects performance. A major issue which typically results in ineffective decision making and ***human error*** is poor communication among the crew. A ***human factors*** consideration important to the safety and productivity of AMTs is the practicing of communication and coordination among aircrew inside and outside of the aircraft. This term is commonly known as crew resource management (CRM) (Shappell & Wiegmann, 2000).
- *Unsafe Supervision (Third Level).* An example of unsafe supervision may be the lack of proper supervision for aircrew personnel. One instance of unsafe

supervision would be placing two pilots who have less experience flying at night or even in adverse weather which results in ***human limitations*** (Shappell & Wiegmann, 2000)**.** This example would likely result in aviation accidents (or unsafe acts) to occur.

- *Organizational Influences (Fourth Level).* The organization itself could be examined in terms on how training is conducted, skill level of the workforce (i.e., proficiency level of aviation maintenance technicians), handling of budget cuts (i.e., employees poor workers and amount of training provided), and whether that organization's workers conduct poor or excellent communication skills. These organizational factors may service as preconditions on how performance is conducted and may determine the level of errors made.

Human Factors Analysis and Classification System (HFACS). Although the four levels of human failures should be recognized as a part of human factors awareness training, it is important that these levels are explained in further detail in order to identify the causes of aviation accidents. Although this particular description pertains mainly to the operator (pilot), an issue that likely occurs with maintainers is performing tasks beyond their capabilities. Also, the time frame in performing a maintenance inspections may be less than what the maintainer can do effectively and thoroughly; therefore, resulting in more errors.

Unsafe Acts – Level One Failure. The Human Factors Analysis and Classification System (HFACS) analyze each level of failure based on category type. First, the level of Unsafe Acts consists of two categories which are errors and violations (Shappell & Wiegmann, 2000). The first category of unsafe acts is ***errors*** which consist of three subdivisions: skill, perceptual, and decision. Skill-based errors occur when inexperienced technicians are hired to perform complex tasks, when AMTs are assigned to work on too many complex tasks within a short timeframe, lack of task prioritization, inattentiveness to task requiring concentration, and improper use of equipment. Examples of perceptual errors are misjudgment in handling aircraft parts during troubleshooting, misinterpretation of situations when performing a detailed inspection, leaving a fuel cap unsecure upon completing an oil change, constant distraction during task performance, and failure to properly follow all the checklist points when performing an inspection. Decision errors occur in situations such as when excessive time is spent on one task and wrong decisions are made when abnormal situations come up.

The second category of ***unsafe acts*** is violations. Violations are defined as "the willful disregard for the rules and regulations that govern the safety of flight" (Shappell & Wiegmann, 2000, p. 3). Some examples of acts of violation include AMT workers failing to follow safety orders/procedures on assigned tasks, skipping / taking shortcuts on mandatory inspections, improper use of aircraft equipment, and leaving hazardous equipment and parts unsecured and unattended.

Preconditions for Unsafe Acts – Level Two Failure. The second level of human failure is Preconditions for Unsafe Acts which include two subdivisions. These subdivisions are known as substandard conditions of operators and substandard practices of operators. The first category of substandard conditions of operators is known as adverse mental states, which address the mental conditions affecting aviation performance (Shappell & Wiegmann, 2000). Another example of adverse mental states is complacency, defined as self-satisfaction or contentment following unawareness of danger or trouble ("The Free Dictionary", n.d.).

For example, if an AMT failed to perform a very thorough inspection due to aircraft engine problems and chose to take constant shortcuts instead, simply because they have been content with performing those types of inspections, then complacency occurs. The lack of situational awareness (not completely aware of surroundings) is another factor. The second category under substandard conditions of operators is called adverse physiological states. This category is described as mental and physiological conditions that affect aviation performance, such as visual illusions and spatial disorientation (Shappell & Wiegmann, 2000). Although visual illusion and spatial disorientation pertains mainly to the pilot/operator, adverse physiological states apply to AMTs in terms of fatigue. First, fatigue may occur as a result of physical weariness, emotional exhaustion, skill degradation, working without adequate rest, and lack of sleep (Australian Transport Safety Bureau, 2008). In fact, research has shown that "after 18 hours of being awake, mental and physical performance on many tasks is affected as though the person had a blood alcohol concentration of 0.05 percent" (Hobbs, 2008, p. 30). Fatigue is a major reason why scheduling of shifts should be carefully planned out by supervisors; otherwise, more errors may result. The third category of Level 2 failures is physical/mental limitations which typically occur when "mission requirements exceed the capabilities of the individual at the controls" (Shappell & Wiegmann, 2000, p. 12). Physical limitation is also known as human variance which stresses the different forms of measurement, anthropometrics, and performance ("FAA Human Factors Awareness Course," n.d.). For example in a maintenance environment, it may be more of a challenge for an AMT to perform tasks requiring an 'arm reach limit' for a female who is 5 feet tall versus a male of average height. Mental limitations are described as the time and/or complexity involved with completing a task; therefore, the time it takes to complete a task may be shorter than the worker's ability to efficiently complete it. Also, workers may have difficult time processing information that is given to them, resulting in more mistakes made on the job.

The second subdivision is substandard practices of operators. This level focuses on crew resource mismanagement and personal readiness. The term CRM has been known from the last few decades and refers to poor coordination among personnel (Shappell & Wiegmann, 2000). Coordination among aircrew personnel does not apply *only* within the aircraft; it also refers to personnel outside the aircraft, such as air traffic controllers (ATC) and maintenance technicians (Shappell & Wiegmann, 2000). Personal readiness is not necessarily an unsafe act; however, good use of judgment is expected prior to shift work, such as getting a sufficient amount of sleep and a healthy meal (Shappell & Wiegmann, 2000).

The third level of failure is Unsafe Supervision which consists the following four categories: inadequate supervision, planned inappropriate operations, failure to correct a known problem, and supervisory violations (Shappell & Wiegmann, 2000). Although the Human Factors Analysis and Classification System (HFACS) associate this factor primarily with pilots/ operators of aircraft, it is important that AMTs are provided with sufficient training and guidance in order to perform their tasks efficiently. A good example of unsafe supervision is the lack of Human Factors Awareness Training, including CRM. If AMTs/ other crew members are not provided with the sufficient training they need to perform their jobs successfully, then the risk of ***error*** will increase. The first category of unsafe supervision is inadequate supervision. Examples of inadequate supervision are the supervisor's lack of providing adequate training to aircrew personnel along with lack of professional guidance from the supervisor to the worker (Shappell & Wiegmann, 2000). Planned inappropriate actions may occur when there is improper crew pairing. An example of this is when a senior level aircraft technician is paired with a less experienced in performing a more complex task. If the less experienced worker points out a potential problem during the troubleshooting process, the senior level technician may disregard that worker's concern, which may result in a tragic outcome with the aircraft. The failure to correct a known problem typically occurs when a problem situation is detected by the supervisor; yet does nothing to prevent it (Shappell & Wiegmann, 2000). If the less experienced AMT reported to the supervisor that the senior level technician disregarded his concern about the engine defect and the supervisor does nothing about it, this would be an example of failure to correct a known problem. The fourth category of unsafe supervision is supervisory violations which results from lack of enforcing rules and regulations to subordinates (Shappell & Wiegmann, 2000). An example of supervisors committing violations is the failure to acknowledge the proper certification and qualification requirement for AMTs (e.g., hiring a non-certified technician to perform maintenance on aircraft jets).

