INSTRUCTIONAL FEATURES AND THE USER

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Abstract

Flight simulators play a key role in the training of military aircrew. They provide an environment in which the aircrew may train and practice procedural and flight tasks under the close observation of qualified instructors. The instructor is responsible for controlling the training event, evaluating performance, and providing feedback. As training requirements increase and simulators become more complex, so does the task of operating and interacting with them. Most of this complexity involves the Instructor Operator Station (IOS), the interface between the instructor and the simulator and between the instructor and the trainee. The quality of training received from these devices depends a great deal on the instructor's ability to monitor aircrew activities. Thus, these devices incorporate instructional support features to aid the instructor, but their utilization is the exception rather than the rule. This is not because instructors are incapable of the task, but because the complexities of operation require substantial training and experience in order for these features to be used effectively.

This indicates a failure to properly analyze the task of the instructor in designing the IOS around his needs. The purpose of this paper is to provide a general overview and discussion of instructional features from a user's standpoint. The intent is not to document the merits of instructional features, but provide insight into user needs. The information presented is based on interviews with simulator instructors and observation of simulator training sessions at numerous Navy and Air Force simulator training facilities.

Introduction

Flight simulation technology has kept pace with the ever increasing advancements in military aviation. However, most recently the instructor has become overloaded and undertrained in the operation and training application of some of the more complex simulators. This situation has evolved as the result of the changing role of the simulator instructor over the years combined with dramatic advancements in technology. This paper presents a brief history of how this situation evolved and suggests the first steps toward a solution.

Background

One of the first major training applications of the simulator was instrument flight training. The student was taught the dynamics of aircraft control using flight instruments as his only reference. The simulation was basically a generic system which provided the dynamics of flight controls. Basic instrument flight skills were monitored by a set of duplicate flight instruments mounted on the simulator control console. The instructor's main role was to provide immediate feedback with respect to the student's ability to fly basic instrument patterns. In most cases this instructor was a simulator specialist and the student gained most of his instrument skills from practice.

A noticeable change in simulator requirements came with the jet age. Not only did things happen more quickly in the cockpit, but the aircraft systems became more complicated with high pressure hydraulic flight control systems, stability augmentation systems, complicated fuel systems, etc. As a result, cockpit procedures became more complex and demanding. To meet these additional training requirements, simulators had to incorporate aircraft specific design. Cockpit and control response fidelity became important, and the role of the instructor required that he have knowledge of the actual aircraft. Thus entered the flight instructor. The simulator console took on an expanded role and became the Instructor Operator Station. The design of the IOS used actual aircraft instrumentation and layout as a criteria. The flight instructor used his familiarity with the layout to monitor student performance. So far so good. The instructor became familiar with and accepted this type of device with little more than some "on-the-job" training. He could effectively control the exercise. The variables pertained to fairly straightforward environmental conditions, and the procedures trained were structured and standardized as they had evolved essentially as extensions of flight-line procedures.

A recent noticeable change in aviation came with the advancements in computer technology. The digital computer became more powerful, compact, and economical. Aircraft and weapons system design benefitted from these advancements. Aircraft systems have been simplified with respect to pilot procedures. Cockpit instrumentation and controls have been designed using the latest in human factors engineering. In general, the pilot's workload with respect to flying the aircraft has decreased. However, the military pilot's workload with respect to successfully accomplishing a mission has not. The sources of information to monitor and the number of decisions the pilot has to make have dramatically increased. Aircrew duties in the cockpit are slanting more toward data monitoring and management. Interaction with the aircraft and weapon systems is through a computer interface rather than the direct manipulation of controls.

The simulator industry has also taken advantage of computer advancements. Simulation is now capable of creating the total environment for full mission training. The pilot may now be exposed to "smart" adversaries and make decisions based on dynamic "real world" scenarios with all of the resources and data presented to him with precise fidelity. However, problems have recently arisen. The complexity of control and evaluation in simulator training has progressed far beyond the traditional methods of flight line and flight instruction transfer. Recent studies and surveys conclude that the total training effectiveness of

the more recently designed simulators (especially WST's) is poor[1,2,3]. The systems are not being used effectively nor to their fullest extent. Instructors find the IOS difficult to use. They claim the IOS is too complicated and the information required to conduct an exercise and evaluate student performance is either not available or too difficult to find. The simulation engineers claim that all the features have been designed, developed and tested in accordance with specifications. Instructional personnel claim that formal and extensive training is required to properly utilize these devices. Operational commanders claim that they can't afford the time to train simulator instructors.