The fourth level of failure is known as Organizational Influences. Although failure resulting from factors such as organizational structure and upper management is not typically recognized, it is important to address the issues surrounding them. The categories of organizational influences are resource management, organizational climate, and operational processes (Shappell & Wiegmann, 2000).

Organizational Influences: Cost Cutting Measures. Resource management involves training (or the lack of sufficient training) due to companies taking cost-cutting measures (Shappell & Wiegmann, 2000). When workers receive an insufficient amount of training, it greatly impacts the safety levels of passengers and aircraft, since the quality of training is less. Another danger with organizations taking cost-cutting measures is the providing of less expensive equipment and tools to perform maintenance procedures; therefore, this results in lower quality of aircraft parts and equipment. Another concern with taking cost-cutting measures is that organizations typically hire lower skilled workers for less pay, which increases the chance for missed items/errors occurring during task performance.

Method

Methodology

Hypothesis Formulation. It is ***hypothesized*** is that exposure to human factors will result in higher levels of worker productivity, cognitive learning levels, and motivation.

Research Design. A qualitative research methodology was used to focus on the types of behavioral factors that contribute to human errors or outcomes through the examination of aviation maintenance accident reports. This study was applied to determine the strength and direction in which exposure to human factors awareness has on teamwork and communication.

Problem Identification. A study on the coordination and safety behaviors in commercial aviation maintenance groups was conducted using one of the human factors principles, team coordination, as a basis of detecting and correcting behavior among AMTs in the commercial aviation industry (Suzuki, Geibal, & von Thaden, & 2008). Although this study focused primarily on one human factors principle, it was shown that the ability to detect and take corrective action through effective communication improves flight operations (Suzuki et al., 2008).

The study further broke down the types of coordination groups which are 1) within the maintenance department (internal coordination) and 2) the maintenance team along with outside departments (external coordination). The two forms of coordination contributing to aviation incidents/accidents were teamwork and communication (Suzuki et al., 2008). When it comes to safety and performance, communication is considered as a critical medium for coordination and is interactive in nature (Suzuki et al., 2008). In order for communication to be effective, it needs to be extensive among workers.

Types of Coordination Problems. Based on an examination of incident reports from the NASA Aviation Safety Report, a lack of coordination among workers was considered as the third largest contributing factor in aircraft technician errors leading to aviation accidents (Suzuki et al., 2008). Based on research information, the study focuses on the types of coordination problems that mostly occur in aviation maintenance. Coordination problems consist of nine categories which are listed below (Suzuki et al., 2008):

- Failure to share information/failure to deliver information;
- Wrong information being sent;
- Listening (lack of);
- Misinterpreting messages/wrong assumption;
- Lack of responsibility;
- Lack of assertiveness;
- Communication channel (or “chain”) not established/ambiguous role;
- Emotional state of a person affects coordination;
- Conflict/disagreements

Since recognition of conflict is a major part of effective coordination among workers, this study broke down the types of conflicts occurring between maintenance and other departments including task, relationship, and procedural conflicts. They are described in more detail below (Suzuki et al., 2008):

- *Task Conflicts*. Misinterpretation of instructions with performing a maintenance task. An example is when the AMT misinterprets which problem needs troubleshooting.
- *Relationship Conflicts***.** This type of conflict occurs when there is interpersonal conflict between workers.
- *Procedural Conflicts.* This conflict occurs when problems arise due to lack of responsibility and failure to delegate tasks. Also, procedure conflicts apply when the procedures for task accomplishment are not quite clear or identified.

Combination of Qualitative Analysis and Categorical. An analysis was conducted in which 680 aviation incident reports were examined and analyzed out of 1,000 reports originally compiled (680 of them were shown to be human factors-related). Since each *type* of outcome failure and contributing factor (cause) needed to be analyzed and coded, researchers and SMEs examined the narrative section of each report (Suzuki et al., 2008). The contributing factors were analyzed according to the HFACS "Swiss Cheese" model information (see earlier section).

To determine the reliability of this study, a break-down in analysis was performed in which conflicts/disagreements and coordination problems resulting in outcome failures were classified by their types – based on the nine categories listed above.

Communication. The first four categories of coordination problems pertain to failure in communication (not delivering information, sending wrong information, not listening, and misinterpretation). Since communication plays a major role in human error, it is classified by three types which are message, reception, and system failures. Each type of communication failure addresses the coordination problem it falls under (Suzuki et al., 2008):

- Message failures by the receiver and sender fall under these types of coordination problems in which the worker experiences 1) failure to deliver information, 2) sending the wrong information,
- Reception failures occur when the receiver of information fails to listen to instructions, and/or misinterprets the information provided to them.
- System failures fall under the coordination problem of when the proper communication channels are not clear and/or established (2008), therefore resulting in poor communication across channel lines, which often occurs within and outside of the maintenance department.

Interpretation of Findings. The overall level of reliability achieved in this study was 0.4 to 0.6 based on Cohen's kappa (Suzuki et al., 2008). Since the type of coordination issues were broken down, the inter-rater reliability was stated to be 0.75 (Suzuki et al., 2008). As mentioned earlier, coordination for this particular study was broken down into two groups 1) **Inter-department**: Among the maintenance department (internally) and 2) **Intra-department**: Maintenance team along with outside departments (externally).

The ***findings*** for this study demonstrated that 115 (or 17%) of the 680 analyzed reports contained some form of coordination (Suzuki et al., 2008). (See *Types of Coordination Problems* section for a list of category types of coordination). Also, 91 out of 115 reports contained coordination errors which occurred *within* the maintenance department*,* as compared to 17 out of 115 reported issues *between* maintenance and other departments (Suzuki et al., 2008). A very low number of seven, or 1%, reported issues occurred both within and outside of maintenance groups (Suzuki et al., 2008).

In addition to identifying errors by coordination group (internal and external), the study findings also addressed the number of reported maintenance errors based on the coordination problem and type of failure. These numbers were reported within a two-year time period - from August 2004 – July 2006 (Suzuki et al., 2008).

Table 1 **Conflicts and Errors Relating to Human Factors**	
Intra-Department (between AMTs & other departments)	Inter-Department (among AMTs)
Coordination Problem #1: Not delivering information Number of errors due to: missed inspection = 4; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 6; missed/wrong logbook/document entry = 2; installing wrong parts = 7; MEL not applicable = 3; wrong damage analysis/troubleshoot = 2; aircraft/component damage = 2; other failures in procedures = 6	**Coordination Problem #1: Not delivering information** Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 1; installation of wrong parts = 0; MEL not applicable = 2; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 2

Table 1 **Conflicts and Errors Relating to Human Factors**	
Intra-Department (between AMTs & other departments)	Inter-Department (among AMTs)
Coordination Problem #2: Sending Wrong Information Number of errors due to: missed inspection = 3; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 3; installing wrong parts = 4; MEL not applicable = 3; wrong damage analysis/troubleshoot = 1; aircraft/component damage = 1; other failures in procedures = 1	**Coordination Problem #2: Sending Wrong Information** Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 0; installation of wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 2; aircraft/component damage = 0; other failures in procedures = 1
Coordination Problem #3: Listening Number of errors due to: missed inspection = 1; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 1; other failures in procedures = 2	**Coordination Problem #3: Listening** Number of errors due to: missed inspection = 1; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 1; installing wrong parts = 0; MEL not applicable = 2; wrong damage analysis/troubleshoot = 1; aircraft/component damage = 0; other failures in procedures = 1