A solution to this problem has been to apply the advancements in human/computer interface technology to develop a more functionally useful IOS. The increase in computational power and performance/cost ratio means that an increasing amount of the computational resources are now available to be applied to the instructor/simulator interface. The new devices are now using state-of-the-art in IOS design (e.g. multi-function CRT's, light pens, touch panels, etc), and a greater percentage of the computational power is being allocated to instructional features. However, there still seems to be a lacking ingredient to successfully implement these advancements.

Identifying the Instructor Needs

Just as modern training systems are dependent on a thorough analysis of the student training requirements, and modern cockpit design is dependent on human factors engineering and analyses, this approach also depends on an analysis of the primary user's needs. It depends on the tasks and functions the instructor will be required to perform.

Aircrew training devices may be conceptualized as consisting of two main components: the simulation system and the instructional system. The simulation system provides the capability to replicate the training environment, while the instructional system transforms the simulator into a training device. The goal of the instructional system is to increase the instructor's efficiency and effectiveness by providing instructor support features and thus reducing the instructor's workload. This workload includes such tasks as student briefing, exercise preparation, simulator control, performance measurement and recording, and student performance feedback both during training and during debriefing. Instructor support features can be designed to aid the instructor in all these tasks. The combined set of these features makes up an instructional support system. A properly designed instructional system facilitates training and allows the instructor to devote more attention to providing personal, high quality, one-on-one instruction, rather than dividing his time among the student and countless other required activities.

Most simulator specifications have been developed as part of the Instructional Systems Development (ISD) process. The training analysis conducted as part of this process addresses the student interface with the training device, not the instructor's. Training device characteristics are based on specific operational tasks to be trained, but do not consider functional requirements of the instructor. The resultant IOS may be inappropriate for the application and may be difficult and cumbersome to use. Many instructor support features on such systems are seldom, if ever, used.

Interviews and on-site observations recently conducted at Air Force and Navy aircrew training sites reveal that with very few exceptions simulator training events follow one pattern[4]. As the instructor conducts the training event, he proceeds through pre-training, training, and post-training functions. Thus a convenient and complete way to analyze instructor functions is to step through the training event from the instructor's point of view.

Instructor Functions

Pre-training requirements are those instructor functions which must be conducted prior to active training on the aircrew training device (ATD). Pre-training requirements include preparing for the training event, simulator set-up, and briefing the student. The requirement to keep the training materials up-to-date and the requirement for instructor training are also included in this category.

The training requirements phase includes those functions performed to accomplish the training activity. The instructor's support needs will depend on the ATD configuration, instructor location, level of training and the training task to be performed. These support needs are generally expressed in terms of control and informational requirements, and are a key factor in the effective design of the instructor station. Training requirements include controlling the simulation, monitoring student activities, instructing the student, and evaluation.

Post-training requirements are functions performed to complete the training event. These functions include debriefing the student and recording grades.

An analysis of instructor requirements should step through the functions in each phase. These functions are described below along with common problems observed for instructors performing the function.

Instructor Training Function

Instructors require formalized initial training on the effective utilization of the device, and a capability to refresh this knowledge at periodic intervals. Several surveys have shown that instructional support features installed in ATDs are often not used because instructors either do not know the features are present, or how and why to use them. It was noted that "casual" users (i.e. operational squadrons) and qualified instructors who have not utilized the device for prolonged periods, have no acceptable means of quickly refreshing their knowledge. Instructor handbooks do not provide system documentation which is relevant to the effective accomplishment of training.

Prepare Function

The instructor must be familiar with all aspects of the planned training event prior to briefing the trainee. This includes a review of the event description, specific training objectives, performance criteria, procedures to be followed, and current status of the ATD. Trainees' records should be reviewed to determine training progress and to diagnose any aspects of performance

which may affect the current training event. This process is necessary so the instructor can plan how the training event will be conducted, identify control requirements, training methods, and possible event tailoring to meet the needs of the trainee.