Table 1 Conflicts and Errors Relating to Human Factors	
Intra-Department (between AMTs & other departments)	Inter-Department (among AMTs)
Coordination Problem #4: Wrong Interpretation Number of errors due to: missed inspection = 2; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 0; installing wrong parts = 1; MEL not applicable = 1; wrong damage analysis/troubleshoot = 1; aircraft/component damage = 0; other failures in procedures = 0	**Coordination Problem #4: Wrong Interpretation** Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 1; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 1; other failures in procedures = 0
Coordination Problem #5: Lack of Responsibility Number of errors due to: missed inspection = 2; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 2; installing wrong parts = 6; MEL not applicable = 1; wrong damage analysis/troubleshoot = 1; aircraft/component damage = 0; other failures in procedures = 3	**Coordination Problem #5: Lack of Responsibility** Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 1

Table 1 **Conflicts and Errors Relating to Human Factors**	
Intra-Department (between AMTs & other departments)	Inter-Department (among AMTs)
Coordination Problem #6: Lack of Assertiveness Number of errors due to: missed inspection = 2; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 1; installing wrong parts = 2; MEL not applicable = 1; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 2	**Coordination Problem #6: Lack of Assertiveness** Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 0
Coordination Problem #7: Ambiguous Role Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 0	**Coordination Problem #7: Ambiguous Role** Number of errors due to: missed inspection = 1; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 1; installing wrong parts = 1; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 1

Table 1 **Conflicts and Errors Relating to Human Factors**	
Intra-Department (between AMTs & other departments)	Inter-Department (among AMTs)
Coordination Problem #8: Emotional Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 0	**Coordination Problem #8: Emotional** Number of errors due to: missed inspection = 0; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 0; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 1
Coordination Problem #9: Conflict/Disagreement Number of errors due to: missed inspection = 1; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 2; installing wrong parts = 0; MEL not applicable = 4; wrong damage analysis/troubleshoot = 1; aircraft/component damage = 0; other failures in procedures = 1	**Coordination Problem #9: Conflict/Disagreement** Number of errors due to: missed inspection = 1; wrong procedure performed pertaining to Minimum Equipment List (MEL) = 1; missed/wrong logbook/document entry = 0; installing wrong parts = 0; MEL not applicable = 0; wrong damage analysis/troubleshoot = 0; aircraft/component damage = 0; other failures in procedures = 1

Based on the data presented in Table 1, the total number of erroneous maintenance procedures performed due to the minimum equipment list (MEL) was 14. A MEL is described as a list which provides for the operation of the aircraft, with particular equipment inoperative, and is more restrictive based on the aircraft type (“Minimum Equipment List,” n.d.).

However, six of those 14 errors were reported under the first type of coordination/conflict problem of not delivering information between maintenance and other departments (Suzuki et al., 2008).

The number of errors due to missed inspections for all groups combined totaled to be 18 (Suzuki et al., 2008). Some of the coordination problems for missed inspections by maintenance resulted from departmental conflicts (internally and externally), ambiguity (among AMTs), lack of responsibility within maintenance department, lack of assertiveness, misinterpretation of steps/instructions, and not properly listening to instructions.

Summary

The study reported there were disagreements among researchers and SMEs based on which contributing factors were best linked to particular outcome failures. As a result, coding reliability might have been affected, although a separate human factors researcher was brought in whenever these situations occurred. Another limitation is that out of the 1,000 aviation maintenance incidence reports, 320 were taken out due not being considered as human factor-related (Suzuki et al., 2008). For example, a narrative in an incident report stated that the receiver misinterpreted the instructions provided to them, when in fact the sender may have originally provided the wrong instructions to the receiver. Also, the researcher and/or SME may form an opinion on the type of human factors issue attributing to the outcome failure since the concept of human factors could be perceived differently by researchers.

Although this study mainly presented the number and types of conflicts that arose both within and outside the aviation maintenance department, future findings should place special emphasis on human factors training in the areas of communication, interpersonal relationships, and CRM. This may be done by conducting semi-annual sessions based on "what-if" role-playing scenarios (ones that apply in present day aviation), employee participation, along with mandatory testing. These training sessions should be kept up-to-date and consist of lesson materials that are easy for the workers to retain.

Question #5

Statement of the question

The ADDIE model of instructional systems development not only places emphasis on the five phases of curriculum design; also on the importance on availability of resources prior to implementation of training courses and instructional products. As mentioned earlier in this paper, the ADDIE model represents all the phases to instructional/training design which are analysis, design, development, implementation, and evaluation. The training of military personnel directly impacts performance in the operational environment (OE); therefore, the quality of training they receive at the institution or schoolhouse should be of high importance to instructional designers (IDs).

Pertaining to making certain ID decisions, a study of practitioners emphasized the difference between design prescriptive theories and learning descriptive theories. According to Christensen and Osguthorpe (2004), prescriptive design theory stresses on what instruction should be like; whereas the ID describes the planning and preparation process under instruction. Descriptive theories base training decisions on what fits the particular situation, or context. The focus for this program outcome is on the actual activities by designers in the ID process along with making decisions pertaining to curriculum development. Prior studies have shown that experts seemed to rely heavily on past experiences in addition to solution types such as job aids, databases, template, selection procedures, and other performance support tools (Christensen & Osguthorpe, 2004). Also, studies have shown that designers tend to employ instructional strategies based on their views regarding how people learn.

The ISD / SAT process will be examined along with the characteristics of each phase of the ADDIE process. The importance of resources prior to delivery and implementation of training will also be addressed in this examination, in spite of the recent military budget cuts. The types of resources that directly impact the IPO of military training products are planning, time, funding, and personnel. In order to successfully produce training products at a faster rate than what the traditional model originally calls for, resources should be addressed and accounted for by management, SMEs, and IDs. The education technology aspects of ***CBI, simulation systems, curriculum development,*** and ***adult teaching*** and ***learning techniques*** will be examined in terms of importance associated with each ADDIE / ISD phase.

Research and Analysis of the Question

According to Learmount (2007), the most common reason for aviation accidents is training, or lack of. Research has shown that the lack of pilot judgment and appropriate actions account for nearly 80% of all aviation-related accidents (Learmount, 2007). Therefore, training mechanisms or tools used by learners play a major role in flight safety and performance. With that being said, without the proper planning, budgeting, and hiring of skilled personnel, training may result in a wasted product in terms of costs, efficiency, and development since instruction is not always the solution to problems that occur on the job. As mentioned in the Department of Defense Handbook (2001b), “if a problem is caused by equipment, organizational, doctrinal, and/or other inadequacies, then instruction is not an appropriate solution” (p. 4). The ISD model is the cornerstone that provides answers and solutions to problems that occur in the job environment.

Although planning is not one of the phases in the ISD process, it is the key to ensuring that training events and functions are carried out. The system functions of the ISD model are listed below (Department of the Air Force, 2002a).

- *Management.* This function involves directing /controlling the instructional system and its operations.
- *Support.* This involves maintaining all the parts of the instructional system,
- *Administration.* This function involves the day-to-day processing and record keeping of operations.
- *Delivery.* The function involves the providing of instruction to learners.
- *Evaluation.* This is the central feedback network. There are different levels of evaluation which are formative, summative, and operational. The levels of evaluation will be further discussed in this examination.

The ISD process requirements and procedures as referenced in various Air Force Handbooks may apply for any branch of the military, although training may differ in terms of whether a course or lessons needs to be modified or created. This examination will address the basic fundamentals and functions of each ADDIE phase along with their importance in aviation training and education.

Analysis Phase. The first phase of the ADDIE process, analysis, involves a Front-End Analysis (FEA) along with determining what kind of instruction is needed. The FEA involves conducting analysis in areas such as performance, job, needs assessment, and target audience analysis, such as education, demographics, and prior knowledge and skills. Also, the purpose and goal of the instruction should be identified during the analysis stage.

Although the system may be revised or updated to best accommodate the training needs of learners, a needs assessment should be conducted: A needs assessment or training needs assessment (TNA) is conducted in order to identify solutions to defined problems (Department of the Air Force, 2002b). In other words, it provides detail on whether the problems are caused by lack of instruction or other factors (e.g., motivation, incentives, equipment defects, etc.). A TNA is the determining factor in whether the ISD process should be pursued or not.

After an instructional deficiency is identified, the factors should be analyzed by the IDs and/or course managers. These areas may vary based on the instructional need and the target audience. They are listed below:

- ***Purpose of Instruction***. In other words, it asks what we want our students in the aviation field to know and do upon completing this lesson, module, or course.
- ***Instructional Goals.*** It is important to identify goals of this module, lesson, and/or or course. What will students be able to achieve out of this lesson of instruction to the job?
- ***Who are the Intended Learners?*** This involves identifying the target learners' background such as demographics, years of education, and experience level on the job. This information provides a basis for identifying the appropriate MOI, media, and learning objectives gathered during the design phases.
- ***Performance and Learning Context***. This factor addresses the types of conditions students will be exposed to in order to achieve the learning outcome. For example, it will need to be identified during the analysis phase as to whether students will be performing skills in a shop area, in a classroom, etc.
- ***Tools and Equipment.*** Provides a description of the type of equipment and tools to be used in the performance and learning context, such as components, actual equipment, simulation systems, etc.

The analysis phase also applies when the ID analyzes the job performance and develops a task list. The job task list is then compared with the knowledge, skills, and abilities of the intended audience or incoming students (Department of the Air Force, 2002a). In the curriculum development field, this is commonly known as a task analysis. A task analysis is defined as "the process of describing job tasks in terms of Job Performance Requirements (JPRs) and the process of analyzing these JPRs to determine training requirements" (Department of the Air Force, 1993, p. 109). In order to successfully determine what instruction is needed for the intended audience, the ID needs to determine the difference between what target learners *already* know and *able* to do and what the job *requires* them to know and be able to do. After it has been determined that instruction is needed to successfully perform their tasks/duties on the job, then the design phases begins.

The ***curriculum development aspect*** examines the importance of MOI/media selection, selecting instructional strategies, developing test items, and creating objectives essential to training during the design phase. During this phase, it is assumed a TNA has already been conducted and an instructional need has been identified. The design phase of the ISD process involves coming up with a detailed plan of instruction. Media and MOI selection are applied at this stage along with creating learning objectives (LOs) and test items. The overall goal of this phase is to create a condition in which learners gain mastery of new material, helping them move from what they already know (Department of the Army, 2012).

Design Phase. During the design phase***,*** it is important to select the most appropriate a***dult teaching and learning techniques*** in order for learning to successfully transfer to the aviation (or operational) environment. Although not all are discussed in detail in this examination, the design phase would typically operate sequentially based on the following events (Department of Defense Handbook, 2001b, pp. 77-78):

- Develop learning objectives (LOs)

- Categorize LOs by learning type.
- Construct the learning analysis hierarchies.
- Identify the student target population prerequisite requirements.
- Review existing materials.
- Develop test items.
- Determine instructional strategies.
- Select the instructional methods to be used.
- Select instructional media.
- Analyze resource requirements/constraints.
- Design lessons.
- Update ISD/SAT evaluation plan.
- Update management strategies.

Development of Learning Objectives. The LOs are examined and identified during the first stage of the design phase. LOs are defined as a "precise statement of the learned capability – skills, knowledge or attitudes (SKA)-a student is expected to be able to demonstrate" (Department of the Air Force, 1993, p. 44). In relation to the SKAs of learners, each LO includes a condition, action, and standard. The action (behavior), condition, and standard are described below:

- The action (or behavior) best describes what the student is expected to perform at completion of instruction (United States Marine Corp, 2004). Typically, in an LO statement, behavior statements are stated in the form of an action verb (e.g., "identify", "perform", "operate", "explain", etc.). Verb usage is dependent on what the student is expected to do upon completion of instruction. See Appendix G for a sample of LO statements and their parts.

- The condition is defined as the situation or context under which the task is to be performed. For example, a condition answers the question based on “what will the student be provided with as a part of their instruction”? Examples of conditions may include a computer workstation, writing utensils, aircraft components (which are specified), and classroom / shop area.
- A standard is typically the last part of an LO and is s the criteria in which performance is considered as acceptable. Standard statements may be measured or stated in terms such as completeness, accuracy, time constraints, rates of performance, or qualitative requirements (Department of the Air Force, 1993). Examples of final parts of an objective include “with 100% accuracy” (accuracy), “45 words per minute” (time constraints), and “without supervision” (criteria for acceptable performance).

During the design phase, the ***adult teaching and learning techniques aspect*** is associated with the instructional strategy recommendations, MOI and media selection process. It is important that the target audience and training needs are already identified at this stage since the recommendations made should accommodate the target learner. For example, it may not be beneficial to a student taking an Aviation 101 course to jump right into a full flight simulator as a part of their training. Therefore, the LOs along with types of MOI and media used may be sequential based on complexity and/or learner experience with the subject matter.

The MOI (or instructional method) is best described as “the process used to deliver the training content and to provide guidance for students to retain the knowledge and skills imparted" (Department of Defense Handbook, 2001b, p. 101). The type of MOI selected is ultimately determines how the students will be instructed. The three types of MOI commonly used in DoD training products are presentation, student interaction, and knowledge application (Department of Defense Handbook, 2001b).

The student interaction (learner-centered) methods are listed below:

- ***Questioning.*** Questioning involves an instructor and/or courseware controlled interactive process used to emphasize a point, stimulate thinking, check understanding, or review material content (Department of Defense Handbook, 2001a).

- ***Programmed Questioning*.** The ***CBI aspect*** of programmed questioning involves a courseware controlled interactive process which systematically demands a sequence of appropriate student responses and may be used directly. Can be done by a classroom instructor or computers – at individual workstations (Department of Defense Handbook, 2001a). This can take place in a classroom or via distance learning.

- ***Student Questioning.*** When students have the opportunity to search for information assigned by a classroom instructor, tutor, mentor, or a programmed computer (Department of Defense Handbook, 2001a). An example of student questioning is when the students conduct research on additional information regarding a question/problem through the Google search engine. Student questioning can be in the form of distance learning or in a classroom. This method examines the CBI aspect.

- ***Discussion.*** This type of method is instructor-controlled and typically takes place in a classroom (Department of Defense Handbook, 2001a); however it can also be done via distance learning, such as Blackboard (***CBI aspect)***.
    - The discussion method also involves the process of sharing information and experiences in order to achieve a learning objective (Department of Defense Handbook, 2001a).

The knowledge application methods applied in blended learning are:

- ***Performance.*** When students interact with objects, data, equipment, other persons, gaming, simulators, actual equipment. Typically supervision takes place by a classroom instructor or a coach (Department of Defense Handbook, 2001a). The ***simulation systems aspect - education technology*** applies for performance-based methods since students typically use simulator-based systems while being supervised.

- ***Case Study.*** A description of a problem situation is given which provokes discussion among students (Department of Defense Handbook, 2001a).