Training Set-up Function

It has been observed that training set-up is normally performed at the IOS at the start of the training event. This activity is generally time consuming, and involves the instructor's complete attention to access information, enter data and configure the IOS for the upcoming training event. These administrative tasks are performed at the expense of valuable training time, and occasionally concurrent with student training activities in the cockpit. The instructor requires the capability to minimize the training set-up requirements at the IOS.

Develop Training Function

The instructor not only needs the capability to tailor training to meet the student's needs, but must be able to develop new training scenarios to meet operational requirements. In order to maintain an up-to-date training program, the means to develop new training objectives, e.g., to meet changes in aircraft equipment, and defined mission requirements should be provided in a convenient and timely manner.

Brief Function

The training effectiveness of any system is directly related to the quality of the briefing. The brief sets the tone for the entire training event. Briefing should provide the student with a complete overview of the training event, including specific training objectives, performance criteria and known discrepancies between the ATD and the aircraft. Depending on the level of training, the instructor may be required to discuss common difficulties, specific procedures, techniques, displays and cues which would enhance the hands-on training in the ATD.

Control Function

This function includes control of the content and conduct of the simulation exercise as well as control of the simulator. It was observed that manual control of simulation variables is the method preferred by instructors for most training situations. Automated control is normally used to establish initial conditions and perform some integrated complex scenarios. But even during many complex training events, the instructors maintained control of simulation stimuli. Instructors indicate the need for flexibility to tailor training in real-time, and time to configure IOS displays to monitor and evaluate the trainee's activities. These control procedures can be cumbersome, time consuming and often a distraction to the instructor's primary responsibility of instructing. Careful analysis of training requirements and instructor needs will identify instructor effective and training efficient control options.

Monitor Function

This function refers to the presentation of information required by the instructor. It must be relevant, easy-to-interpret, and readily available. Graphic depictions of scenarios are widely used, but there are noted problems in the display of alphanumeric data. In general, too much information is presented and at a rate that is difficult to interpret. Additionally, displays which depict procedures are rarely used by instructors because they are usually out of date. It is essential that efficient update features be incorporated into the devices requiring procedures monitoring displays for instructor support.

Instruct Function

This function involves instructor activities during the training exercise that direct the growth of skills and knowledge of the student while providing feedback in a systematic way. The training analysis identifies what the student must learn and the entry level skill and knowledge base. This information must be considered when defining features to support the instructional capability of the ATD. For example, entry level flight students may benefit from various types of parameter freeze options, while such options other than a basic freeze function would not be required for experienced aircrews in advanced training.

Evaluate Function

The values of specific parameters must be observed and evaluated to determine if specific criteria are being met. In more complex training scenarios, the number of parameters, the speed with which they change, and the dynamics of the war gaming may far exceed human capability to observe and properly evaluate. Effective evaluation may require automated measurements of those parameters which are difficult, if not impossible, to humanly interpret in real time. The resulting information should be presented in a meaningful, easy-to-interpret format.

Debrief Function

A very important part of training is student feedback which must be provided during the training event and during the debrief. Immediate feedback is necessary during the simulator event especially for training motor skills. During debrief the instructor summarizes student performance, identifies problem areas and recommends corrective action for subsequent training. In many cases the instructor relies on hand written notes and his memory to support the debrief function. This method can be cumbersome, detract from the active training session, and possibly cause the instructor to miss or omit key training points. Hardcopy printout is available on many devices. However this feature is seldom used because the design falls short of meeting instructor debriefing requirements.

Conclusion

As previously stated, simulation technology has kept pace with the increasing complexity of aircraft systems, weapon systems and the tactical training environment. Due to many factors such as operating cost, security requirements, available assets and operating areas, more and more demands will be placed on simulators (WST's) to develop tactics and create the environment where judgmental training plays a major role. It is our opinion that the current gap that exists between the simulation and instructional systems will continue to broaden unless more emphasis is placed on the needs of the instructor.

This paper does not provide the ultimate solution to the complexities of IOS design and instructor simulator interface. Rather, it has identified a few of the necessary characteristics of the solution. The simulation system has been successfully designed around student requirements derived from a formal analysis process. This paper proposes that the design of the instructional system be based on instructor requirements derived from a similar formal analysis process.

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