The most common MOI applied in traditional-based instruction include presentation methods, as listed below:

- ***Lecture-Based (formal).*** Instructor presentations and instructor-led discussions in a classroom setting. Formal lectures “involve one-way communication primarily intended for reaching a large audience and typically in a classroom setting.” (United States Marine Corp, 2004, p. 2-44).

- *Demonstrations:* The instructor will verbally explain along with showing the procedures, techniques, or operations of handling certain systems or pieces of equipment (Department of Defense Handbook, 2001a). Videos and clips can also be classified as demonstration.

Media Selection. For the ***adult learning and techniques aspect***, *i*n order to deliver instruction that is cost-effective and suitable to the learner, IDs will need to identify which media is most applicable with the MOI being used. For example, when students are instructed on the fundamentals of corrosion, they are mostly likely using ICW, web-based tools, or slides as a medium. On the other hands, if they are performing takeoff procedures as the training task, the medium may be simulator trainers (or ***simulation systems)***. The section below lists the different types of media, as shown in Department of Defense Handbook (2001b):

1) *Instructor/tutor:* lecturer, demonstrator (most common) and tutor/coach

2) *Audiovisual:* Overhead transparencies, chalkboard, slides, film strips, videotapes/DVDs, tape recorder.

3) *Interactive Multimedia Instruction **(IMI):*** Interactive Courseware (ICW)

4) *Electronic publication:* Technical manuals (interactive or electronic)

5) *Electronic testing***.**

6) *Simulation:* Virtual Reality or higher level ICW

7) *Electronic management systems:* Electronic Performance Support System (EPSS), CAI, Learning Management System (LMS), electronic job aids

8) *Digital or printed materials.* Workbooks, study guides, job aids, training manuals, programmed instruction booklets, technical orders

9) *Trainers:* Simulator trainers, platform trainers, a combination classroom/platform and component and simulator (or hybrid trainers)

10) *Advanced Distributed Learning (ADL) products*: On-line (e.g., Internet, intranet, extranet, etc.), web-based (asynchronous and synchronous instruction) – online or offline, CD-ROM, DVD, Broadcast television (including cable and satellite), video /audio conferencing

Test Items. Another step in the design phase is developing test items. The intent of providing tests are to identify any problems or weaknesses in the instruction and assess student's achievement of the LO (behavior). The testing method (type) should match the student's learning outcome. For example, multiple choice tests are more appropriate for intellectual learning; whereas, matching may work best for conceptual learning. Also, a performance test is best for aviation students when motor skills are used upon assessment. The types of test most commonly used in aviation training are as follows (See Table 1)

Table 1

Test Type	**Learning Outcome**
Multiple Choice	Intellectual (Discrimination)
True/False (not always preferred)	Intellectual (Discrimination)

Labeling	Intellectual (Concepts)
Sorting	Intellectual (Concepts)
Matching	Intellectual(Concepts)
Essay	Verbal
Fill-in-the-Blank	Verbal
Performance-based	Motor skills
Observations	Attitudes

Instructional Strategy (IS). Determining the instructional strategy (IS) typically occurs once the MOI and media have been selected in the design phase. IS consists of the activities which support each recommended media/MOI types. For example, if the media selected was an ICW Level 2 and the MOI was demonstration, then the most appropriate IS may be programmed instruction (Department of Defense Handbook, 2001b). Below is a sample of the strategies most commonly applied in Air Force training development (Department of Defense Handbook, 2001b):

- *Programmed Instruction* – for training using trainers or computer-aided or ***computer-based instruction***. Some examples are ICW, training devices, and Aircraft System Maintenance Training (ASMT).
- *Traditional instructor-led classroom instruction* (or lecture-based**)**. An example is teaching by an instructor, with a lesson outline, whether scripted or unscripted.
- *Exercise, experiential, or experimental instruction* – Some examples are training scenarios/exercises, learning content based on previous experience or trial-and-error type training.

- *Small group instruction*
- *Peer/group instruction*
- *Mentor or apprenticeship instruction*

Development Phase. The third phase of the ISD/SAT process is development - which is also critical to the ***curriculum development*** aspect. Although the steps included in this phase may vary based on each need in the aviation training environment, they are as follows:

- ***Step 1: Prepare a Plan (or Program) of Instruction (POI).*** This is also known as the course syllabus or instructional management plan. POIs are typically arranged or sequenced by units or modules of instruction (Department of the Air Force, 1993). Although POIs vary in formatting based on the training development organization, below is what they typically include:
    - *Description of course*
    - *Lesson and Course goal*
    - *Instructional media*
    - *MOI*
    - *Materials, tools, equipment used*
    - *Facilities*
    - *LOs*
    - *Sequence of lessons*
    - *Lesson numbers*
- ***Step 2: Instructional Materials Development.*** This step includes development of instructional materials. They may include: print-based materials, slides/tapes, audio /video tapes, ICW, CBT, IMI, videos, practical exercises, and scenarios.

- ***Step 3: Install Instructional Information Management System***. This step may or may not occur in all training organizations; however, this is an important step since it involves an operating system which stores instructional content and needs to be maintained for proper documentation and usage.
- ***Step 4: Update ISD Evaluation Plan.*** The focus is performing quality improvement (QI) procedures on a continual basis for each phase. QI is referred to the processes and products which are "continuously assessed for quality with emphasis on how well they meet the users' needs" (Department of the Air Force, 1993, p. 7).
- ***Step 5: Update ISD Management Plan.*** This entails the updating of milestones and continuing to managing and maintaining the management systems and instructional systems process.
- ***Step 6: Validate Instruction.*** This is to identify any deficiencies in the instruction prior to implementation. Some forms of validation include internal reviews, individual/small group tryouts – which are a part of formative, summative, and operational (field) tryouts (Department of the Air Force, 1993).
- ***Step 7: Finalize Instructional Materials.*** Finalize materials prior to implementation to ensure accuracy and completeness.

Implementation Phase. The fourth phase of the ISD/SAT process is implementation which occurs once the instructional system has been designed and developed along with the completion of the evaluation processes – formative and summative evaluation (Department of Defense Handbook., 2001b). Also, this phase takes place when the instructional system is executed; therefore, it is operating under normal conditions. This phase also focuses on ensuring quality improvement (on a continual basis) of the instructional system, operational, internal, and external evaluations, along with providing feedback periodically (Department of the Air Force, 2002).

Evaluation Phase. The fifth phase of ISD does not occur on a "one-time" basis. Evaluation is a continuous process which begins from analysis and continues on throughout the life cycle. The primary types of evaluation commonly used in aviation training development along with other DoD products are operational, formative, and summative. The table below describes them in further detail:

Table 2: Types of Evaluation	
Formative	Also known as an internal evaluation. This occurs when the process of the program activities is still forming and being evaluated "Types of Evaluations in Instructional Design," n.d.). Also, this type of evaluation occurs *throughout* the lifecycle of the ISD/SAT process. The key events during formative are validation (final activity of "trying out" instruction with small groups) and quality control (QC) which occurs *throughout* the ISD phases.
Summative	Also known as external evaluation. This type of evaluation is described as a "method of judging the worth of a program at the end of program activities. The focus is on the outcome" ("Types of Evaluations in Instructional Design," n.d., para. 4). The target audience is exposed to the delivery of instruction at this stage. Summative evaluation also occurs once formative evaluation activities are complete.
Operational (or Field Tryouts)	This evaluation is conducted periodically to ensure that the course being offered produces graduates that are able to meet job performance requirements successfully (Department of Defense Handbook, 2001b)

Method

Methodology

Hypothesis Formulation. The hypothesis is that resource limitations in curriculum development will result in decreased performance of Air Force personnel in the operational environment.

The research questions are addressed below:

<u>Primary Research Question:</u>

- Will resource limitations result in decreased performance of Air Force personnel in the operational environment?

- What role does the knowledge of adult learning theory versus access to resources play in making ISD decisions? What resources are used in order for IDs to make sound decisions which affect quality in a positive manner? What resources are used to update design decision-making? (New strategies and ideas)

<u>Secondary Research Questions:</u>

- How often is different information sources (resources) used in developing curriculum products?
- How frequently are theories used as a basis for making instructional design decisions?
- How frequently is design strategies used as a basis for making instructional design decisions?

- What are some of the flexibilities involved in producing TSPs using the ADDIE model given the following constraints: lack of sufficient time, lack of sufficient resources (i.e., subject matter experts and instructors), and shortage of staff?
- Due to recent military budget cuts, will the ADDIE model still be considered as a useful tool in producing training support packages (TSPs) in Air Force education?
- Is flexibility of the ADDIE process solely dependent on the clients' needs? How does this impact its uses along with the quality of training products?

Research Design. A research study was conducted for 113 instructional designers (IDs) which consisted of surveys conducted via web to determine how frequently they used ID theories as compared to certain resources / design strategies (Christensen & Osguthorpe, 2004).

- *Subjects in the Study.* A random sample was used with recent graduates in ID from Brigham Young University, Florida State University, Indiana University, San Diego State University, and Utah State University. Since every other e-mail address for each of those lists was used for the study, a total of 256 alumni were surveyed (Christensen & Osguthorpe, 2004).

First Section of Survey - Demographics. Some questions asked in the study were "what was the highest degree earned in instructional design?", "what area is the percentage of your instructional design experience spent in?" The areas that respondents were to select from included K-12 education, vocational/adult education, higher education, military, or other (Christensen & Osguthorpe, 2004). Also, respondents were asked where they completed their ID training.

Second Section of Survey. The survey was based on a 5-point scale and asked respondents how often they used each of the 12 design strategies. The rating was selected based on *never, almost never, sometimes, often,* and *very often.* Each statement (design strategy) is listed below which determines the instructional strategies that IDs applied to develop their training products – along with how often these strategies were applied. As mentioned in Christensen and Osguthorpe (2004), the 12 ID strategies are listed below:

- Brainstorming sessions with other instructional design project members.
- Comparison of current situation to others; adapt strategies which proved effective in similar cases.
- Adapt and modify useful instructional strategies that others have used.
- Brainstorming of ideas based on goals and objectives presented.
- Nontraditional activities: job aids, performance tools, incentives, and selection procedures.
- Consultation with SMEs (or content experts) to get ideas.
- Follow previous instructional template.
- Follow other forms of successful instruction having similar goals and objectives.
- Use of descriptive (learning) theories / research.
- Use of specific prescriptive (instructional design) theories / research.
- Consult with others learners for ideas (ones using the same instructional strategies).
- Follows existing instructional template.

Third Section of Survey. This section focused on asking respondents regarding how often each information source was used towards learning new instructional theories or strategies.

Fourth Section of Survey. In this section, contrasting statements were used in a 5-point Likert Scale format. An example question used in this survey was, “I’m most concerned about teaching accurate representations of knowledge" versus "I'm most concerned about teaching knowledge that is personally meaningful and useful" (Christensen & Osguthorpe, 2004). The questions were target to and answered by mainly experts/practitioners in the field, *not* ones who went through schooling, but did not pursue a career in ISD.

Data Collection Procedures. The number of respondents was based on the following data (Christensen & Osguthorpe, 2004):

- Ones who actually perform instructional design as a part of their job (e.g., upon graduation, some pursue careers unrelated to ID).
- Therefore, the actual count of respondents who reported to work in an instructional design setting was 32%, or 82 designers, out of 256 total surveyed
- The 32% of respondents pertained to direct contacts who attended Brigham Young University, Florida State University, and Utah State University.
- The number of ID practitioner participants in the indirect contact group (ones who finished the survey) was approximately 28.
- The total number of respondents was 113.
- Out of the total number of responses, 69% reported that they received their master's degree, 30% for doctorate, and 1% with no degree indicated.

Results. Out of the total number who completed the survey and work in an instructional design setting, the largest percentage of ID experience fell in the business/industry field at 46%, with higher education being the second (32%). The percentage of respondents reported as performing ID work in a military training setting was 13%, right under K-12Education - 17% (Christensen & Osguthorpe, 2004). These percentages are considered as an important factor in the study since instructional designers having experience in certain fields may rely on more on adult learning theories rather than resources in making training development decisions.

The most frequently used design strategy was brainstorming techniques with other instructional designers in the project group. Although this strategy was reportedly used by 86% of respondents, approximately half of them also reported using specific theories – both learning and instructional design – to make instructional strategy decisions (Christensen & Osguthorpe, 2004). These percentages were tallied by researchers according to the number of *very often* and *often* responses.

An interesting factor from this study is that 20% of the survey respondents also added comments to strategies not mentioned (Christensen & Osguthorpe, 2004). Based on the comments listed, the results seem to indicate that a mix of resources and research are applied with making certain curriculum design decisions. The survey comment most frequently mentioned was 'staying current on research and best practices in related fields'. Other comments included:

- *Strategies Prescribed by Others*
- *Trial & Error Approach*
- *Instructional Strategy Bias* – base decisions on most relied strategy
- *Needs Assessment Emphasis*
- *Trial & Error Approach*
- *Re-purposing Materials*
- *Performance Engineering*

The survey results indicate that decisions may result from other “recycled” or “reused” products (i.e., previously applied decisions, processes, and procedures); therefore, possibly affecting the training products delivered to aviation students along with the task outcome.

Instructional Design Theory Usage. The results indicated that although IDs applied more than one instructional design theory towards making curriculum development decisions (total number of respondents in this category was n=59), the frequency of the ADDIE instructional model was only 7. The instructional design theory with the highest frequency level was Gagne/Gagne, Briggs, &Wager (Christensen & Osguthorpe, 2004). Another familiar theory is the Dick & Carey theorist model which had a frequency of 12. The theory having the second highest frequency of 16 was Component Display Theory (CDT) - M.D. Merrill. CDT is described as learning based on content and performance and centers on learner control; therefore, students/learners may select their own instructional strategies based on the two dimensions of CDT which are content and performance (Merrill, n.d.).

Learning Theory Usage. It was shown that over 50% of respondents reported using more than one theory in terms of making ID decisions. The types of learning theories as noted in the questionnaire are listed below:

- *Constructivism, Social Constructivism*. Constructivism is defined as a learning theory which is based on observations about how people learn in addition to their own understanding and knowledge through experiencing things and then reflecting on those experiences (“Constructivism as a Paradigm for Teaching and Learning,”2004). In other words, learning new information is stated to be more effective if the student has the ability to link it to previous experiences.

- *Cognitive Theories***.** These theories include: brain-based learning, information processing theory, schema theory, cognitive load theory, learning orientation research, and acquisition of expertise (Christensen & Osguthorpe, 2004).
- *Instructional Theories.* Instructional theories were also listed above on the learning theories frequency count; however, were also totaled in this section due to a research error – the proper distinguishing of learning theories, instructional theories, and instructional templates.
- *Motivational Theories.* Keller's ARCS Model and self-regulated learning
- *Behaviorism.* Behavior Management and Bloom's Taxonomy
- *Andragogy Theories.* These theories include experiential learning, action learning, and Malcolm Knowles's theory of adult learning.

Although it was shown that the ADDIE model had a low frequency, the use of instructional templates included development models; therefore, it may be used more often than the results indicated. This was due to confusion on the meaning of a template.

Information Sources. Information sources are classified according to how new instructional design theories and strategies are discovered or learned. The average number of respondents for this category was n=105 (Christensen & Osguthrope, 2004); although, rounding errors occurred on some of information sources. In addition, the number of IDers who reported using any of the nine strategies regularly is based on the *"often"* in addition to *"very often"* responses, which are accounted. The nine sources are listed below (Christensen & Osguthorpe, 2004):

- *Interactions with peers or coworkers*. This had the most responses, "as 81% of the respondents reported regularly using this information source" (p. 14). Also 0%

reported *never* having used this particular resource. Therefore, it indicates that interaction is one of the key areas into developing a successful training product.

- *Instructional design textbooks.* The respondents reporting using these were 51%.
- *Internet sites.* The number of respondents reporting using these on a regular basis was 48%.
- *Professional journals and magazines.* The number of respondents reported using these on a regular basis was 48% .
- *Books/journals written by other ISD field professions.* These were reported to be used 6% less of the time than sites and journals/magazines (42%).
- *Education/teaching methods or textbooks/trade books.* Used regularly 33% of the time.
- *Professional conferences.* Conferences (e.g., annual, bi-annual, etc.) were used regularly reported by 28% of participants (n=103).
- *Educational psychology textbooks.* About 23% of respondents reported using this source regularly.
- *Internet forums.* These were used regularly by the least amount of respondents (19%).

Objectivist and Constructivist Philosophies. Using a 5-point *continuum scale*, the percentage of respondents is shown based on their preference between an objectivist and constructivist philosophy. The objectivist view states that if students simply repeat what is taught, then learning is successful ("Constructivist vs. Objectivist Theories of Learning," n.d.). A constructivist view states that learning is best applied to each individual's experiences and background.

This scale shows the percentage of respondents who agree with each statement listed pertaining to each of these philosophies. The total number of respondents was n=106.

These percentages are listed on the following table (Christensen & Osguthorpe, 2004):

Table 3: Objectivist and Constructivist Philosophies	
Objectivism (teacher-centered) Statements	**Constructivism** (student/learner-centered) Statements
Teaching accurate representations of knowledge: 26% of respondents leaned towards this viewpoint.	*Teaching knowledge that is most personally meaningful and useful:* 45% of respondents leaned towards this viewpoint.
Finding better ways to transfer knowledge for learners to use: 45% of respondents leaned towards this viewpoint.	*Creating environments where learners can build knowledge based on own and/or previous experiences.* 29% of respondents leaned towards this viewpoint.
Specifying goals and objectives are essential and best represent a content area: 36% of respondents leaned towards this viewpoint.	*Determining how the learners' intentions and experiences relate to goals of the instruction:* 40% of respondents leaned towards this viewpoint.

Summary

It is shown that the overall curriculum development process is more group or team-focused; therefore, a scarcity of information sources may negatively affect the quality of training provided for Air Force personnel. The importance of this study was on what instructional designers perceived as being the most effective instructional method(s) in addition to the information sources applied to curriculum development. This research also included each respondent's views, applying an objectivism versus constructivism approach. A constructivist view focuses more on learning created by individual students and is learner-centered; whereas an objectivist view focuses on transfer of learning from the teacher to student (teacher-centered). These views may impact how training is conducted. For instance, if curriculum developers focus primarily on accuracy of technical content; lectures may be the central focus of instructional delivery. This in turn, may not be feasible for students who need to perform troubleshooting procedures on a CH-53 engine following performance-based evaluation. However, learning should not be so unstructured in which recalling of brand new subject matter is too challenging for aviation students. Although it was shown that the percentage of respondents who reportedly applied the ADDIE model was lower than expected, overall, most IDers may not realize they are utilizing this process as a part of curriculum development. To ensure effective design and delivery of instruction, the focus should not only be on classroom instruction, but also on technology tools and performance-based MOI (e.g., scenarios, case studies, and learning tied directly to previous experiences).

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Appendix A

Level 1 Failure – Unsafe Acts

Table 1, Unsafe Acts (Level 1) – Errors Category	
Types of Errors	**Description/Example**
Skill-based	• Inexperienced technician; • Working on too many complex tasks at once; • Lack of task prioritization; • Inattentiveness to tasks requiring concentration; • Improper use of equipment
Perceptual	• Misjudgment of detecting an engine parts' correct location; • Misinterpretation of performing an inspection; • Leaving a fuel cap unsecured upon completing an oil change; • Constant distraction during task performance; • Failure to properly follow all the checklist points of performing an aircraft inspection
Decision	• Excessive time spent on one task; • Abnormal situation in the aircraft with wrong decisions made

Table 2, Unsafe Acts (Level 1) Violations Category
• Failure to follow safety orders/procedures • Skipping / taking shortcuts on mandatory inspections • Improper installation • Improper use of equipment • Improper use of equipment • Leaving hazardous items unsecure and unattended

Appendix B

Level 2 Failure – Preconditions for Unsafe Acts

Table 3, Preconditions for Unsafe Acts (Level 2)

Category 1 - Substandard Conditions of Operators	**Description/Example**
Adverse Mental States	• Lack of mental preparation • Complacency (self-satisfaction of the situation) • Lack of situational awareness (SA)
Adverse Physiological States	• Visual illusion • Spatial disorientation (mainly pertains to pilots/operators of aircraft) • Physical fatigue • Taking over the counter medication which may impair the operator/technician's decision-making ability (i.e., lack of sleep drowsiness, and overmedicated)
Physical/ Mental Limitations	• **Mental limitation**: The time required in performing a task(s) is shorter than the worker's ability to efficiently complete the task; therefore, productivity and quality is lower. • Inability to process information • **Physical limitation:** Physical abilities are incompatible with equipment / tools

Table 4, Preconditions for Unsafe Acts (Level 2)

Category 2 - Substandard Practice of Operators	**Description/Example**
Crew Resource Mismanagement	• Lack of teamwork/poor coordination among crew personnel • Lack of communication among aircrew personnel
Personal Readiness	• Using poor judgment in preparation for work (i.e., eating an unhealthy lunch prior to task performance and/or lack of sleep)

Appendix C

Level 3 Failure – Unsafe Supervision

Table 5, Unsafe Supervision (Level 3)	
Unsafe Supervision	**Description/Examples**
Inadequate Supervision	• Lack of providing adequate training to aircrew personnel • Lack of professional guidance from supervisor to the worker
Planned Inappropriate Operations	• Improper crew pairing: pairing a senior aircraft technician with a “novice” or new technician to perform highly complex maintenance tasks
Failure to Correct a Known Problem	• Supervisor is aware with certain deficiencies of individual workers and equipment/tool defects; yet no corrective action is taken
Supervisory Violations	• Failure to enforce rules and regulations of crew workers • Failure to acknowledge qualifications and license requirements (i.e., hiring a technician with an expired license/certificate)

Appendix D

Level 4 Failures – Organizational Influences

Table 6, Organizational Influences (Level 4)	
Organizational Influences	**Description/Example**
Resource Management	• *Training* - Cost-cutting of the organization results in lack of sufficient training and decreased safety levels • *Equipment* – Less expensive equipment may be used; therefore, the quality is lower • *Workers* – less skilled aviation maintenance technicians; chances for missed items/errors occurring are much greater
Organizational Climate	• Structure of the organization • Policies implemented by the organization • Organizational culture which includes: norms/values and beliefs. Culture is defined as the "unofficial or unspoken rules, values, attitudes, beliefs, and customs of an organization" (HFACS, pg. 17).
Organizational Process	• Operations (e.g., how are quotas, time lines, incentives handled?) • Organizational procedures • Use of Standardized Operating Procedures (SOPs) • Adequacy of scheduling workers • Monitoring of risks due to mishaps

Appendix E - Acronyms

Advanced Distributed Learning (ADL)

Advanced Imaging Technologies (AIT)

Air Cargo Advance Screening Pilot (ACAS)

Aircraft System Maintenance Trainer (ASMT)

American Civil Liberties Union (ACLU)

Analysis, Design, Development, Implementation, and Evaluation (ADDIE)

Aviation Maintenance Technicians (AMT)

Aviation and Transportation Security Act (ATSA)

Behavior Detection Officers (BDOs)

Computer-aided Instruction (CAI)

Computer-assisted Passenger Prescreening System (CAPPS)

Computer-Based Instruction (CBI)

Computer-Based Training (CBT)

Crew Resource Management (CRM)

Department of Homeland Security (DHS)

Electronic Performance Support System (EPSS)

Explosive Detection Systems (EDS)

Explosive Trace Detection (ETD)

Explosives Trace Portal (ETP)

Federal Aviation Administration (FAA)

Front-End Analysis (FEA)

Government Accountability Office (GAO)

Human Factors Analysis and Classification System (HFACS)

Interactive Courseware (ICW)

Interactive Multimedia Instruction (IMI)

Instructional Designer (ID)

Instructional Strategy (IS)

Instructional Systems Design (ISD)

Instructional Systems Design/Systems Approach to Training (ISD/SAT)

Instructional System Developer (ISD)

Knowledge, Skills, and Abilities (KSAs)

Learning Management System (LMS)

Learning Objectives (LOs)

Master of Aeronautical Science (MAS)

Method of Instruction (MOI)

Minimum Equipment List (MEL)

National Aeronautical and Space Administration (NASA)

Naval Air Warfare Center Training System Division (NAWCTSD)

National Institute of Standards and Technology (NIST)

On-the-Job Training (OJT)

Part-task Trainers (PTTs)

Plan of Instruction (POI)

Quality Control (QC)

Quality Improvement (QI)

Skills, Knowledge, Attitudes (SKA)

Screening of Passengers by Observation Techniques (SPOT)

Subject matter experts (SMEs)

Training Needs Assessment (TNA)

Training Support Packages (TSPs)

Transportation Sector Network Management (TSNM)

Transportation Security Administration (TSA)

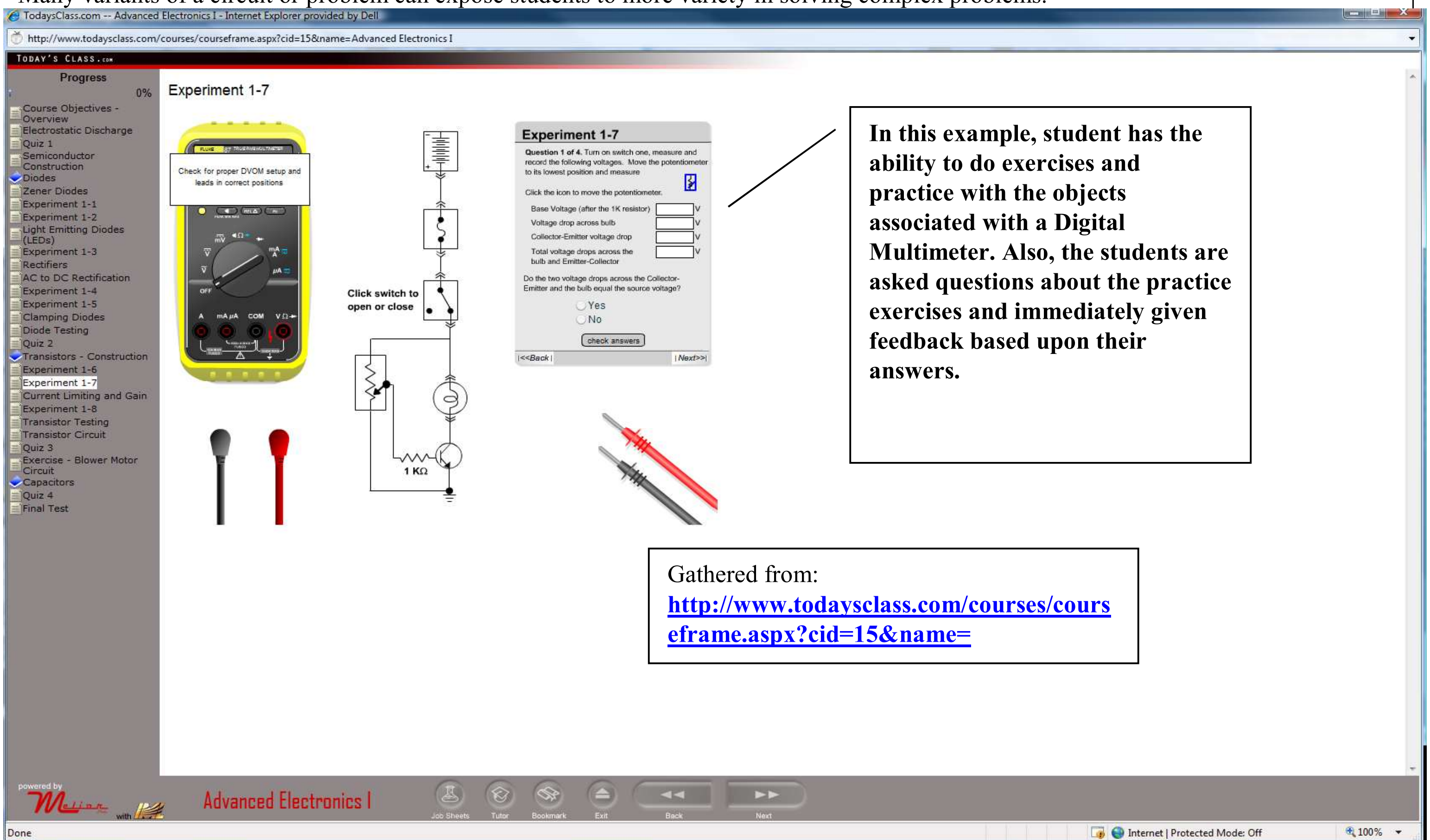
Unit Load Devices (ULDs)

Appendix F

Drill and Practice – Example Illustration

Drill and Practice

- Are commonly used in procedural lessons and ones which require practice exercises by the students.
- Used to reinforce procedures and processes that are used in a classroom/textbook or through computer-based tutorials.
- Students are typically allowed to repeat lessons if answers are incorrect.
- Typically provides immediate feedback based on student responses such as "correct" or "incorrect".
- Many variants of a circuit or problem can expose students to more variety in solving complex problems.



In this example, student has the ability to do exercises and practice with the objects associated with a Digital Multimeter. Also, the students are asked questions about the practice exercises and immediately given feedback based upon their answers.

Gathered from:
http://www.todaysclass.com/courses/courseframe.aspx?cid=15&name=